DETERMINANTS OF CONSUMPTION PATTERN AND WILLINGNESS TO PAY FOR SOLAR DRIED VEGETABLES AMONG RURAL HOUSEHOLDS IN TANZANIA

YEGON CHERUIYOT WILBON

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has never been submitted in this or any other university for the award of a degree.

Signature:………………………………… Date:………………………

Yegon Cheruiyot Wilbon

KM15/11695/16

Recommendation

This thesis has been submitted with our approval as the official University Supervisors.

Signature: ………………………………… Date:………………………

Dr. Oscar Ingasia Ayuya , PhD

Department of Agricultural Economics and Agribusiness Management,

Egerton University

Signature: ………………………………… Date:………………………

Dr. Justus Ochieng , PhD

World Vegetable Center, Arusha, Tanzania

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DEDICATION

This thesis is dedicated to my caring parents Elijah and Sarah for their unwavering love and inspiration.

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ABSTRACT

Recent development in technology has led to adoption of advanced technologies like irrigation and greenhouses for horticultural crops in Africa with limited focus on post-harvest technologies. This study focused on ways of reducing post-harvest losses of traditional African vegetables (TAVs) through drying. Specifically, it assessed two methods of drying vegetables: solar drying and open sun drying. Solar dried TAVs are better in terms of quality as opposed to traditionally known open sun dried TAVs that is predominantly common among rural households in Tanzania. The specific objectives of this study were; to identify the attributes consumers consider when purchasing dried vegetables, assess household's consumption frequency of solar and open sun dried vegetables, estimate household's willingness to pay (WTP) for solar dried TAVs and factors influencing WTP. Secondary data collected in July to August, 2016 from three districts in Tanzania; Kongwa and Mpwapwa in Dodoma region and Iramba in Singida region was utilized. Structured questionnaire was used to obtain data from 240 respondents that were later analyzed using STATA software. Factor analysis was used to analyze the product attributes that consumers consider when purchasing vegetables, Ordered bivariate probit to analyze the consumption frequency of dried vegetables while a double bounded dichotomous choice model was used to determine factors influencing willingness to pay. Three methods were used to estimate the willingness to pay, real choice experiment, contingent valuation and Becker-DeGroot-Marshack. From confirmatory factor analysis both marketable qualities and physical product characteristics are important when purchasing dried vegetables. Market attributes and being female significantly influenced consumption frequency. The premiums varied significantly with elicitation techniques. Contingent valuation method gave the highest premium of USD 0.30; followed with choice experiment with mean premium of USD 0.04 while the mean willingness based on experimental auction was below the market price. Experimental auction is the most suitable since it had the lowest efficiency ratio. It brings out the actual consumer willingness to pay. Consumer WTP for solar dried TAVs was elicited through Double bounded dichotomous choice model. Age, gender, years of schooling, being household head or spouse, income and awareness of solar dried TAVs was some of the factors positively determining consumer willingness to pay. The study findings did not only help in understanding demand and WTP for solar dried TAVs but also gave insights on interventions needed to promote solar drying technology to farmers and private food processing businesses. Awareness creation on availability of low cost solar dryers is required.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AVRDC	Asian Vegetable Research and Development Centre
BDM	Becker-DeGroot-Marshack
CE	Choice Experiment
CVM	Contingent Valuation Method
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GSI	Good Seed Initiative
KGs	Kilo grams
NBS	National Bureau of Statistics
TAVs	Traditional African Vegetables
TDV	Tanzania Development Vision
UNEP	United Nations Environmental Programme
USD	United States Dollar
WHO	World Health Organization
WTP	Willingness To Pay

CHAPTER ONE
INTRODUCTION

1.1 Background information

Under-nourishment is a major challenge facing about one billion people in this planet (Bond *et al*., 2013;UNEP, 2014). Malnutrition and food insecurity are the main challenges faced by most developing countries including Tanzania (Holmer *et al.,* 2013). An estimated 760 million people in these countries are undernourished. In Eastern Africa 124 million people are still undernourished (FAO, 2015). Tanzania had an estimated population of 44.9 million people in 2012 with a projection expected to be 59.4 and 89.2 million by 2021and 2035 respectivelyl with about 80% comprising of rural population (Mwakisisile *et al*., 2019; NBS, 2013). Agriculture is the main economic activity employing more than 70% and contributes to 24.1% of the GDP (Economic survey, 2010). Rapid economic growth seems to have less significance in poverty reduction and enhancement of nutrition (Pauw & Thurlow, 2011). Forty-two percent of children below five years of age were stunted, 59% and 34% were suffering from iron and vitamin A deficiency respectively (NBS, 2010).

Vegetables are essential for food and nutrition security, particularly, traditional African vegetables (TAVs) can help mitigate this problem (food insecurity and malnutrition) if its consumption is enhanced through various promotional activities (Ochieng *et al*., 2017; Kamga *et al*., 2013). TAVs are known to be robust and productive making it the most suitable to feed the hungry and the most vulnerable in the society (Muhanji *et al*., 2011). TAVs are vegetables that trace their origin to Africa or have been integrated and intertwined into cultures through a robust selective process (Gido *et al*., 2017).

Understanding consumer acceptance of TAVs is key in enhancing its intake to increase micro nutrient uptake (Gido *et al*., 2017). There has been a rising political interest and increased public health awareness on diversification into highly nutritious traditional vegetable in Tanzania (Afari-Sefa *et al*., 2015). Vegetables are rich in vitamin A and C known to keep the eye and skin, teeth and gums healthy respectively (Uusiku *et al*., 2010). Moreover, it aids in absorption of iron. Vegetable value chain from production, processing and marketing can create potential employment opportunities attractive and lucrative to young people (Schreinemachers *et al*., 2018).

The interventions by various stakeholders in Tanzania have led to gluts of vegetable during the rainy season (Gramzow *et al*., 2018). Most households consume fresh vegetables during this period. However, due to excess production lot of it result in wastages. This is contrary to the fact that there is scarcity and limited access to vegetables during the dry season. Processing, packaging and preservation is a necessary condition in enhancing the vegetable value chain (Chagomoka *et al.*, 2014). Preservation of vegetable can be done by drying.

Drying is a process that involves removal of biologically active water to a safe level that reduces deteriorative chemical reactions, provides microbiological stability and extends the shelf life of dried products (Perumal, 2007). The choice of drying method depends on the type of the product, availability and cost of the technology in use. Sun and solar drying are cheap and affordable. Mechanized drying is expensive though it is the most effective (Ahmed *et al.,* 2013).

Open sun drying is the most preferred since it requires less energy and low equipment demand (Musebe *et al*., 2017). However, open sun drying is prone to many problems, since the product is exposed to rain, storm, windborne dirt, dust and infestation by insects, rodents and other animals (Folaranmi, 2008). Open sun-dried leaves also tend to dry non-uniformly and lose nutrients (namely vitamin A and C) through exposure to direct sunlight, decreasing end product quality (Musa & Ogbadoyi, 2012).

Under Good Seed Initiative (GSI) project, several activities were carried out in Dodoma region (from 2013 to 2015); among others to promote intake of vegetables aimed at improving dietary diversity and nutrient content in food (Kansiime *et al*., 2018). Drying of vegetables training gaps were done in few villages. Training on solar drying was meant to improve traditional practice in which direct sun was used in drying the vegetables. Solar dried products retained more of the nutrients, reduced microbial load compared to those dried by direct sun (Ukegbu & Okereke, 2013). Solar dried TAVs offer an opportunity for households to be nutrient sufficient. This study offers insights on how to transform the existing supply chain and reduce postharvest losses as well as improving food and nutritional security of rural population and thus appreciate evolution of vegetable industry.

1.2 Statement of the problem

The rural population in Tanzania is faced with low access to food thus suffer from high nutritional needs. Solar dried traditional African vegetables (TAVs) are the most favourable

option to meet nutritional requirements of this segment. Households consider certain product characteristics in purchasing food. Dried vegetable can easily be transported without or with less damage. The main problem is that households were consuming open sun dried TAVs which had several limitations (dirt, low hygiene, low nutrient content, bad colour and unsafe). On the other hand, the solar dried TAVs was rarely bought or consumed by rural households because it was still new. FAO recommends on measures that would enhance access to balanced diet by the rural poor. Consumers however, might have access but might not afford or are not willing to pay. Moreover, there was need to understand product attributes both intrinsic and extrinsic that consumers consider in their daily purchase and consumption of vegetables. Limited studies have been conducted to test consumers' willingness to pay (WTP) for TAVs of better quality in rural Tanzania. Therefore, this study aimed at estimating households' willingness to pay (WTP) for solar dried TAVs that can be readily available in the vegetable market. Earlier consumer studies (Carlson *et al.*, 2005; DeGroot *et al.*, 2014; Domonko *et al.*, 2018) mostly used choice experiment (CE) and contingent valuation method (CVM) and solicited consumers' WTP for hypothetical products. However, they have been criticized for being unrealistic and not offering proper incentives so that consumers would reveal their true preferences. Therefore, this study compared the results from these methods with recent experimental auctions (Becker-Degroot-Marschack, BDM), which allows for real transactions to take place and participants bid with real money on real products.
Combining elicitation methods ensured robustness of the results and conclusions .

1.3 Objectives of the study

1.3.1 General objective

The general objective of this study was to contribute towards improved food access and nutrition security among rural populations in developing countries by assessing the consumption pattern and willingness to pay for solar dried traditional African vegetables.

1.3.2 Specific objectives

The specific objectives were:

i. To identify the attributes consumers consider when purchasing dried vegetables.
ii. To determine factors influencing household consumption frequency of solar dried and open sun dried traditional African vegetables.
iii. To estimate the households' willingness to pay for solar dried traditional African vegetables.

iv. To determine the factors influencing households' willingness to pay for solar dried traditional African vegetables.

1.4 Research questions

i. What product attributes do consumers consider when purchasing dried vegetables?
ii. What are the determinants of the household consumption frequency of solar and open sun dried traditional African vegetables?
iii. What is the mean amount households are willing to pay for solar dried traditional African vegetables?
iv. What are the determinants of households' WTP for solar dried traditional African vegetables?

1.5 Justification of study

Solar dried traditional African vegetables (TAVs) retain most nutrients, dry uniformly and hygienically they are good. Its quality is far much better compared to open sun dried TAVs. The data is from central region of Tanzania, that is, Dodoma and Singida, which are well known for drying and consumption of dried vegetable. Understanding product attributes that consumers prefer helps in coming up with policy intervention and recommendation to processors to enhance consumption of solar dried TAVs. If however, these are the perceived attributes further training and theory of change is adopted. Most of the previous studies focused on WTP for safety, method of production and quality attribute among leafy vegetables. This is an eye opener in advancement of vegetable value chain. It also give empirical evidence of current consumption of dried vegetables. The findings from this study contributes towards the development of policy interventions to enhance WTP for solar dried TAVs and thus in the long run attain sustainable development goal two and in achieving Tanzania development vision (TDV, 2025) of high quality livelihood, that is, food self-sufficiency and food security which will finally culminate to Agenda 2063, that is, zero hunger. Training by AVRDC-The World Vegetable Centre had previously been done on solar dried TAVs thus this offers a basis for enhancing their study and gauge the extent of acceptance of solar dried TAVs. This study contributed to the measure of WTP by combining three elicitation methods, enhanced adoption of low cost solar driers and increased consumption of solar dried TAVs.

