Role of Farmers' Personal Values in Soil Fertility Management Decisions: Evidence from Means-End Chain Analysis of Peri-urban Leafy Vegetable Production in Kenya

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Abstract

Peri-urban areas play a major role in the supply of vegetables consumed in urban areas. In order to meet high demand for aesthetic quality characteristics, peri-urban farmers use intensive production practices characterized by use external inputs. This paper uses Means-End Chain analysis approach to examine the role farmers' personal values play in the decision to use soil fertility improvement inputs namely, animal manures (organic fertilizer) and inorganic fertilizers. It found that use of animal manures and inorganic fertilizers was driven by the need to earn higher profit margins thus making more money in order to meet family needs. This in turn met farmers' personal values relating to, among others, happiness, leading a comfortable life, independence and healthy life. The major implication of these findings was that farmers' private goals could, with the urging of the market that demands unique aesthetic quality characteristics, promote intensive applications of both the organic and inorganic inputs with potential negative environmental consequences.

Key words: Peri-urban vegetable farmers, manure and fertilizer use, personal values, means-end chain approach

1. Introduction

The increase in urban populations in many developing countries has led to a rise in demand for food. Similarly, increased in incomes and consumer concerns with health have led to growing demand for non-staple foods especially vegetables (Okello and Swinton, 2010). The peri-urban areas, due to close their proximity to urban markets have become important sources of fresh vegetables consumed in urban areas (Nyamwamu, 2009). In Kenya, cultivation and sale of leafy vegetables in the peri-urban areas, is an important source of income to many smallholder farmers (Oduor et al. 1998). However, declining soil fertility resulting for continuous cultivation threatens to productivity of the tropical soils (Dechsel et al. 2004). Transfer of soil nutrient through the harvesting of grains, fodder, removal of manure for other purposes and biological process such as volatilization. These losses are likely to disrupt nutrient balances that ensure sustainable agro-ecosystem (Jabbar et al. 1995). Livestock play a significant role in stabilizing farming systems by providing manure which is a valuable resource in replenishment of soil fertility (Wanjiku and Manyengo, 2005; Saleem, 1998). Peri-urban farmers use nutrient management strategy that is characterized by a trade-off between animal manure and chemical fertilizers and, has agronomic, economic and environmental advantages and disadvantages. A recent study found that 72% of peri-urban vegetable farmers use animal manure in leafy vegetables as a way of soil fertility management (Kutto et al. 2011).

Peri-urban vegetable production systems are often characterized by intensive use of fertilizer and manure (Nugent, 2000). Livestock manures (both solid and slurries) and chemicals fertilizers are applied to leafy vegetables to meet crop nutrient requirements, improve soil fertility and increase farm productivity and profitability (Wanjiku & Manyengo, 2005). The utilization of fertilizer may however result in accumulation of nitrates and heavy metals in the leafy vegetables which may pose health risks to consumers. These risks can be exacerbated by naturally occurring and heavy metals introduced via human activities. Karanja et al. (2011) for instance found that there was high concentration of nitrates and nickel in kale produced in peri-urban areas of Nairobi where high rates of manure use were reported. A recent study has found evidence that some of the animal manure applied in such areas contained microbial pathogens such as E.coli O157, Salmonella, Listeria, Campylobacter, Cryptosporidium and Giardia in some of the samples which may cause food borne illness (Kutto, et al. 2011). Presence of nitrates or

Arsenic concentrations and pathogenic microorganisms in plants is a primary risk to human health (WHO, 2006). The management and handling of livestock manures, particularly the length of time and how they are stored are important factors that determine the pathogen loads and the likelihood of their contaminating the food crops (Kutto, et al. 2011; Hide *et al*. 2001).

Past studies on drivers of use of fertilizer and manure (the two main soil fertility improvement inputs) have focused on economic and institutional factors such as prices and market, fertilizer provision and distribution, research and credit, etc., agro-climatic conditions and characteristics of the farm or the farmer (e.g. education, age, experience and farm resources). Moreover, most of past and recent studies on fertilizer and manure use have dwelt on adoption and have tended to assume that farmers make adoption decisions based on utility maximization principle (Zhou et al., 2010). However, no study has examined the inner motivations or drives behind peri-urban farmers' decision to use soil fertility management technologies in the production of leafy vegetables. This study applied a means-end chain approach to investigate the underlying reasons or motives behind farmer use of the two most widely applied soil fertility management strategies namely manures and fertilizers. The specific objective of this study was to determine the relevant attribute-consequence-value relations in farmers' soil fertility management decisions by setting up relevant hierarchical farmer value maps using the means-end chain approach. The study differs from all previous studies on soil fertility management in the sense that no other study has attempted to examine farmers' inner motivations. It also differs from all past studies that have applied the means-end chain approach because they focused on consumers rather than farmers. Understanding the inner motivations behind farmers' decision to use soil fertility improvement technologies is important because farmers differ from each other in personality, cognitive ability, attitude and purpose for farming.