1.6 Scope and limitations

This study only considered willingness to pay on sun and solar dried TAVs from rural households in Tanzania. It was limited to vegetables and only covered Kongwa, Mpwapwa Districts in Dodoma and Iramba District in Singida region. Though the sample was relatively small to represent the entire country but it contributed to the existing body of knowledge. Comparison of the three elicitation techniques of willingness to pay was quite challenging.

1.7 Operational of terms

Willingness to pay-is the desire to give a certain amount of money to obtain or acquire a certain product, in this case solar dried TAVs.

Open sun dried TAVs- vegetables dried through direct exposure to sun rays for a given period of time.

Solar dried TAVs –vegetables dried by solar dryers that harness the solar energy.

Food nutrition security- this is where there is sufficient access to safe and nutritious food (in this case solar dried TAVs and open sun dried TAVs) by all people at all times anywhere such that the populations are active and healthy**.**

Consumption – use of a product, in this case the use of solar and open sun dried TAVs by individual households.

CHAPTER TWO

LITRATURE REVIEW

This section focuses on other studies related to the vegetable sub-sector and consumer willingness to pay. Logical and critical reviews was done while identifying gaps and how the current study fills the gaps. This chapter has seven sub-sections. It begins by looking at the overview of vegetable sub-sector in Tanzania. It is followed by vegetable preservation techniques considering merits and demerits. A closer look on determinants of consumption of traditional African vegetables was done . An indepth look on elicitation of consumer willingness to pay was done focusing mainly on contigent valuation method, choice experiment, Becker-DeGroot-Marshack and a combination of various elicitation techniques. Determinants of willingness to pay were also reviewed. This led to identification of gaps. Finally, the consumer utility theory was adopted as the basis of the study and thereafter conceptualization of the study presented.

2.1 Overview of vegetable sub-sector in Tanzania

Vegetable is undoubtedly essential for daily nutrition, especially traditional African vegetables (TAVs). According to Yang and Keding (2009) they are rich in micronutrient and great antioxidants. A study by Sreeramulu and Raghunath (2010) indicated that consumption of vegetable prevent degenerative diseases resulting from oxidative stress. In an investigation on availability of indigenous food in Uluguru North and West Usambara Mountains, Tanzania among 180 households Msuya *et al*. (2010) found out that there were 114 forest edible plant species. This means Tanzania is rich in African indigenous vegetables.

Pauw and Thurlow (2011) in their review on agricultural growth and nutrition showed that more than half of the cropland in Tanzania is under cereal production. This is in agreement with a study by Nyomora and Mwasha (2007) on indigenous vegetables citing development of settlement and expansion of staples as well as cash crops as a threat to indigenous vegetables in Tanzania. Long-term low investment in research and development in horticultural sector especially in African indigenous vegetables is common (Afari-Sefa *et al*., 2012). This implies that vegetable sector is still underdeveloped with root crops such as cassava and Irish potatoes accounting for up to 15% of harvested crops. However, the same reference revealed that in urban areas vegetables were among major crops in home gardens due to their attachment to importance in household nutrition. The main types of vegetables among smallholder farmers are amaranth, sweet potato leaves, pumpkin and tomato crops

(Schlesinger & Drescher, 2018). Adeniji and Aloyce (2012) disclosed that growth of vegetable sector, basing their study on amaranth is hindered by both biotic and abiotic factors in Tanzania. This is a major setback in enhancement of vegetable growth in the country. A cross-sectional survey carried out by Mbwana *et al.* (2016) on 120 households in determining household dietary diversity in Morogoro and Dodoma regions, Tanzania, recommended that more attention should be given to agro-ecological environment. This study therefore tried to bridge the environmental gap through preservation by enhancing technological adoption of solar dryers.

Ojiewo *et al*. (2010) found out that there are more than 150 species of indigenous vegetables in Tanzania. Rajendran *et al.* (2016) assessed farmer-led enterprises to access certified seeds for TAVs in four administrative regions of Tanzania: Dodoma, Tanga, Morogoro and Arusha with a sample of 90 households and concluded that vegetable sub-sector is hindered by lack of access to quality seeds, spatial, timely availability and affordability of certified seeds. However, Ojiewo *et al.* (2010) in their study on contribution of World Vegetable Centre in vegetable value chain further unfolded that the center based in Arusha breeds and multiply seeds to prevent their extinction. The species whose breeding are done at the Centre have nutritional capability which are immense and are among those that were analyzed in this study.

Vegetables are produced by small-scale farmers. Its production, sale, purchase is largely done by women in Tanzania (Mmasa, 2013). They are also highly involved in decision making concerning vegetables (Fischer *et al.*, 2017). They consume fresh vegetables and the surplus is sold to brokers, medium scale processors and exporters and the rest are sold to small-scale (homestead) enterprises. However, this contradicts with Nyomora and Mwasha (2007) findings that vegetable consumption is about 108 g/person/day in Tanzania on average that is below WHO recommendation of 240g (WHO, 2015). Ochieng *et al*. (2017) in a cross-sectional study on effect of consumption of TAVs on household nutrition focused on promotional activities in Arusha, Tanzania on 258 respondents who participated in Good Seed Initiative program and 242 in a control region. Good seed initiative (GSI) has been involved in promotion of production and consumption of TAVs in Arusha region (Kansiime *et al*., 2018). This has enhanced development of vegetable sub-sector in the East African country.

Traditional vegetable supply chains are not developed and rely on intermediaries. Tomatoes, onions, carrots and African nightshade are the major vegetables being traded on (Benali *et al*., 2018). The brokers are responsible for bulking and wholesaling of fresh vegetables then sell to medium scale processors and small medium enterprises who are secondary processors. Small medium enterprises, secondary and small-scale homestead processers use solar driers to dry the green vegetables. The home processors sell to the local low income consumers in rural areas. According to Omolola *et al*. (2017), vegetables are dried to stop multiplication of micro-organisms since they obtain water and nutrients from the vegetable they grow. The vegetable sub-sector can be conceptualized as shown in Figure 1.

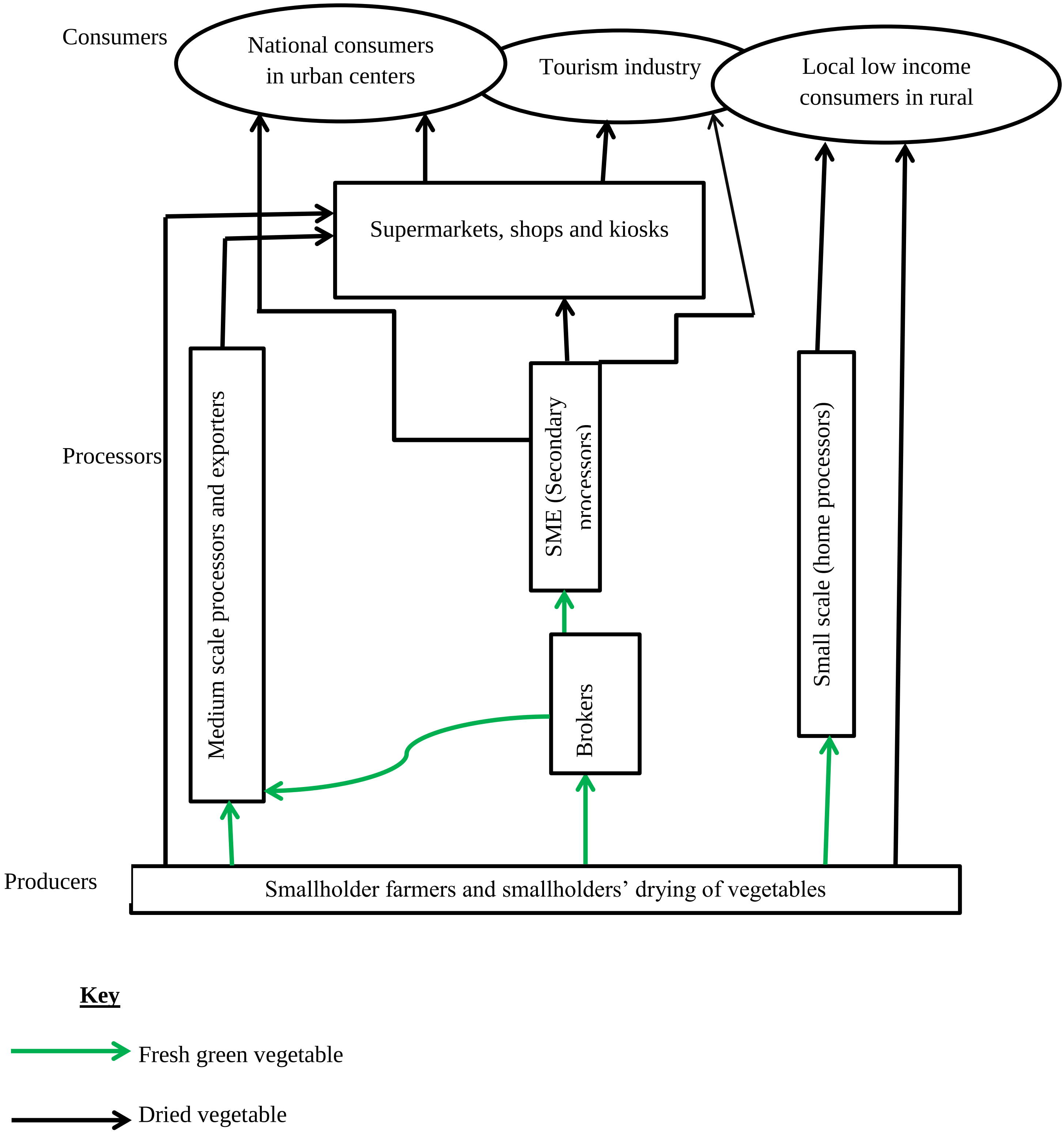

Figure 1: Vegetable marketing in Tanzania

Source: Adopted from Chagomoka *et al*. (2014)

2.2 Vegetable preservation

In vegetable, mainly the leafy parts are harvested. However, in other cases leaves with tender stems, barks, fruits, and roots are harvested (Habwe *et al.,* 2009; Kamga *et al.,* 2013). Vegetables can be consumed when harvested or minimal preservation can be done to consume it at a later date. Preservation is a process of extending vegetables' shelf life. Ndukwu (2011) noted that fresh vegetables could visibly look good but contain high population of microorganisms. The study recommends extension of shelf life through evaporative cooling technology of which vegetables maintain the colour for up to three weeks. After harvesting vegetables are either chopped before drying or dried whole leaf. In some like cucurbits fibrous materials are removed before leaves are chopped and dried. Some like *Brassica carinata* can be blanched before sun drying as this improves colour and carotene retention. Blanching deactivates enzymes however it results in loss of ascorbic acid (Vitamin C) (Chiewchan *et al.,* 2010).

In their review Ahmed *et al.* (2013) outlined various techniques that can be used to preserve vegetables. They include but not limited to sun drying, solar drying, freeze drying, oven drying and osmotic dehydration. Their study however, showed that in most cases sun drying of vegetables resulted in spoilage. Their study cites solar drying as the best alternative to sun drying as the vegetable can dry faster. It further recommends freeze-drying on perishable vegetable mainly on transit. In addition, oven drying is suitable for drying of a small portion considering its limited capacity. Zhang *et al.* (2017) argues that the method used should not only be efficient and economical but also maintain the colour, nutrients, dry uniformly as well as retention of favourable texture and appearance; gave credit to solar dryers, heat pump dryer, super steam dryer and multistage dryer. Babu *et al.* (2018) in the review of leaf drying mechanisms classified leaf drying into three broad categories, that is, thermal drying, chemical drying and special drying.

The same reference (Babu *et al.* ,2018) further expound that thermal drying uses heated air temperature, is efficient and is commonly used. Thermal drying is further sub-divided into natural convection comprising of open sun drying, shade drying and wind drying, the other sub-division is forced convection made of cabinet tray that has fixed bed drying, fluidized drying, hybrid drying, oven drying ,solar drying and heat pump drying as well as conveyor drying. Chemical drying comprises of glycerin drying, silica sand drying and calcium chloride drying. Finally special drying is made up of press, greenhouse, freeze, carbon IV oxide, microwave vacuum, radio frequency and vacuum drying. On their effectiveness it is generally accepted that forced convection takes a shorter time compared with natural convection.

According to Omolola *et al*. (2017) open sun drying is the cheapest and the most common method used in developing countries like Tanzania. Mats and sacks are used as drying surfaces and in most cases they are placed on raised platforms to cushion vegetables from wind blown dust and domestic animals. This method however does not effectively prevent dust and are prone to insect infestation. In some households where natural flat stones exist they make good surfaces as drying process is faster than on mats or sacks. Preserved vegetables last for two to four months. Preserved vegetable can be used for own consumption or sold.

Porat *et al*. (2018) found out that loss occur in the agricultural value chain from production to consumption. The issue of food loss and waste is a major threat as more than half of vegetables and fruits produced are lost and not consumed. Strategies should thus be adopted to reduce such losses. Nyomora and Mwasha (2007) disclosed that more than 2000 women in Tanzania had been trained on preservation of vegetables. This is advancement in enhancing availability of dried vegetables. The main vegetables being processed included; black jack, cowpea leaves, amaranth and African nightshade. This study did not only identify various species being processed but also examined the frequency of their consumption.

According to Maria *et al*. (2015) vegetables can be contaminated during storage and transport. Proper refrigeration is important to reduce pathogen attack and spoilage (Mathews, 2009). This is a good alternative; however, refrigeration is expensive with high maintenance cost and requires electricity which is not accessible and affordable to rural farmers (Yimer & Sahu, 2014).

The focus of this study was on open sun dried TAVs and solar dried TAVs currently being utilized in Tanzania as shown in Figure 2. Guiné *et al.* (2011) in their comparative study on pears drying found out that there was a reduction of up to 40% drying time when solar dryer was used as opposed to open sun drying. Agrawal and Sarviya (2016) are in agreement that solar dryers are attractive and cost effective. Zend *et al*. (2016) carried out an extensive research in India using open sun drying and solar drying and found out that vegetable could be stored for up to six months. According to Cao *et al.* (2016) on effect of different drying technologies on the quality of red pepper in Beijing, China concluded that, despite its shortcoming (time consuming) it was also evident that open sun drying was superior to infrared drying and hot air drying in colour preservation for red pepper. Analysis by Matemu and James (2016) proved that solar dried vegetable retain several micronutrients. This was also in consensus with a study by Chege *et al*. (2014).

Figure 2: Solar dried and open sun dried traditional African vegetables in the study area

Source: Kessy *et al*. (2018)

2.3 Determinants of Consumption of traditional African vegetable

Vegetables contributes towards expanding the dietary diversity among urban and rural populations. However, the consumption level of vegetables in the developing nations has been found to be lower than the recommended standard of at least 240 grams per person per day. A study by Jape (2017) sought to find out the patterns and factors determining consumption in Tanzania. The study utilized cross-sectional data that was gathered from farm households. It embraced logistic regression in analysing the data. The results revealed that the average daily consumption of vegetables per individual was 205. 9 grams hence it did not meet the recommended standard by World Health Organization. In addition, education, gender of household head, regular and easy access to vegetables and ownership of vegetable gardens had a positive and significant influence on household consum ption of vegetables.

However, household size, concern for vegetable safety and household income were negative and significant. The study recommended policy measures aimed at improving the consumption of vegetables. However, the study indicated that number of children who were less than five years and those aged between 5 and 15 years did not influence household consumption of vegetables. This contradicted the findings of Ochieng *et al.* (2017) who reported that number of children within the age bracket influenced household consumption of vegetables.

Mbwana (2019) investigated the consumption pattern of wild leafy vegetables in Tanzania using qualitative approach. The data used was gathered from rural women using techniques such as focus groups and face to face interviews. According to the study, wild vegetables were consumed by most of the women due to their nutrients, good taste, medicinal value and availability. The study pointed out the need for the vegetables to be domesticated and commercialized to generate income for households. However, the study did not indicate whether or not the consumption level of the vegetables among the rural households met the recommended standards.

Gido *et al.* (2017) used count data model (ZINB) to investigate the intensity of leafy indigenous vegetables consumption among rural households in Kenya. The study embraced correctional data that was gathered from respondents within urban and rural areas. The results indicated that the consumption intensity of the vegetables in rural areas exceeded that of urban areas. Moreover, the consumption intensity of leafy indigenous vegetables was influenced by occupation, age, household size, distance to the market, awareness of the vegetables' medicinal value, diversity of the vegetable leaves and income proportion allocated to food budget. The study recommended the need to adopt strategies aimed at educating the young and male consumers about leafy indigenous vegetables. Also, it pointed out the need to improve the efficiency of the supplied chains and diversify production to increase the consumption intensity of the vegetables. However, the study did not take into consideration the seasonal variations that could influence consumers' behaviour thus affecting their intensity of consumption.

Another study by Kimambo *et al.* (2018) used factor analysis and Generalized poison to investigate factors determining consumption frequency and perceptions on TAVs in Tanzania. According to the study, consumption of TAVs was inlunced by consumers' income, taboos, price of the vegetables and distance to the market. Conversely, the outcome of factor analysis revealed that taste, freshness, health and perception had a significant influence on the consumption of TAVs. The study pointed out the need to promote to cooking approaches that could support preservation of food taste. Moreover, it pointed out the need to adopt technology which could preserve nutrients and freshness on of TAVs.

2.4 Elicitation methods of consumer willingness to pay

Willingness To Pay is the amount of money an individual or household is willing to give to obtain a product (considering solar dried TAVs in this case) given the preference, income and other characteristics (Ramasubramania, 2012). The choice of a method depends on how easy to understand, conduct and if it can be carried out with one individual at a time (Alphonce & Alfnes, 2016). In her review Jerop (2012) on consumer WTP for dairy goat milk in Siaya County, Kenya, highlighted various approaches to elicit WTP. These include open ended, bidding, payment card approach, and dichotomous choice payment, that is, either single-bounded or double-bounded approaches. Apart from contigent valuation method,Willingness to pay can be elicited through real choice experiment, Becker DeGroot Marshack mechanism among others.

2.4.1 Contingent valuation method (CVM)

According to Senyolo *et al.* (2014) there are various elicitation techniques for consumer WTP including Contingent valuation method (CVM). CVM is a survey-based method of eliciting how consumers evaluate new goods and services not found in the market place. The method uses a stated preference approach to elicit consumer's preference. Ongudi *et al.* (2018) argues that it is flexible and can measure use and non-use value of a product hence it is supported globally. Lagerkvist *et al.* (2013) employed a payment card (PC) contingent valuation to determine WTP for food safety among respondents at a point of purchase of kales in Nairobi, Kenya. Payment card is used to ask consumers for a choice from a series of ranges (Kimenju *et al.*, 2005). Chelang'a *et al.* (2013) and Senyolo *et al.* (2014) used semi-double bounded CVM to analyze consumer willingness to pay for leafy vegetables in Eldoret, Kenya and South Africa respectively. Amfo *et al.* (2018) used the closed double-bounded CVM to elicit WTP a premium for certified vegetables arguing that it generates realistic estimates and easier for consumers to respond.

According to Rodriguez *et al.* (2008), CVM is commonly used for evaluation of consumers' monetary value preferences for nonmarket goods and services. It is applicable to a small-scale niche to market goods, solar dried TAVs are not usually available in all places at the moment. Contingent valuation method tends to quantify the value consumers assign to a product by facing a hypothetical purchasing situation in which they have to answer how much money they would be willing to pay for a given product, or if they would be willing to pay a certain price premium. In dichotomous choice Contingent valuation consumers are given a specific amount (bid), B_n and asked whether they are willing to pay that amount. The respondent has a choice to answer with a "yes" or "no". This is then followed with a higher bid till the consumer answer with a "no" for an initial bid answer "yes" and lower bid till the respondent answer "yes" if the initial bid was a "no".

2.4.2 Choice experiment (CE)

Contingent valuation method came under heavy criticism on validity of the results. Attempts to reduce the hypothetical bias resulted in choice experiment (CE) (Carlson *et al.,* 2005).
Choice experiments (CE) is based on Lancasterian consumer theory which proposes that consumers make choices, not on the simple marginal rate of substitution between goods, but based on preferences for different attributes of these goods (DeGroot *et al.,* 2014). The disadvantage of this technique is inconsistency in responses and high variation in the estimated WTP. Domonko *et al.* (2018) on consumer perceptions of vitamin A deficiency of biofortified rice in Morogoro region of Tanzania used CE and CVM to measure WTP using a sample of 300 consumers. CE was used to estimate preference for product attributes. They sighted the two methods since superiority of CVM to CE was unknown. CE was analysed by conjoint analysis for different rice attributes.

2.4.3 Becker-DeGroot-Marshack (BDM)

BDM mechanism induces individuals to truthfully reveal their WTP and reflect real purchase situation (My *et al*.,2018). According to De Groot *et al.* (2011) . BDM supersedes English auction, second price auction (vickery), and random *n*th price auction in that it can be executed individually thus preferred by researchers despite all of them being incentive compatible. Becker-DeGroot-Marschak (BDM) mechanism is seen as a suitable option.those taking part in bidding bid against a number drawn from a random distribution, imitating an auction. Participants whose bid is higher than the randomly drawn price win. They however must purchase the the product or service at the random price. The process is suitable for conducting research on individuals. It is thus applicable to a random population (Chege *et al*., 2019; DeGroot *et al.,* 2014). BDM has been reported to be very easy to be understood by participants and the outcome is based on an individual decision-making mechanism instead of group decisions (Xie & Gao, 2013).