This study focuses on the use of animal manure and inorganic fertilizers by kale (*Brasica oleracea*) farmers in peri-urban areas of Nairobi namely, Wangige, Athi River and Ngong. Peri-urban farmers supply large amount of fresh leafy vegetables consumed in most urban towns including Nairobi. Decline in agricultural land sizes in the peri-urban areas (due to population growth and the conversion of some farm lands into other uses notably residential and industrial manufacturing) has encouraged farmers to apply intensive production approaches which involve heavy dependence on inorganic fertilizers and animal manure. Kale farmers were chosen for this

study because kale is one of the most widely consumed leafy vegetable by urban households in Kenya and it is grows well on fertile soils.

1. Conceptual Framework: The means-End Chain approach

The Means-End Chain (MEC) theory was developed by Gutman (1982), and Olson and Reynolds, 2001 based on the personal construct psychology developed by Kelly (1955). It has been used widely in the fields of marketing and psychology to study factors influencing choice or decision-making by individuals and consumers. Consumer oriented applications of the Means-End-Chain approach for fresh food are vast (see Santosa and Guinard (2011) for an overview of the existing literature). The MEC theory could be applied to analyze farmer's decision-making process. In the context of the farming environment, the theory would posit that the farmer would utilize or apply a certain production practice (means) to generate particular benefits that will ultimately serve to attain more abstract cognitive personal values (end) that the farmer associate with the benefits. Thus MEC approach could facilitate the understanding of the kale farmer's motivations in their decisions regarding the use of soil fertility management strategies. The MEC approach states that perceived self-relevant product *attributes* lead to *consequences* which lead to certain personal *values* being fulfilled (i.e., maps attributes to consequences and ultimately consequences to values). Each *consequence* supports one or more cultural values and/or existential goals. The consequences can be direct, indirect, physiological, psychological or sociological. Thus farmers who make decisions about soil fertility management methods attributes act so as to maximize of the positive consequences and minimize the negative consequences (Gutman, 1982). They learn which attribute leads to what consequence. In addition, the more important the value is, the more significant are the attributes and the consequences leading to this value (Gutman, 1997). Means-end theory suggests that concrete attributes link to self-relevance and more abstract associations.

Values were the end states of the MEC and were cognitive representations of abstract goals, being similar to needs that motivate action and conceptually different to personality traits. Values represent standards that guide thought and action. They were trans-situational and inherently desirable (Roccas et al. 2002). In terms of an individual's behavior values played an important role because they were cognitive representations of individual needs and desires, on

the one hand, and of societal demands on the other. That is, values were translations of individual needs into a socially acceptable form that could be presented and defended publicly. The inter-linked production practice-consequence-value chains formed an associative network of knowledge, which functions as a cognitive and/or as a motivational structure. When applied to the farmers' decision-making process concerning choices of production practices (especially soil fertility management strategies), the MEC approach assumes a hierarchy of goal levels guiding the actual behavior. In a decision-relevant cognitive structure perspective, a farmer may gather and analyze information from the environment by relating it to information stored in the memory. The behavior of the farmer was then directed towards the attainment of a goal in mind by using the structure of the means-end chain as a roadmap. On the other hand, the motivational perspective gives emphasis to the intensity between either the attributes or consequences and the values. The stronger this intensity was perceived, the more activated the decision-maker will be and the larger was the probability that the farmer gets motivated to take action. Therefore by examining the MEC related to use of production practices, one could determine the inner motives or drivers of farmer's choice. Thorough understanding of such drivers is imperative for the development of measures to improve proper application of soil fertility management technologies and hence the safety and quality of food produced in the peri-urban areas.

2. Research methods

A proposition of this research was that studying the Means-End-Chains for famers' choice of soil fertility management methods allows for detection of interactions between actual behavior, in form of choices made by the farmer in relation to soil fertility practices, and the specific motivations behind the choices made by the decision-maker. Means-End-Chains are elicited during the laddering-interviews. This interview technique was originally developed by Hinkle (1965) and subsequent work by Reynolds and Gutman (1988) and Gengler and Reynolds (1995) have developed well-manifested protocols for this technique. Laddering has been widely used in personal construct research (Costigan et al. 2000), but has also been used in research on knowledge acquisition (Rugg & McGeorge, 1995) and organizational research (Rugg et al., 2002). In marketing studies, the techniques has been extensively applied to consumer research and food product design (e.g. Costa et al, 2004; Grunert & Grunert, 1995; Reynolds & Gutman,

1988). However, the application of MEC paired with laddering to study the motivational structure of farmers is sparse and limited, to the best our knowledge, to a study by Johnston and Healy (2006) and Salame (2004). Johnston and Healy (ibid) examined Australian farmers' choices of supply chain channels while Salame (2004) who studied Lebanese farmer's motivations for choice organic versus conventional production methods.