2.4.4 Combined elicitation methods

Alphonce and Alfnes (2016) compared four methods on WTP for organic characteristics and food safety in tomatoes among participants involved in food purchase in Morogoro, Tanzania; BDM, multiple price lists, multiple price lists with stated quantities and real-choice experiment techniques were used. They found out that for all the methods consumers were willing to pay a premium for safety attribute in tomatoes. For the interest of this study we base the conclusion on BDM and CE. The study agrees that BDM give direct estimates each consumer is WTP with real choice experiment giving generally higher values. Field experiments are not common in African context due to finance and logistical problem (Alphonce & Alfnes, 2012; De Groote *et al.,* 2011; Lagarkvist *et al.,* 2011; Probst *et al.,* 2012;). Vickrey-style sealed bid auction with endogenously determined market prices and BDM mechanism with exogenously determined prices are the most commonly used experimental methods (Becker *et al*., 1964; Vickrey, 1961). These methods induce participants to reveal their true preferences.

Kimenju *et al.* (2005) concluded that understanding consumer' attitudes and preference is important. Their study was undertaken by use of three methods, CVM, CE and experimental auction. It also revealed that experimental auction produced most realistic results and the drawback of CE is being more demanding. Shi *et al.* (2018) compared WTP estimates from real choice experiment, real double-bounded dichotomous contingent valuation and Becker-DeGroot-Marshack in an attempt to explain discrepancies and found that the bids in BDM were understated.

2.5 Determinants of willingness to pay

In ascertaining the market potential of hypothetical product or product that is new and its market price not well known, WTP is the most preferred technique. In such studies, socio-demographic, perceptional and institutional factors that may influence consumer WTP are hypothesized (Ongudi *et al.,* 2018). Ngigi *et al.* (2011) in their assessment of 150 urban consumers found out that females were more involved in the purchase of leafy vegetables and those with university and higher education was significant in terms of quality and safety. They further found that nutritional value was highly ranked by consumers. Lagerkvist *et al*. (2013) in an investigation on mean WTP pay for safer kale among peri-urban consumers in Nairobi, Kenya though determinants being market segment specific, safety attribute was significant .This tally with a study by Oniang'o *et al.* (2008) who concluded that occupation, sex, income and education are some of the major factors affecting consumption and utilization of leafy vegetables.

A study by Chelang'a *et al*. (2013) on African leafy vegetables in Eldoret, found that WTP is influenced by age, presence of children, years of schooling, household decision maker and consumption period. However, analysis by Owusu and Anifori (2013) on consumer WTP price premium for organic watermelon and lettuce among consumers in Kumasi Metropolis of Ghana found out that age and gender were insignificant. Senyolo *et al.* (2014) agrees that gender, age, taste and availability of African leafy vegetable influence the WTP. This is also consistent with a study by Pato (2012) on WTP for cassava leaves. In his study more than 80 % were willing to pay a premium for TAVs. This contradicts with Domonko *et al.* (2018), who found out that consumers with higher education were less likely to choose biofortified rice, though significant education was negative. Older people were less likely to choose rice associated with reducing risk of visual impairment. The results showed that females and low income earners were willing to pay for higher nutritional rice. Decreasing income by a unit increased the probability of consumer believing that they were not at risk of suffering from vitamin A deficiency (VAD). They noted that lower income individuals were not aware of risk associated with VAD. Only a small portion of consumers were aware of biofortification of rice (18%). Coulibaly *et al.* (2011) brings out additional aspect of availability as a determinant. Kathuria and Singh (2016) further found out that off-season availability as important determinant among consumers of imported fruit and vegetables in India. Kessy *et al.* (2018) in their study on awareness, perceptions and factors affecting purchase decision of solar dried TAVs in Dodoma and Singida regions, Tanzania using cross-section data concluded that young consumers seem to consider nutritional value, taste, and off-season availability as important attributes. Similar reference show that females were more concerned on safety while married consumers valued nutrition whereas unmarried were more concerned with price. This study agrees that timely availability and drying method were highly perceived by consumers as important. Safety, colour, taste, easiness of preparation, nutritional value is important attributes considered by consumers.

In his thesis on assessment of consumer WTP for induced quality attributes on processed cassava leaves in Morogoro, Tanzania, Pato (2012) found out that dried leaves had the lowest score for colour attribute while processed cassava leaves were rated highly for texture, aroma and general appearance. This study will however, try to overcome this by promoting solar dryers that maintain colour attribute. Pato (2012) further recommends a study on WTP on other indigenous vegetables and replication in other parts of Tanzania. Traditional African vegetables have a good taste, are easy to cook and handle (Musebe *et al.,* 2017). Knowledge of TAVs was associated with high consumption of leafy vegetables among rural households (Gido *et al.,* 2017). The same reference further showed that young consumers with high level of education had perception that AIVs had unfavorable taste among urban dwellers. Ngigi *et al.* (2011) focused on a range of attributes of leafy vegetables including safety, nutrition, environmental friendliness and hygiene. According to Coulibaly *et al*. (2011) attributes like colour and freshness was an important consideration among the consumers. The study recommends development of packaging and labeling of organically grown vegetables. Amfo *et al.* (2018) examined consumers in Tamale, Ghana, on certification; found out that young, well educated and affluent consumers were WTP a premium for certified vegetables.

According to Ongudi *et al*. (2018) on the determinants of consumers' willingness to pay for biofortified pearl millet in Kenya using a two-stage Heckman model; frequency of consumption of finger millet, household income, level of awareness on the benefit of biofortified millet products, if the decision maker consumes the product were some of the factors determining the level of WTP. Those who were aware of the benefits and with high income were willing to pay a higher premium for biofortified pearl millet. However, their study did not discount for consumers who were not willing to pay the initial set bid. This is in line with the findings by Ngigi *et al.* (2011) on WTP for leafy vegetables among urban consumers in Nairobi, Kenya.

Kessy *et al*. (2018) on awareness, perceptions and factors affecting purchase decisions asserts that gender, income, household size, price, experience or prior consumption of dried vegetable and awareness of dried vegetables are the major determinants of household perceptions towards solar dried TAVs. Amfo *et al.* (2018) carried out a survey targeting Ghanaian women purposively and ascertained that women are solely involved in vegetable purchasing decision.

2.6 Gaps in literature review

Miller *et al*. (2012) posed a serious question on which method is the most suitable to measure WTP. Their study sights that consumers are faced with how to actually estimate a new product value, unwillingness to pay while others give strategic answers hoping to get lower prices. The findings from Miller's study show that BDM has the least deviation. This study compared mean WTP from various methods.

Various studies like Mamiro *et al.* (2011) advocate for creation of awareness to enhance consumption of cowpea leaves in Singida and Dodoma regions among rural households. However the study did not state how the vegetable can be accessed by consumers throughout the year. This study thus intends to suggest possible ways of enhancing its availability. Nyomora and Mwasha (2007) recommended a further study on nutritive and non-nutritive value of fresh and preserved TAVs. From the literature limited studies for example Kimenju *et al.* (2005) combined the three methods in a study on biofortification of maize in Western Kenya. This study contributes not only to the three elicitation methods but also in advancement on vegetable study in Tanzania. Kessy *et al*. (2018) despite focusing on solar dried TAVs in Dodoma and Singida did not test for consumers' WTP. This study will therefore focus on testing consumers' WTP for solar dried TAVs. It is also evident that most of these studies were carried out among urban consumers and with fresh TAVs with a few like Gido *et al.* (2017) who carried out a comparative study between the two segments. This study exclusively focused on dried vegetables among rural households.

2.7 Theoretical and conceptual framework

2.7.1 Theoretical framework

This study is grounded on consumer utility theory. This is because consumers in developing countries face uncertain conditions during the consumption process and are likely to make their decision depending on the expected utility derived from solar dried TAVs. The study expects that consumers will base their decision to pay or not to pay for the solar dried TAVs in relation to satisfaction they will derive from it. The consumer will be willing to pay for the solar dried TAVs if the utility they derive from it is higher than they obtain from open sun dried TAVs.

The consumers' decision is in the form of a utility function and therefore the problem will be a utility maximization problem. The study assumes that an individual derive utility from paying for solar dried TAVs. Consumers' willingness to pay for solar dried TAVs is represented by V, where V=1 if the consumer is willing to pay and V= 0 if he or she is not willing to pay. The utility preference function for an individual can be written as $u(x, q)$ where $x = x_1,........, x_n$ is a vector of private goods and $q = q_1............q_n$ is a vector of public goods. Individuals have to make choices for private goods since their availability is limited and come at a cost while public goods are readily available thus considered exogenous. An individual maximizes utility subject to income *y*. The direct utility function $v(p,q,y)$ is given by:

$$V(p,q,y) = \max\{u(x.p) \mid p.x \leq y\} \quad \text{………………………………………………….. (1)}$$

The derivative of the expenditure function yields the Hicksian or utility constant (compensated) demand function with the sub script indicating the Marshallian or demand curve:

$$u_1(p,q,y) = mp_1(p,q,u) \quad \text{……………………………………………………………….. (2)}$$

WTP is defined using the indirect utility function as;

$$v(p,q^* y - WTP) = v(p,q,y) \quad \text{…………………………………………………………… (3)}$$

Where $x^* \geq x_1$ and increases in *x* are advantageous $\frac{\partial v}{\partial x} > 0$ implying that higher consumption level of *x* leads to higher utility.

This can also be modeled under random utility theory especially in the case of choice experiment. The decision to select solar dried TAVs over open sun dried TAVs occur only if the utility expected from select solar dried TAVs is greater. If u_o is the utility derived from the open sun dried TAVs u_1 is the utility derived from select solar dried TAVs then the model can be expressed as:

$$u_0 = \beta_i X_i + \varepsilon_0 \quad \text{……………………………………………………………… (4)}$$

$$u_1 = \beta_i X_i + \varepsilon_1 \quad \text{……………………………………………………………… (5)}$$

where β_i is the parame P and ε_0 and ε_1 are disturbance terms. A consumer decides to purchase solar dried TAVs ter to be estimated, X_i is the explanatory variables that influences the u_1 household WT if is greater than u_o.

2.7.2 Conceptual framework

Figure 3 shows conceptualization of consumption of dried TAVs and willingness to pay for solar dried TAVs. Willingness to Pay can be assessed to depend on various interlinking factors. Product qualities tend to attract or push away consumers. Solar drying technology is likely to change product qualities thus enhance attitudes and perception towards solar dried TAVs resulting in consumer willingness to pay for it. Colour is an important aspect in solar dried TAVs. Packaging method can also influence the perception and attitude of consumers on utility likely to be derived from consuming such product. Knowledge of dried vegetable is likely to influence awareness of availability of solar dried TAVs resulting in households' consumption for it. The driving force is technology (solar driers). Consumers' socio-economic factors include age, gender, income, household composition and education level. Institutional factors like location, awareness of dried TAVs and information access were also hypothesized as critical determinants of consumption and WTP. If consumers are WTP it will lead to enhanced access of solar dried TAVs resulting in long term goal of household nutritional security. On the hand if consumers are unwilling to pay for solar dried TAVs it may result in limited access to nutritious vegetable and its effect will be evident in malnouris hed rural households.