The laddering technique builds on either a face-to face or a pencil-and-paper format. It involves individual in-depth interviews in which subjects/interviewees are required to generate or verify associations between attributes-consequences-values (ACV). This can be done in two ways namely, in sequences utilizing an a priori list of ACV's (hard laddering) or situations in which subjects are more free in their associations and where ACV's are reconstructed during the interview (soft laddering). There is still a big debate about which type of laddering that is most appropriate (Costa et al. 2004). Hard laddering entails the risk of discerning associations that were not there from the beginning thus generating a too restricted scope of motivations. It also has the tendency of providing a mechanistic environment that potentially risks the predictive ability of the technique by reducing the active involvement of subjects during interviews (Jonas and Beckman, 1998). Soft laddering, on the other hand, is more often employed in studies with few respondents (< 50) and where the focus is more explanatory. It has the advantage, from the motivational viewpoint, of being more appropriate in revealing more complex underlying motivations for decisions taken by respondents (Reynolds and Gutman, 2001).

Laddering interviews consist of two stages: firstly respondents were asked to indicate the most salient attributes associated with the topic under study (namely soil fertility management), and secondly, through a series of probing questions in form of "why is that important to you?", respondents were gradually led to reveal the importance of these attributes with respect to their consequences and values. For the purpose of this study respondents were required to reveal how production practices attributes, usage consequences, and personal values were linked in the person's mind. Doing so helped create a meaningful "mental map" of the farmers' view toward the targeted production practices. These ACV relationships therefore form the means-end-chain (MEC). By combining the maps of similar farmers, a large, more exhaustive map can be developed. The hierarchical value map (HVM) is a graphical description of a laddering interview that is used to see the relationships between the attributes, consequences, and values. A semi-

structured laddering approach in which elements of both the hard and soft laddering techniques are combined was used in this study. Before the interviews, the respondents were reminded that there would be no right or wrong answers. This information was intended to make the respondent feel more at ease thereby making the respondent speak more freely and honestly (Reynolds and Gutman, 1988). At the initial point of each laddering interview, kale farmers were asked to rank soil fertility management methods they use in producing kale in order of preference. This formed the study association. Following a hard laddering approach, the respondent was asked to state the strategies they adopt in managing fertility of kale fields. The responses included were grouped into two attributes (soil fertility management methods) namely, 1) manure (cow, goat/sheep, poultry, pig, rabbit and compost manure) and 2) chemical fertilizers. These are the main soil fertility management methods applied by peri-urban farmers around Nairobi and in producing kale. Pig, rabbit and compost manure was mentioned by less than three respondents thus dropped from further analysis.

The interviewers used Dictaphone to record the responses of every respondent. Ladders were also noted in a notebook during the interviews and reviewed after every interview session to ensure that all consequences are followed. The generated ladders were also used as a reference points during transcription of data. The ladders across the respondents were recorded on a separate coding form for the entire set of ladders. The inspection was done to ensure completeness. A set of summary codes was developed to ensure that all the attributes, consequences and values that were mentioned by the respondent were covered. This was done by first classifying all responses into three categories namely, attributes, consequences and values in manure and fertilizer in order to produce consistency in content analysis.

The analysis of the laddering data was conducted in line with the recommendations by Reynolds and Gutman (1988). The values stated by the respondents were sorted according to the classification of values which is suggested in individual-level value structure. The "Mecanalyst Software" was used for the analysis of the data collected during the laddering interviews. After entering and encoding the data, the software constructs an implication matrix that indicates how often concepts have been mentioned and linked to each other, both directly and indirectly. The Mecanalyst Software furthermore enables an aggregation of the Means-End Chains (MEC) into a Hierarchical Value Map (HVM). The attributes, consequences and values form chains that are

put into a hierarchical value map (HVM), depicting the cognitive or motivational decision structure of the farmer (Grunert and Grunert, 1995).

3. Data

This study used data collected from three peri urban areas of Nairobi namely, Wangige, Ngong and Athi River. The areas were chosen based on proximity to the city and involvement in kale production. They represented most major smallholder peri-urban vegetable growing sites in Kenya. The farmers in the study areas practiced intensive agriculture characterized by use of manure, fertilizer and pesticides in kale production. The average land ownership was one acre per household which 0.5 acre being available for farming.

The respondents were randomly sampled from a list of the 120 farmers who had earlier participated in a household survey conducted as the first phase of the study. The 120 farmers were randomly sampled from lists of kale growers in the three sites with weights proportional to the population of farmers. For the laddering interviews, a random of kale growers were taken from the list of household survey respondents in each of the site which yielded a total of 54 kale farmers (Athi River, n=5; Ngong, n= 24; and Wangige, n= 25). Thus the study used a sample size that is greater than those used in most laddering/MEC studies. Table 1 summarizes the characteristics of the farmers interviewed during this study.

Table 1: Summary statistics of the laddering interview respondents (n=54)

Variable	Mean	Std. Dev.
Age (years)	47	13.36
Gender (1= male, 0=female)	0.75	0.44
Farming experience (years)	16.26	12.23
Years of schooling	8.88	3.44
Highest education	1.49	0.70
Kids under 5 (1=yes, 0 =no)	0.52	0.45
Household size	3.45	1.97
Household income (Kshs*)	16,882	11,619
Farm acreage (acres)	1.06	0.80
Kale growing acreage (acres)	0.49	0.40
Distance to nearest market (Km)	3.48	3.58

* Ksh = Kenya Shillings. 1 US dollar was equal Ksh 71 at the time of this study

It shows that the farmers covered in this study are older with an average of 47 years. In addition, most of the respondents had, on average, primary level of education. Most of the respondents were male (75%) and had, on average 16.26 years of farming experience. It also showed that farmers were of relatively low and variable average monthly income with an average of Kshs16,882 (US$ 238).

4. Results and discussion

51. Peri-urban farmers' motivations for using animal manures in kale production

The hierarchical value map in Figure 1 generated using the MEC approach represents the synthesis of the decision to use cow manure as soil fertility improvement strategy in kale production. This aggregated decision map thus highlights similarities in farmers' motivational structure and behaviour in relation to use of animal manure in kale production. A cut-off level of 9 was chosen to develop HVM which means that a link was drawn between two concepts if at least nine respondents had mentioned it as a direct or indirect link. Choosing a cut-off level involved a trade-off between the amount of data represented by the map and the transparency of the map. Usually, a minimum of 70% of the relationships on the map should be represented (Gengler, 1997). In this study, the HVM in Figure 1 includes 89% (at the cut-off of 9) of all direct links mentioned by the respondents.

The three consecutive levels of the map represent attributes (at the bottom), consequences (in the middle) and values (at the top). The lines represent the MECs or the associations, with the thickness indicating the strength of the associations. Hence, a very thick line between two concepts means that many respondents made this association during the interview. Ladders or codes with incomplete chain or missing antecedent were excluded in the implication matrix from being represented graphically in the HVM.

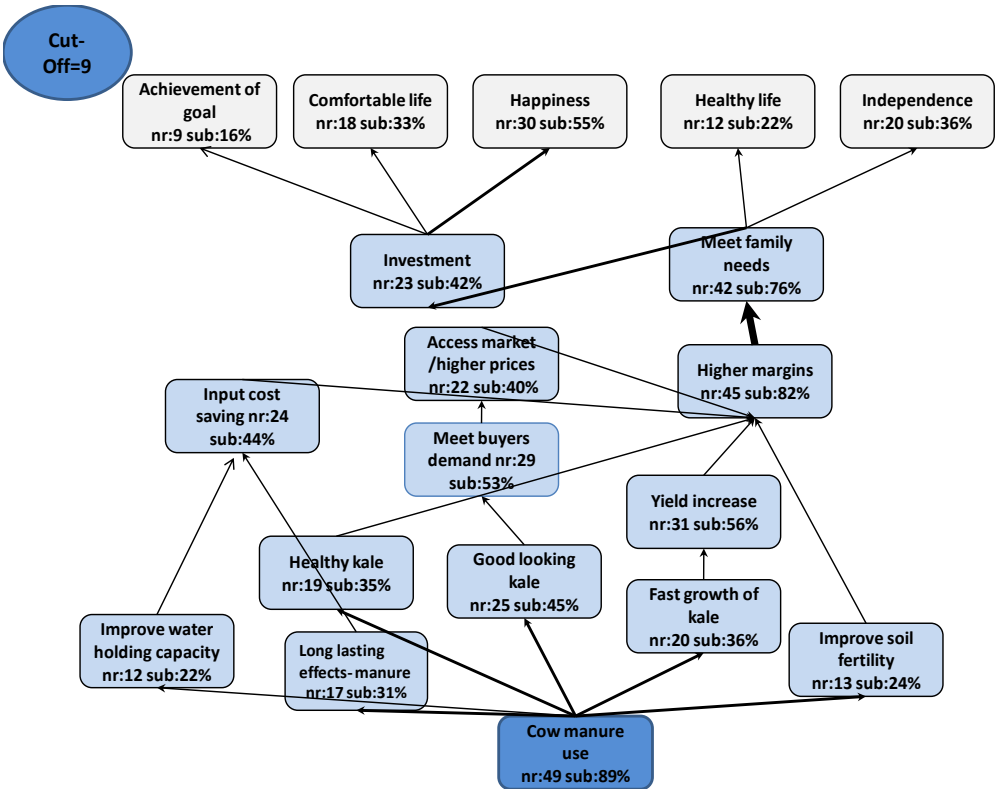

Figure 1: HVM for cow manure use in kale production

The results presented in the Figure 1 have only one attribute namely cow manure usage because decision to use different sources of manurewere motivated by different factors. In addition, the cut-off level used eliminated the other attributes (namely pig, rabbit and compost manure). The decision to use cow manure as an attribute had 13 consequences and five end values. The HVM indicates five motivational structures of ladders with respect to cow manure usage namely, achievement of goals in life, happiness, good health, comfortable life and independent.