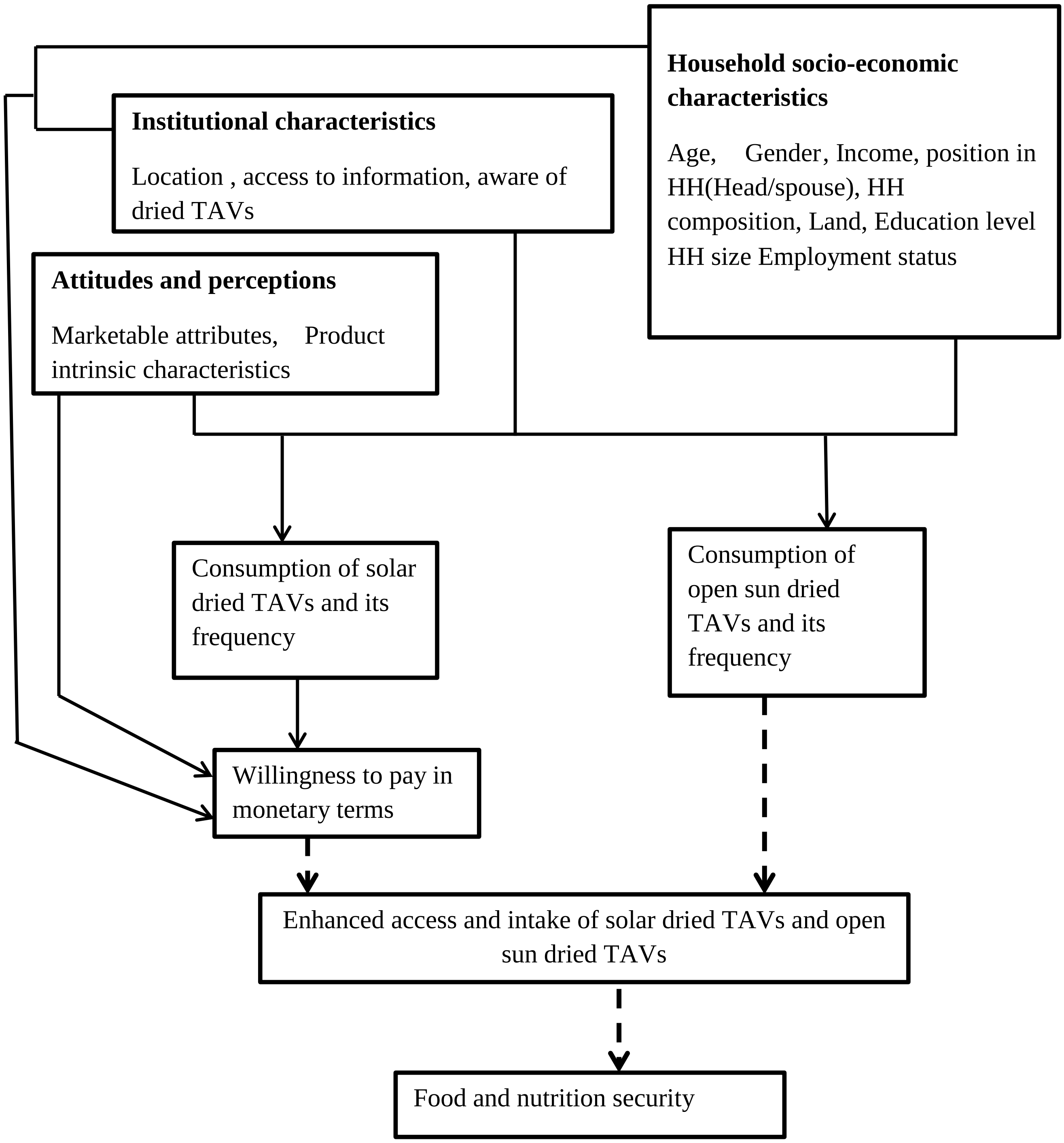

Figure 3: Conceptualization of consumption and willingness to pay for TAVs

TAVs-traditional African vegetables

HH-household

CHAPTER THREE

METHODOLOGY

This chapter deals with materials and methods. It begins by looking at area where the study was carried out. It thens provide the sampling procedure and how the data was collected. Finally a comprehensive analytical framework for each objective was technical written. This sub-section provides modeling and the econometric models adopted and used.

3.1 Study area

This study was based on rural households in Tanzania officially referred to as United Republic of Tanzania (URT). Tanzania is located between 1° and 12° south of the equator and between 29° and 41° east of Greenwich meridian (Nyomora &Mwasha, 2007).This study majored on three districts of Mpwapwa and Kongwa (Dodoma region) and Iramba district (Singida region). As per 2012 census Mpwapwa district had a total of 305,056 people comprising of 278,455 in the rural and 26,601 being urban. Kongwa District had a population of 309,973 with a distribution of 279,961 living in the rural and 30,012 making up the urban population. Iramba had a total of 236,282 with 218,645 and 17,637 being rural and urban populations respectively. The two districts in Dodoma were purposively selected because the World Vegetable Center had initially conducted trainings on vegetables drying. In addition, Iramba District was selected as control because it was not reached before by the same intervention. The three districts forms part of the semi-arid central zone of Tanzania, which experiences low rainfall in short seasons which are often erratic, with fairly widespread drought in one year out of four. Total rainfall ranges from 500 mm to 800 mm per annum (URT, 2016). Moreover, temperature differences are observed between day and night and may be very high, with hot afternoons going up to 35 °C and chilly nights going down to 10 °C. The map of study area is as shown on Figure 4.

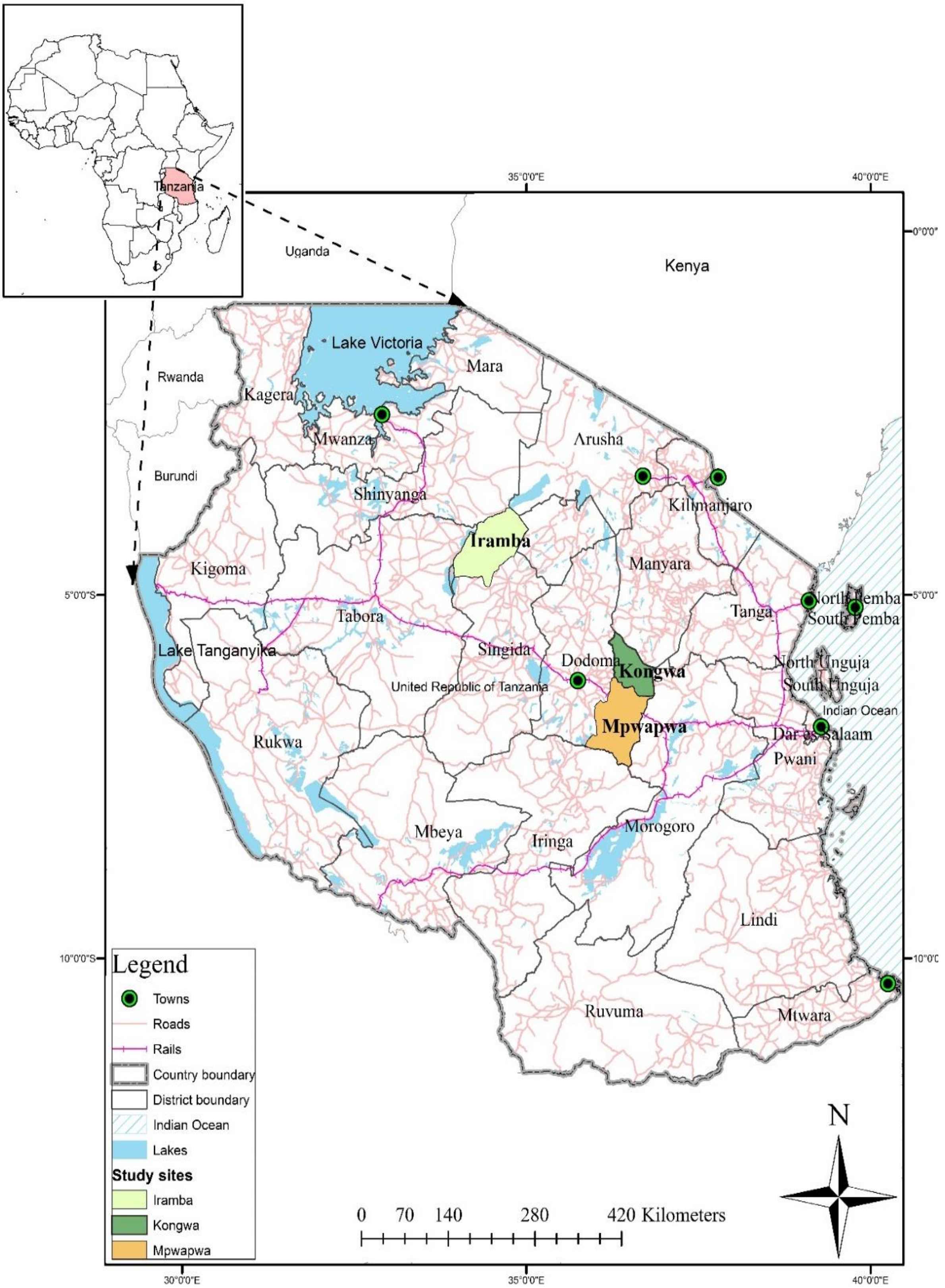

Figure 4: Map of the study area

Source: Geography Department, Egerton University (2018)

3.2 Sampling procedure

A multistage sampling procedure was used to obtain rural consumers to participate in the survey. In the first stage, purposive sampling technique was adopted to identify the districts based on interactions with vegetables stakeholders. Divisions were purposively selected, that is, one in each district. Two wards in each division were also purposively selected and finally the villages were randomly selected. The villages are the lowest administrative unit in the country and were therefore suitable as primary sampling unit. Two villages were randomly selected from each ward.

Within each selected village, twenty households were randomly selected to give a total of 240 consumers. The selected households were visited between July and August 2016 by six trained enumerators. The respondents were either household head or the spouse of the head because they are mainly involved in food purchase decision making and preparation.

3.3 Data collection

This study utilized secondary data collected in July to August 2016. Data was collected through personal interviews using pre-tested questionnaires by six trained enumerators. The data collected includes socio-economic information, information on awareness and demand for dried vegetables; product attributes on Likert scale, consumers' attitudes, perceptions and consumption, constraints to consumption and finally their WTP by choice experiment, contingent valuation and BDM.