The illustration shows that kale farmers mostly used cow manure as source of crop nutrients. The motivation for applying cow manure in kale was to improve soil fertility, ensure that kale was good looking or was of high sensory quality attributes and to improve water holding capacity of soil (thereby reducing frequency of irrigation). In addition, farmers applied cow manure due to it long lasting or residual effects and also because they believed that it produced healthy kale with attractive aesthetic quality attributes. The consequence of healthy and

good looking kale in turn attracted more buyers by meeting the aesthetic quality attribute sought after by consumers. It also helped farmers venture into high-end markets namely supermarkets and specialty stores where they got higher prices.

Having healthy and good looking kale also increased harvestable quantities thus generating more money through higher profit margins to growers. On the other hand, the consequences of long residual effect of manure and its ability to improve water-holding capacity reduce the frequency of irrigation as well the need to apply much inorganic fertilizers. Reduction in these activities in turn lowers the need for labor leading to reduced cost of hiring labor.

The consequence associated with higher margins from kale production is the ability of the farmer to meet his/her family needs. These needs include children's education as well as the provision food, clothing and shelter for the family which leads to another consequence that of being able to invest in other projects (i.e., longterm cash generating venture) or to expand the farm business. As the HVM shows, the major personal value of the farmer derived from being able to meet family needs was healthy life and becoming independent (not depending on help from others – neighbors and friends – to meet family needs). In other words, famers used cow manure sequentially to eschew failure to meet family needs which may deprive them of happiness and cause them health problems. The problems cited by most respondents as resulting from inability to meet family needs were sleeplessness and hypertension. Self-dependence specifically relates to being able to provide own and family needs without external help was important because it eliminated the shame of borrowing or depending on others for financial support (which is interpreted by the society as failure).

Investment in long-term ventures resulted in three values/benefits to farmers namely, happiness, comfortable life and achievement of life goal. Happiness was the main driver of desire by farmers to invest in long-term ventures. Indeed, majority of the famers that identified with this consequence-value chain argued that lack of happiness could cause stress-related diseases hence poor health. The other end means of kale farmers' motivation to use cow manure was the ability to invest in other longer-term income generating activities that enables them to live a comfortable life in future.

5.2 Peri-urban farmers' motivations for use of sheep and goat manure in kale production

The HVM for goat/sheep manure use (see Figure 2) is almost similar to that of cow manure in kale production. However, goat /sheep manure usage was only mentioned by nine respondents. As shown in the HVM, the motivations for applying goat/sheep manure in kale production was to ensure that soil fertility has improved, kale was good looking or that kale had high sensory quality attributes. It was also applied in kale in order to improve water-holding capacity of the soil or because it had long lasting effects on soil health which ensures that the farmers produces healthy kale in future plantings. Improved water-holding capacity was associated with an additional consequence namely, cost savings due to reduced irrigation water use and labor. The consequences identified under goat/sheep manure HVM are therefore similar to those identified in cow manure HVM.

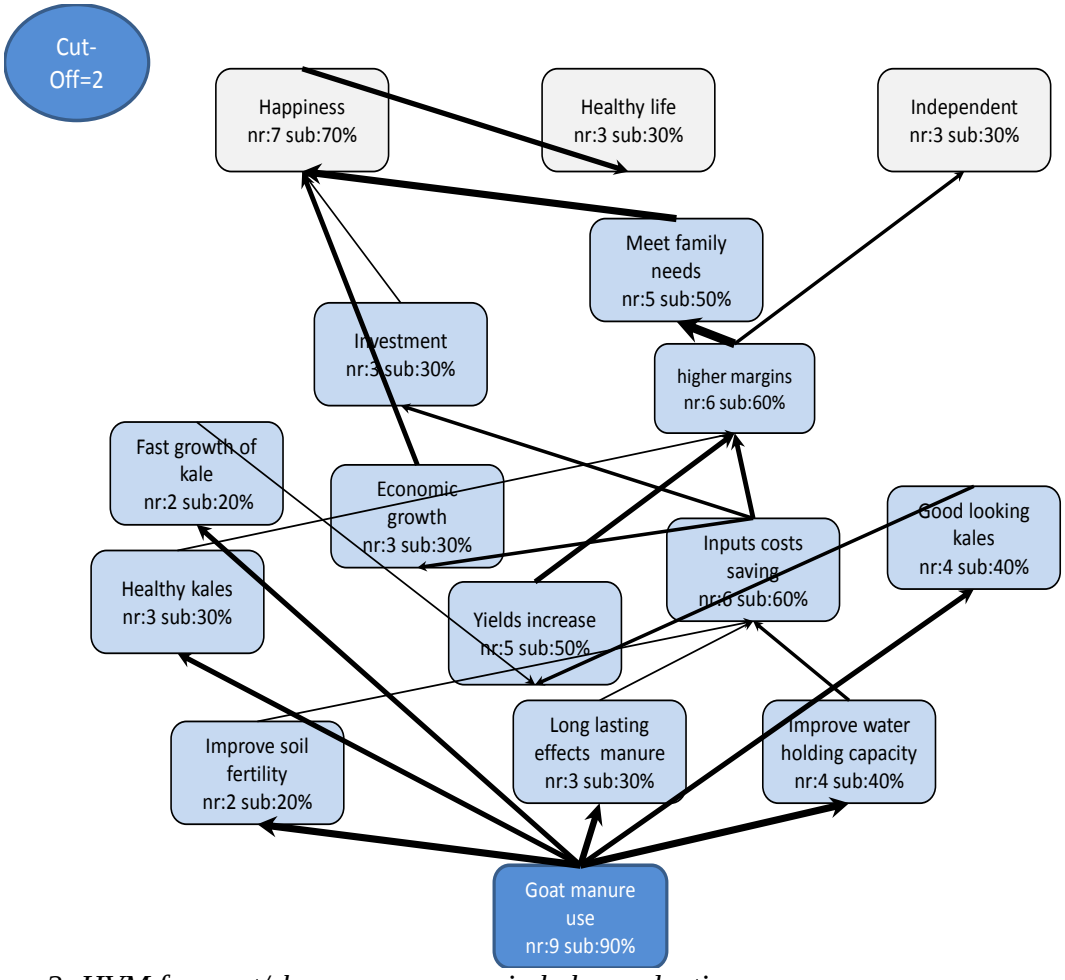

Figure 2: HVM for goat/sheep manure use in kale production

One unique consequence that featured in the goat/sheep HVM but not in cow manure one was economic growth. Respondents that mentioned this consequence indicated that input cost savings increased their income and hence contribution to economic growth of their local economies through payment of value-added taxes on purchases of non-agricultural products[1]. Economic growth results to employment creation and improvement living standards. The personal values that the farmers satisfied through the use of goat/sheep manure are healthy life, happiness and independent life.

5.3 Peri-urban farmers' motivations for use of poultry manure in kale production

The use of poultry manure in peri-urban farming was common among households that raised poultry for urban markets. This was the case for Wangige which has one of the largest poultry eggs market in East Africa (the Wangige market) (Okello et al, 2010). The hierarchical value map in Figure 3 represents the motivations for the decision by the farmer to use poultry manure as a source for crop nutrient. A total of 11 respondents mentioned that they applied chicken manure. The motivations (consequences) for using poultry manure in kale production by these respondents included demand by buyers, good looking/healthy kale, water conservation, and fast growth of kale. These consequences in turn led to ability to meet family needs by earning higher margins (through increased profits).

As expected earning higher margins satisfied farmers' personal values relating to having a comfortable life. Indeed, most of the earlier consequences converged to the consequence of higher margins with the result that the farmer leads a comfortable life. As before, the consequence relating to meeting family needs satisfies two of the farmers personal values namely happiness and having healthy life. These values are the same as those discussed in the first two cases above.

[1] Smallholder farmers in Kenya do not pay income taxes hence contribution to tax base is through value-added taxes.