Profiling of all vegetables frequently consumed in the study area was done. They were but not limited to: tomato(*Lycopersian esculentum*), amaranth (*Amaranthus hybidus*),pumpkin leaves (*Cucurbita maxima*), African eggplant (*Solanum aethiopicum*), African nightshade(*Solanum nigrum*),cowpea leaves (*Vigna unguiculata*), spider plant (*Cleome gynanda*) cassava leaves(*Manihot esculenta*), Ethiopian mustard (*brassica* carinata),sweet potato leaves(*Ipomea batatas*), cabbage (*Brassica spp*.), jute mallow*(Corchorus olitorius*), onions(*Allium cepa*), carrots(*Daucas carota*), eegplant(*Solanum melongena*), Chinese cabbage (*Brassica rapa*), and nsonga . In testing willingness to pay cow pea was used as a representative of traditional African vegetables since it is the most commonly grown and consumed in the study area.

3.4 Analytical framework

Data was analysed using STATA 14. Analysis was both quantitative and qualitative.

3.4.1 Objective one: To identify product attributes consumers look for when purchasing vegetable

Product attributes include; taste, price, drying method, colour, ease of cooking, freshness, texture, nutritional value, timely availability, packaging, hygiene of dried vegetables and taste of fresh cowpeas. Factor analysis was used to analyze this objective. It is a process in which the values of observed data are expressed as functions of a number of possible causes in order to find out which are the most important.

Confirmatory factor analysis was carried out with structural equation modeling using generalized least square method (Steptoe *et al.*, 1995). Eleven (11) factors with item rating coded from 1(not important) to 5(very important) were analysed.

According to Yang and Liang (2013) CFA model can be specified as;

$$X = \nu\eta + \varepsilon \quad \text{……………………………………………………………………………… (6)}$$

Where X is the vector for n observable variables item score; ν is the factor loading; η is the factor score vector and ε is the error score. Factor analysis was used in reducing the factors and in generating variables used in regression.

3.4.2 Objective two: To determine household's consumption frequency of solar dried an dsun dried traditional African vegetables

This was modeled by bivariate ordered probit model. This model offers an estimate between correlations of errors (Dumortie *et al.,* 2017). Understanding consumption frequency will help in classifying consumers as either low or high vegetable consumers thus decide the best course of action. Consumption of solar dried TAVs and open sun dried TAVs was expressed as frequency of consumption. The frequency of consumption was the dependent variable measured as an ordinal variable. In this study, we had five categories (1) more than twice a day (2) once a day (3) 1-2 times a week (4) 3-5 times a week (5) once a month. The consumption of the two types of dried vegetables can be estimated simultaneously by a bivariate ordered probit. Consumption frequencies of solar dried TAVs and open sun dried TAVs might not be independent thus make bivariate ordered probit suitable.

The bivariate ordered probit is a development of univariate ordered probit model. Univariate model can be expressed as;

$$y_i^* = \beta X_i + \varepsilon_i \qquad \text{……………………………………………………………..(7)}$$

Where y_i^* is unobserved latent utility of consumption of dried vegetables

β is a vector of coefficients to be estimated

X_i is a vector of explanatory variables

ε_i is the error term

In this study the consumption frequencies are observed discrete categories denoted as y_i;

$$y_i = \begin{cases} 1 & \\ 2 & y_i^* \le u_1 \\ \vdots & u_i < y_i^* \le u_2 \\ & \\ & y_i^* > u_l \\ l & \end{cases} \qquad \text{……………………………………………………………(8)}$$

Where;

u_i Is unknown cut-off of the latent utility to be estimated

l is the number of frequency categories. For this case l =5

If the error term follows a standard normal distribution then we have;

$$p(y_i = 1) = \int_{-\infty}^{-\beta X_i} \phi(\varepsilon_i) d\varepsilon_i = \varphi(-\beta X_i)$$

$$p(y_i = 2) = \int_{-\beta X_i}^{u_1 - \beta X_i} \phi(\varepsilon_i) d\varepsilon_i = \varphi(u_1 - \beta X_i) - \varphi(-\beta X_i)$$

$$p(y_i = 3) = \int_{u_2 - \beta X_i}^{u_3 - \beta X_i} \phi(\varepsilon_i) d\varepsilon_i = \varphi(u_2 - \beta X_i) - \varphi(u_1 - \beta X_i)$$

$$p(y_i = 4) = \int_{u_3 - \beta X_i}^{u_4 - \beta X_i} \phi(\varepsilon_i) d\varepsilon_i = \varphi(u_3 - \beta X_i) - \varphi(u_2 - \beta X_i) \qquad \text{…………………………….(9)}$$

$$p(y_i = 5) = \int_{u_4-\beta x_i}^{\infty} \phi(\varepsilon_i) d\varepsilon_i = 1 - \varphi(u_4 - \beta x_i)$$

Where;

ϕ is the standard normal probability density

φ is the cumulative distribution function

β are unknown parameters to estimated

ε_i is the error term

For open sun dried TAVs and solar dried TAVs the probabilities can be given as;

$$P(y_{1i} = h, y_{2i} = j)$$
$$= \int_{u2(j-1)-\beta_2 x2i}^{u2j-\beta_2 x2i} \int_{u1(h-1)-\beta_1 x1i}^{u1h-\beta_{1h} x1i} \phi_2(\varepsilon 1i, \varepsilon 2i, \sigma) d\varepsilon 1i \, d\varepsilon 2i$$
$$= \varphi_2(u1h - \beta_1 x1i, u2j - \beta_2 x2i, \sigma) - \varphi_2(u1(h-1) - \beta_1 x1i, u2j - \beta_2 x2i, \sigma) \quad \text{.....(10)}$$
$$- \varphi_2(u1h - \beta_1 x1i, u2(j-1) - \beta_2 x2i, \sigma) + \varphi_2(u1(h-1) - \beta_1 x1i, u2(j-1) - \beta_2 x2i, \sigma)$$

Where y_{1i} is the observed frequency of consumption of open sun dried vegetable ($h = 1, ..., 5$) and y_{2i} is the observed frequency of consumption of solar dried vegetable ($j = 1, ..., 5$);

ϕ_2 is the standard bivariate normal probability density

φ_2 is the cumulative distribution function

σ is an unknown correlation between ε_{1i} and ε_{2i} to be estimated

Maximum likelihood will be used to estimate β , σ , u_h, u_j, ε_{1i} and ε_{2i} in this model

The empirical model can be specified as below;

$$y_{1i}, y_{2i} = \beta_0 + \beta_1 EducYrs + \beta_2 Age + \beta_3 Infor + \beta_4 Adult1 +$$
$$\beta_5 Adult2 + \beta_6 Child1 + \beta_7 Child2 + \beta_8 Drought + \beta_9 INCOME +$$
$$\beta_{10} HHpos + \beta_{11} Land1 + \beta_{12} Gender + \beta_{13} Land2$$
$$+ \beta_{14} Kongwa + \beta_{15} Mpwapwa \text{..11}$$

Table 1: Variables used to analyze consumption pattern of dried TAVs

Code	Variable	Measurement of variable	Expected sign
Dependent variable			
y_{1i}	Frequency of consumption of open sun dried TAVs	1=more than twice a day, 2=once a day 3= 1-2 times a week, 4=3-5 times a week , 5= once a month	
y_{2i}	Frequency of consumption of solar dried TAVs	1=more than twice a day, 2=once a day 3= 1-2 times a week, 4=3-5 times a week 5= once a month	
Independent variables			
Mpwapwa	Location	Dummy(1=yes, 0=otherwise)	+/-
Kongwa	Location	Dummy(1=yes,0= otherwise)	+
Infor	Access to solar dried information	Dummy(1=yes,0= otherwise)	+
Land1	Cultivate own land	Continuous	-
Land2	Cultivate leased land	Continuous	-
Age	Age of respondent	Continuous	+/-
Gender	Gender of respondent	Dummy(1=male,0=otherwise)	-
HHpos	Position of respondent in the household	head(1=yes,0=otherwise)	+/-
EducYrs	Education level of respondent	Continuous	+
CHILD1	Children below 4 years	Continuous	+
CHILD2	Children between 5-14 years	Continuous	+
Adult1	Adults between 15 - 64 years	Continuous	+/-
Adult2	Adults above 64 years	Continuous	+/-
INCOME	Gross income	Continuous	+

3.4.3 Objective three: To estimate household's willingness to pay for solar dried TAVs

Willingness to Pay can be estimated through hypothetical methods such as Contingent Valuation or Choice experiment as well experimental auction (DeGroot *et al*., 2014). Cowpea leaves was used in this study to represent other TAVs. This study combined three methods (choice experiment, contingent valuation and Becker-DeGroote-Marshack) to ensure the accuracy for the findings. According to Kimenju *et al.* (2005) comparing premiums from different methods leads to strong conclusions. All respondents selected were given participation fee to purchase the dried cowpea leaves in the willingness to pay (WTP) experiments. Contigent valuation and Becker-DeGroot –Marshack are non comparative as opposed to choice experiment.

For this objective it involved two steps;

i. The first step is to determine the mean amount the consumers are willing to pay based on premiums using three elicitation techniques: contingent valuation, choice experiment and Becker-DeGroote-Marshack
ii. The second step is to compare results based on choice experiment, contingent valuation and Becker-DeGroote-Marshack elicitation technique.

Contingent valuation: double bounded

The double-bounded CVM involves two stages. In the first stage consumer was asked if they were willing to pay for a given bid for dried vegetables. In the second stage consumer was offered with a higher bid if the first respond was 'YES' or a lower bid if the first response was a 'NO'. This results in "YES-YES" or "YES-NO" for an initial acceptance of the bid B_n^r . If the initial bid is rejected a lower bid is offered B_n^l resulting in; 'NO-YES' or 'NO-NO' (Amfo *et al.,* 2018). The probabilities p^* can be written as:

$$p^{yy}(B_n, B_n^r) = pr(WTP_n > B_n^r) = 1 - G(B_n^r;\theta) \text{ ,…………………………..……………. (12)}$$

$$p^{yn}(B_n, B_n^r) = pr(WTP_n < B_n^r) = G(B_n^r;\theta) - G(B_n;\theta) \text{ ,…………………….…………… (13)}$$

$$p^{ny}(B_n, B_n^l) = pr(B_n^l < WTP_n < B_{n_n^r}) = G(B_{n_n^r};\theta) - G(B_{n_n}^l;\theta) \text{ …………..…..……. (14)}$$

and

$$pnn(B_n, B_n^l) = pr(WTP_n < B_n^l) = G(B_n^l;\theta) \quad \text{.......................................} (15)$$

Where; WTP_n is the maximum willingness to pay, $G(*;\theta)$ is cdf of the WTP and θ are the parameters to be estimated.