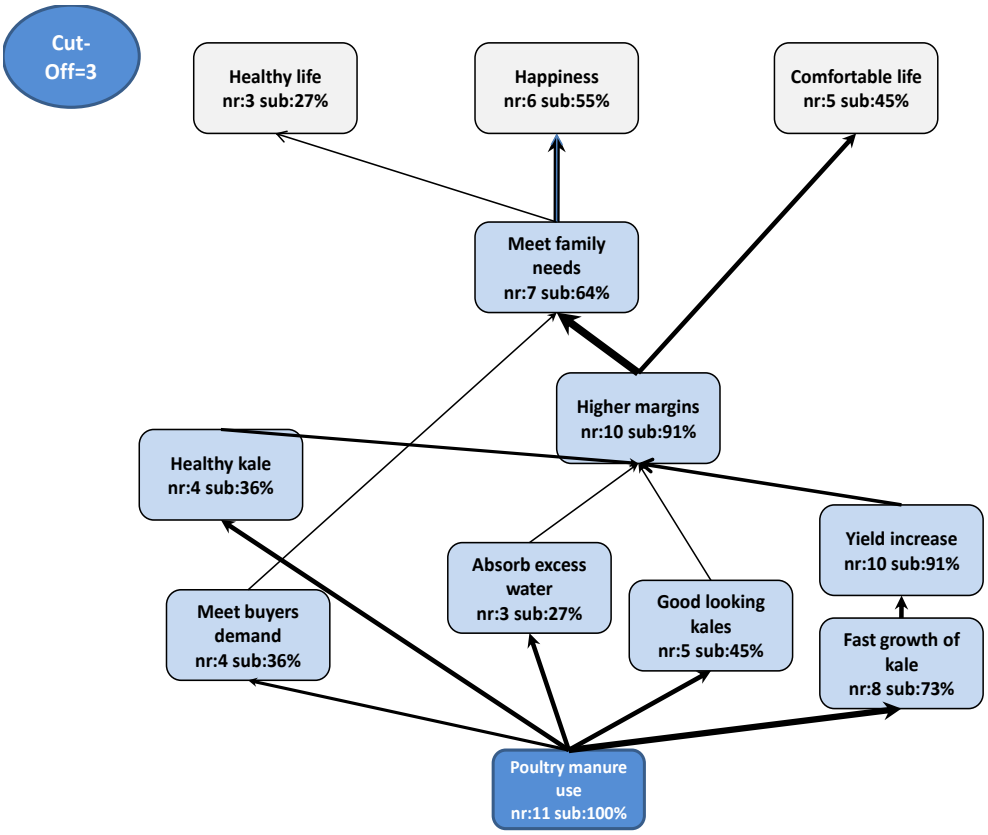

Figure 3: HVM for poultry manure use in kale production

5.4 Peri-urban farmers' motivations for using inorganic fertilizers in kale production

The use of inorganic fertilizers in vegetable production has in the past generated concern about the health effects, especially of nitrates in fresh leafy vegetables (Ngigi et al, 2010). Application of nitrate fertilizers in vegetables by smallholder is common both in developing and developed countries (Santamaria, 2006). Nitrates are safe. However its metabolite nitrite is carcinogenic hence ingestion of nitrates may have long term health effect (Sanchez-Echaniz et al, 2001). This section therefore investigates the motivations for use of inorganic fertilizers, majority of which loaded with nitrates. Figure 4 presents the hierarchical value map for the fertilizer use in kale production.