A double bounded dichotomous choice model was chosen since it took into consideration the higher and lower responses and allowed for simultaneous estimation (Atsiaya *et al*., 2017)

$$LL(\theta) = \sum_{n-1}^{N} \{ d_n^{yy} \ln p^{yy}(B_n, B_n^r) + d_n^{yn} \ln p^{yn}(B_n, B_n^r) + d_n^{ny} \ln p^{ny}(B_n, B_n^l)$$
$$+ d_n^{nn} \ln p^{nn}(B_n, B_n^l) \} \text{.......................................} (16)$$

Where d_n^* are the binary values which is represented by 1 if the response will be chosen

This can thus be formulated as;

$$y_i^* = \beta_0 + \sum_{i-1}^{k} \beta x_{ij} + u_i \quad \text{.......................................} (17)$$

Where y_i^* is unobserved latent variable of the dummy variable;

β is the coefficient to be estimated

X_{ij} is a set of explanatory variables

Choice experiments

Following the principle of utility maximization alternative *j* (solar dried TAVs was chosen by individual *i* if and only if $u_{ij} > u_{im}$. Since utility is not observable, coefficients could not be estimated directly. According to McFadden (1974) the difference is based on utilities and not the absolute levels. If an individual *i* was presented with two alternatives, the probability (P) that the consumer chose alternative ***j*** over ***m*** was estimated as:

$$p_{ij} = prob(u_{ij} > u_{im}) = prob(u_{ij} > u_{im} > 0 = prob(v_{ij} + \varepsilon_{ij} > v_{im} + \varepsilon_{im}) =$$
$$prob(\varepsilon_{im} - \varepsilon_{ij} < v_{ij} - v_{im}) \forall j \neq m \quad \text{.............} (18)$$

From the above equation conditional logit model was adopted.

Since the sum of errors is unknown, the sum can be derived following kimenju *et al*. (2005)

$$p_{ij} = \int \left\{ \prod_{m-j} \exp\left(-\exp\left(-\varepsilon_{ij} + v_{ij} - v_{im}\right) \right\} \exp\left(-\varepsilon_{ij}\right) \exp\left(-\exp\left(-\varepsilon_{ij}\right)\right) d\varepsilon_{ij} \quad \text{……….…..(19)}$$

It follows that;

$$p_{ij} = \frac{e^{v_{ij}}}{\sum_m e^{v_{im}}} \quad \text{……………………………………………………………………………….(20)}$$

This implies;

$$p_{ij} = \frac{e^{\beta x_{ij}}}{\sum_m e^{\beta x_{im}}} \quad \text{…………………………………………………………………………(21)}$$

Thus the probability of consumer *i* choosing the alternative he chooses can be expressed as

$$\prod_j \left(p_{ij}\right)^{y_{ij}} \quad \text{…………………………………………………………………………… (22)}$$

Where $y_{ij} = 1$ for the alternative chosen and zero otherwise

For this case each consumer makes a choice independently therefore;

$$L(\beta) = \prod_{n-1}^{N} \coprod_j \left(p_{ij} \right)^{y_{ij}} \quad \text{……………………………………………………………….. (23)}$$

The log-likelihood is then expressed as ;

$$LL(\beta) = \sum_{n-1}^{N} \sum_j \left(y_{ij} \ln p_{ij}\right) \quad \text{…………………………………………………………… (24)}$$

Where β is the vector of parameters to be estimated in the study. According to Olynk *et al.* (2010) estimated coefficients of random utility model lack interpretation. The mean willingness to pay can be expressed as:

$$WTP = -(\beta_x / \beta_p) \quad \text{……………………………………………………………(25)}$$

Whereby β_x is the coefficient of attribute estimated and β_p is the estimated coefficient of price

Becker-DeGroot-Marschak (BDM) mechanism

BDM represent revealed preference of the respondent. In a BDM mechanism the consumer or participant places a bid, B_n for the product in this case either open sun dried TAVs or solar dried TAVs. The consumer wins the bid if the bid is greater than the random price P already determined exogenously, that is, $B_n > P$ and thus pay the price P for the product. If $B_n < P$, the bidder (consumer) pays nothing and does not get the product. This follows Lusk and Shogren (2007) that;

$$u(1, w - WTP) = u(0, w) \quad \text{.. (26)}$$

Where w is the consumer's wealth at the start of the experiment;

Maximizing the utility we have;

$$\max \int_0^{\beta_n} u(1, w - p)d\phi(p) + u(0, w)(1 - \phi(\beta_n)) \quad \text{... (27)}$$

First order condition (FOC) shows that the optimal bid solves $\left(u(1, w - \beta^{\bullet}_n)\right) = u(1, w)$ and is therefore equal to the WTP.

According to Kimenju *et al. (*2005), considering that the data is cross-section, the average bid is considered as consumers mean willingness to pay. However as normal practice for BDM studies tobit model was adopted.

3.4.4 Objective four: To determine factors influencing households' WTP for SDV

After estimation of WTP and its mean, factors that determine whether a household is willing to pay for Solar dried TAVs was investigated. Double bounded dichotomous choice model was adopted. WTP was determined by socio-economic; attitudes and perceptions based on their knowledge on solar dried TAVs. The significance level accepted was at 10% or less.

This was empirically modeled as;

$$\begin{aligned} z = {} & \beta_0 + \beta_1 EducYrs + \beta_2 Age + \beta_3 Infor + \beta_4 Factor1 + \\ & \beta_5 Factor2 + \beta_6 Awaresolar + \beta_7 Drought + \beta_8 INCOME + \\ & \beta_9 HHpos + \beta_{10} Land1 + \beta_{11} Gender + \beta_{12} Land2 \\ & + \beta_{13} Kongwa + \beta_{14} Mpwapwa \text{...} 28 \end{aligned}$$

Table 2: Variables used in analysis of determinants of willingness to pay for solar dried TAVs

Code	Variable	Measurement of variable	Expected sign
Dependent variable			
Z	Willingness to pay	1 if consumer is willing to pay premium and zero if otherwise	
Independent variables			
AWAREsolar	Aware of solar dried TAVs	Dummy (1=yes, 0= otherwise	+
Factor1	Market quality attributes	Continuous	+
Factor2	product attributes	Continuous	+/-
Age	Age of respondent	Continuous	-/+
Land1	Cultivate own land	Continuous	+
Gender	Gender of respondent	Dummy(1=male,0=otherwise)	-
Land2	Cultivate own land	Continuous	+/-
HHpos	Position of respondent in the household	head(1=yes,0=otherwise)	+/-
EducYrs	Education level of respondent	Continuous	+
Mpwapwa	Location	Dummy(1=yes,0=otherwise)	+/-
Kongwa	Location	Dummy(1=yes,0=otherwise)	+/-
INCOME	Gross income	Continuous	+

CHAPTER FOUR

RESULTS AND DISCUSSION

This section presents the results and discussions of the study. It is divided into five sub-sections. Sub-section one entails the summary of descriptive statistics. Sub-section two, presents the results from factor analysis. In sub-section three is the results for objective two on consumption frequency. Sub-section four presents the results of the mean willingness to pay (WTP) from the three elicitation techniques. Finally in the last sub-section is the results and discussion on factors influencing WTP. From the sampling design 240 respondents were to be interviewed, that is, 80 in each of the three districts. However, 81, 81 and 82 respondents were interviewed in Mpwapwa, Kongwa and Iramba respectively giving a total of 244 respondents. The results presented and discussed herein are from 244 respondents who were interviewed.

4.1 Descriptive statistics

4.1.1 Socio-economic characteristics

Table 3 summarizes the socio-economic characteristics of respondents in the study.

Table 3: Socio-economic characteristics

Variable	Mean	Std. Dev.	Min	Max
Age of the respondent(years)	45.7	13.074	21	85
Years of schooling	6.3	2.861	0	12
Household size				
Number of children below 4 years	0.7	0.784	0	5
Number of children between 5-14	1.8	1.314	0	6
Number of adults between 15-64	2.7	1.365	0	9
Number of adults above 64 years	0.2	0.526	0	2
Monthly Income (US Dollars)	75.92	99.162	2.50	750
Own land cultivated (Hectares)	2.3	3.623	0	40
Years consumed dry vegetables	34.1	16.190	1	84
Leased land cultivated (Hectares)	1.2	2.077	0	10

The youngest respondent was 21 years and the eldest 85 years with a mean age of 45.7(Table 3). The mean age implies a very active group both in consumption and decision making.

Majority of the respondents had a basic education with a mean of 6.3 years of schooling with some without any form of education and those with highest years of schooling being 12 that is secondary level. Technology transfer is associated with the level of education thus considering the low level of education implies little know-how on solar drying technology. Consumers with high level of education are more likely to be aware of nutritional value and quality of vegetables as compared to those with low level of education (Ngigi *et al.,* 2011). Increase in consumers' education level increases willingness to pay for solar dried vegetables The household size ranges from a minimum of one person and a maximum of 13 people. The mean household size is 5.4 people. The bigger the household size the higher the quantity they consume thus the higher the demand for vegetables. However, considering the cost of solar dried TAVs consumers would prefer either fresh vegetables or open sun dried TAVs to solar dried TAVs.

The number of children below four years of age and those between five and fourteen, adults between fifteen and sixty-four years and if there are those above sixty-four years of age ranges from zero (that is, none) to 5,6,9,2 respectively. The mean income of the respondents was 75.92 US dollars with the lowest respondent getting 2.50 dollars and the highest getting up to 750 US dollars per month. According to Nandi *et al.* (2017) consumer income is among factors determining willingness to pay for organic vegetables. In line with this, consumers with high income level tend to be more willing to pay premium price for a product as compared to those with low income.

The results showed a mix of own cultivated land and leased. The mean of own cultivated land was 2.3 hectares while the mean of leased land was 1.2 hectares. Some respondents did not cultivate own nor lease any land while others had a maximum of 40 hactors of own cultivated land and 10 hectares of leased land. Land cultivation can increase the consumption frequency and willingness to pay for solar dried vegetables. Farmers even if they produce other crops can sell those crops and purchase solar dried vegetables. Some respondents have consumed dried vegetables for the last 84 years implying the technique of drying vegetables is not new in the study area with a minimum of consumption length being one year and a mean of 34.1 years. Those with experience in consuming open sun dried TAVs are likely to embrace the solar dried TAVs considering their knowledge on dried vegetables.

The results in Table 4 showed that 76.2 % of respondents were female meaning the purchase decision for vegetables is largely done by women. According to Cobbinah *et al*. (2018), food purchase and preparation is largely done by females. The results are also consistent with the findings of Fungo *et al.* (2016) who indicated that women are main cooks in most families. The results moreover, indicated that 86.9 % of respondents were self-employed, 11.5 % were unemployed and only 1.7% were formally employed. This study was conducted in rural parts and as expected majority of the residents of rural areas engages in informal activities like farming and local business. The informal activities are the biggest employer thus explains why 86.89% of the respondents are self-employed. The unemployed group is either young graduates seeking employment in both formal and informal sector or are either those who are too old to work or even retired from employment.