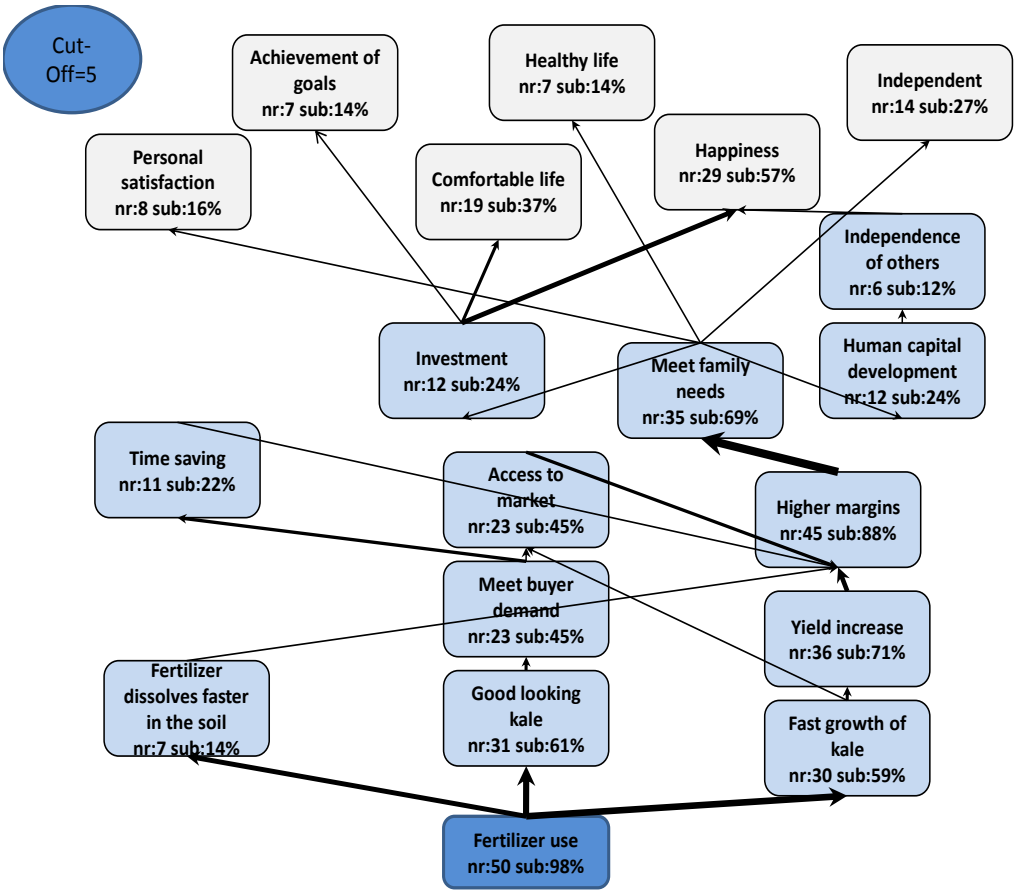

Figure 4: HVM for fertilizer use in kale production

A cut-off level of five was chosen in developing HVM using a sample of 50 respondents who mentioned that they use inorganic fertilizers for soil fertility enhancement. The HVM indicated that there were six motivational structures or ladders with respect to fertilizer use. The personal values satisfied by fertilizer use are happiness, independent comfortable life, good health, achievement of goals and personal satisfaction.

Starting from the bottom of the ladders, the three main motivations for applying fertilizer in kale production were; i) fertilizer dissolve faster in soil, ii) it produces good looking kale and iii) it facilitates faster growth of kale. The consequence of good looking kale in turn results in another consequence namely that kale attracts more buyers and also meets buyers' demands relating to aesthetic quality. Aesthetic quality is one of the most sought after attribute by consumers and high-end retailers. It therefore improves farmers' chances of gaining access to high end markets namely supermarkets and specialty stores which pay higher prices resulting in higher margins. Meeting buyer demands is important to peri-urban farmers because it saves them

the time spent in the market during selling activity because their kale attracts more buyers hence sells faster. The consequence of fertilizer dissolving in soil faster leads to higher margins as a result of higher yields. Faster growth of kale also results into higher yields, increased margins for kale growers and subsequently higher profits.

The consequence associated with making more money from kale production is the ability to meet his/her family. As before, these needs include children's education, and the provision food, clothing and shelter for the family. Children's education leads to human capital development which contributes to those children becoming self-reliant (independent of other) in the future. Farmers' personal value satisfied by self reliance of children in the future is happiness that she/he has succeeded in life. Another consequence associated with meeting family needs is the ability to invest in other projects with long-term benefits or expanding farming business. As the HVM shows, the major personal values satisfied by this consequence are i) achievement of goals, ii) comfortable life and iii) happiness. The value to kale farmers of meeting family needs is personal satisfaction, healthy life and becoming independent.

5. Summary, Conclusion and Policy Implications

This study examines the motivations for peri-urban farmers to choose soil fertility improvement strategies for kale production. The study uses means-end chain approach to investigate the effect of farmers' personal values on the decision to use soil fertility improvement technologies in the production of kale. It finds that the choice of soil fertility improvement technologies especially the use of animal manures and inorganic fertilizers is driven by a number of personal values including happiness, achievement of goals, good health, comfortable life, personal satisfaction, and independent. Farmers uses animal manure in growing kale to improve fertility, improve water holding capacity of soil, enhance aesthetic quality of kale, enjoy the benefits of long lasting residual effects of manure and also produce healthy vegetable. The overriding purpose of using these soil fertility improvement technologies, however, is to increase yield and profit margins thus enabling them to meet family needs. In addition, majority of the farmers use chemical fertilizer to make kale grow faster thus selling faster which allows for more plantings per year, higher profit margins and subsequently ability to meet family needs.

Based on the findings of this study, we conclude that the primary motivation behind use of animal manure and chemical fertilizer in production of kale was to increase yield thus making more money which enabled the farmers to meet family needs and invest in other project with long-term benefits achieving personal values of happiness, independence, comfortable life, good health and achievement of goals.

The findings of this study suggest that while farmers use soil fertility improvement strategies in the production of kale, the goals was usually profit making rather than good environmental stewardship. This has the danger that farmers could adopt intensive production system, notably the use of fertilizers, which could potentially have negative environmental effects as vegetable prices increase and markets become more demanding on aesthetic quality attributes. At the same time, the same market (economic) incentives could cause farmers to apply inadequately cured manure thus increase the risk of kale contamination with pathogens. Environmentally safe use of animal manures and fertilizers by peri-urban fresh vegetable farmers thus require policies that promote good environmental stewardship. Educating farmers on the benefits of incorporating environmental stewardship in their private profit maximizing and social goals will however require the concerted efforts of both conservation and public health agencies. The former are needed to promote integrated soil fertility improvement approaches including safer manures management practices while the later would play a more regulatory role of making sure that sustainable and environmentally friendly production strategies are adhered to. Experience with European standards, notably the Global Good Agricultural Practices (GlobalGAP), also indicate that private fresh vegetable retailers can promote environmentally-friendly practices by enacting and enforcing good production protocols among their suppliers (Okello and Okello, 2010). Thus Kenyan supermarkets can play a role in aligning farmers' incentives to practice good environmental stewardship.

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