Table 4: Gender and employment status of the respondents

Variable	Description	Frequency	Percentage
Gender	Female	186	76.23
	Male	58	23.77
Employment status of respondents	Formally employed	4	1.64
	Self-employed	212	86.89
	Unemployed	28	11.48

4.1.2 Demand for dried vegetables

The summary statistics for demand for dried traditional African vegetables are shown in Table 5. Awareness of both open sun dried and solar dried was investigated. The results indicated that all the respondents were aware of open sun dried TAVs. Drying of vegetables through open sun drying is a common practice as evident by consumption length with a respondent having consumed it for 84 years (Table 3). Since it is a common practice, awareness of open sun dried TAVs was expected to be high. The results indicated that 63.5% of respondents were not aware of availability of solar dried vegetable while only 36.5% were aware. Solar drying technology is a new practice thus this explains the relatively low level of awareness. Malik *et al.* (2013) points out that creating consumer awareness plays a critical role in stimulating buyers' interests in a product. Out of a total of 89 respondents who were aware of solar dried TAVs, 64.0 % have consumed. Awareness creates demand and since solar dried TAVs are of high quality this explains why a high percentage of those who were aware have consumed it. Consumers also respond differently to technology. However, other factors like attitudes and perceptions influence consumption. Kessy *et al*. (2018) established that attitudes and perceptions played a significant part in consumption of solar dried TAVs.

Table 5: Consumer awareness of dried and consumption of solar dried TAVs

Variable	Description	Frequency	Percentage
Aware of open sun dried	Yes	244	100
Aware of solar dried	No	155	63.52
	Yes	89	36.48
Aware and consumed solar dried	No	32	36
	Yes	57	64

Consumers had various reasons for consuming dried vegetables as shown in Table 6. Climate change is among the reasons for consumption of dried traditional african vegetables. The study area receives erratic rainfall, also considered semi-arid thus production of green vegetables throughout the year is not possible for low income rural households. Vegetable was part of almost every meal, this meant high demand. Dried vegetables can be stored for long thus this explains their consumption during dry period or its consumption based on climate change. The intertwining of dried vegetables being a traditional food and climate change was the major reason for respondents consuming it (25.82 % of the respondents). This implies consumers are aware of climatic changes and have put in place measures by drying vegetables to ensure their availability even during dry seasons. Introduction of dried TAVs of better quality (solar dried) is likely to attract high number of consumers as it both a traditional food and a solution to climate change. climate change and a combination of climate change with lack of alternative was also a significant reason with 23.77% of the respondents stating it as a reason.

Table 6: Reason for consuming dried vegetables

Consumption reason	Percentage
Traditional food	7.79
Traditional food and climate change	25.82
Climate change and a combination of climate change with lack of alternative	23.77

4.2 Product attributes that consumers consider when purchasing dried vegetable.

Attitudes and perceptions were hypothesized as important variables in determining purchasing decisions of the consumers. However, data on attitudes and perceptions were large and interrelated thus factor analysis was necessary. To determine what exactly consumers look at when purchasing dried vegetables confirmatory factor analysis (CFA) model was used. CFA was conducted on 11 likert items used to measure the latent construct for attitudes and perceptions. Post estimation tests were carried out to ensure internal consistency reliability, indicator reliability and convergent validity of selected constructs.

The results of confirmatory factor analysis indicated a good fit with the data [χ^2 =1665.05, DF=55, P=0.000] (Table 7).The Kaiser-Meyer-Olkin measure of sampling adequacy [KMO=0.911] was good. This confirms that the sample was adequate to carry out factor analysis. Bartlett's test of sphericity indicated the use of CFA was suitable for the data. A set of factors with Eigen value of one and more was retained. Two factors were retained. These results are consistent with Howard (2016) who in his review on exploratory factor analysis found out that KMO of 0.90 and above is adequate for carrying out factor analysis. The reliability analysis found that the two factors were reliable. Cronbach's alpha of above 0.6 is good. According to the rule of thumb reliability below 0.6 is not acceptable (Shaharudin *et al*., 2010).

Factor 1, market quality attributes, had high loadings on variables that consumer consider in a market setting as important. These include variables related to price, drying method, the colour of the dried product, freshness, nutritional value (minerals and vitamins), packaging and hygiene. Price is a major decision variable to consumers. Those with low income , high prices tend to push them away and might decide not to purchase the dried vegetables. However, price is associated with quality thus some consumers with little knowledge about a product would use price as their basis for decision making. Well dried vegetables attract consumers and will highly influence their decision to purchase and consume dried TAVs. Consumers have preference for green colour as it explains the nutritional value and freshness thus colour is a major attribute consumer consider in purchasing vegetables. Consumers prefer fresh vegetables and if a technique used in drying would maintain freshness then it is a useful decision tool in a market setting. Hygiene is also an important attribute consumer would observe in a market. Packaging creates a face value thus plays an important role in attracting or pushing away consumers. According to Akpoyomare *et al.* (2012) quality attributes of a products plays a significant role in determining consumers' buying decisions. It is worth noting that consumers look for important quality attributes before purchasing a product.

Factor 2, product attributes, had high loadings for variables related to taste, ease of cooking, texture and timely availability. These variables are highly product specific as opposed to market attributes. Consumers' perceived importance of these attributes tends to influence consumption frequency, their willingness to pay and purchase. A research by Davidson *et al.* (2012) indicated that product attributes such as taste and timely availability influenced consumers' willingness to pay for wild sea food and aquaculture fish products. Attributes that are market specific and those that are product specific were hypothesized to positively influence the decision to purchase both open and solar dried TAVs. From confirmatory factor analysis the results showed indeed market quality attributes and product intrinsic attributes are the determinants of consumer decusion to purchase and consume dried vegetables.

Table 7: Results of factor analysis for consumer decision factors

Variables	**Items**	**Factor loading**	**Uniqueness**	**RC**	**AIC**
F1,	Consider Price as important	0.759	0.409	0.928	1.108
market	Consider Drying method as important	0.854	0.242		
quality	Consider colour as important	0.872	0.238		
attributes	Consider freshness as important	0.827	0.237		
Akpoyom	Consider nutritional value as important	0.513	0.523		
are *et al.*	Consider packaging as important	0.804	0.335		
(2012)	Consider hygiene as important	0.899	0.166		
F2,	Consider taste as important	0.585	0.579	0.679	0.432
physical	Consider ease of cooking as important	0.498	0.510		
attributes	Consider texture as important	0.618	0.523		
Davidson *et al.* (2012)	Consider timely availability as important	0.628	0.495		
Chi-square		1665.05			
Degrees of freedom		55			
p-value		0.000			
KMO		0.911			

Note: AIC: average inter-items covariance; RC: reliability coefficient

4.3 Consumption pattern of open sun and solar dried TAVs

From Table 8, 99.2 % of the respondents consumed open sun dried TAVs during the survey period. A majority, 76.9% consumed it at least 1-2 times a day and at least 3-5 times a week cumulatively. This was due to the availability of open sun dried TAVs in the area of study.Open sun dried TAVs do not require any technology thus considered traditional mode of preserving TAVs. The results also indicated that very few respondents rarely consume it with 3.7% of the respondents consuming it at least once a month. This can be attributed to consumer awareness and open sun drying being a common practice. On the other hand, solar dried TAVs is a new product thus 23.4% of the respondents had consumed it. A majority, 64.0% of those who were aware of its availability had purchased it. A total of 33.3 % have consumed it at least once a month. This signifies a high percentage of those who rarely consume it. However, 1.8 % consumed it more than twice a day. The low consumption frequency can be attributed to low awareness and reluctance of consumers to the new product. Solar drying technology is a new innovation in the study area. The 1.8% are the innovators and early adopters who are risk lovers and would wish to try the new technologically dried TAVs.This is consistent with the findings of Appleton *et al.* (2012) and Lynch *et al.* (2012) who argued that low awareness and availability were among major barriers to increasing vegetables and fruits consumption. A study by Mamiro *et al.* (2011) pointed out the need to create awareness in order to enhance the consumption of cowpea leaves among rural households.

Table 8: Consumption frequency of sun and solar dried TAVs

Consumption frequency of open sun dried TAVs (n=244)			Consumption frequency of solar dried TAVs (n=244)		
Frequency	**Freq.**	**Percentage**	**Frequency**	**Freq.**	**Percentage**
Once a month	9	3.7	Once a month	19	33.3
3-5 times a week	91	37.6	3-5 times a week	14	24.6
1-2 times a day	95	39.3	1-2 times a day	19	33.3
once a day	21	8.7	once a day	4	7.0
More than twice a day	26	10.7	More than twice a day	1	1.8
Ever consumed	242	99.2	Ever consumed	57	23.4

4.3.1 Pre-diagnostic tests for consumption frequencies

The bivariate ordered probit was used to analyze consumption pattern and frequency for both solar and open sun dried TAVs. The model was suitable because it allowed for joint modelling of the two consumption frequencies and thus offered simultaneous results. The model incorporated attitudes and perception factors derived from factor analysis, socioeconomic factors and institutional factors. Consumption frequencies of open sun dried and solar dried TAVs are dependent variables. Pre-diagnostic tests were done before carrying out econometric analysis. Multicollinearity is a serious a problem in any econometric analysis, therefore, variance inflation factor test was done on continuous variables**.** From Table 9, multicollinearity is not a problem as the mean variance inflation factor (VIF) of 1.42 is below the threshold of 10 to be considered as a challenge. This validates the use of independent variables in further analysis without dropping some of the variables due to their interdependence. According to Akinwande *et al*. (2015) VIF of below 5 indicates low correlation among explanatory varibles, above 5 indicates high correlation but not too high to be considered a problem. However, VIF of 10 and above is unacceptable as the results will suffer from multicollinearity.

Table 9: Variance inflation factor test results for multicollinearity

Variable	VIF	1/VIF
Age of the respondent	2.8	0.3571
Years consuming dried TAVs	2.27	0.4398
Number of adults above 64 years of age	1.52	0.6577
Number of adults between 15- 64 years of age	1.21	0.8291
Years of schooling	1.2	0.8322
Income in us dollars	1.2	0.8364
Cultivate own land	1.17	0.8553
Cultivate leased land	1.1	0.9054
Presence of children below 4 years	1.1	0.9091
Presence of children between 4-14 years	1.05	0.9520
Mean VIF	1.42	

Note: VIF=variance inflation factor

White test was carried out to test if there was heteroskedasticity. The results in Table 10 indicated that variance of the error term was constant ($p<0.05$). Heteroskedasticity was therefore not a problem. Since there was homoscedasticity in the data, the data was thus subjected to econometric analysis.

Table 10: White test results for heteroskedasticity

Source	Chi2	Degree of freedom	P-Value
Heteroskedasticity	163.08	146	0.158
Skewness	121.25	16	0.000
Kurtosis	2.92	1	0.088
Total	287.25	163	0.000

Pair-wise Correlation analysis was done to test the extent of collinearity among the categorical variables. The correlation coefficients are presented in Table 11. Multicollinearity affects validity of results of a predictor variable. According to Midi *et al*. (2010) collinearity of above 0.8 is a serious concern. The results indicated that colinearity was not a problem with the highest correlation being between household head and gender which had a negative correlation of 0.5.

Table 11: Pair-wise coefficients for categorical independent variables used in regression models

	Gender	HHpos	AWAREsolar	consun	consolar	Buydry	access_infor	factor1	factor2
Gender	1								
HHpos	-0.5723	1							
AWAREsolar	-0.0431	-0.0272	1						
consun	0.0508	0.0932	-0.12	1					
consolar	-0.2382	-0.0553	.	-0.1136	1				
Buydry	0.1321	-0.1539	0.0917	-0.012	0.2257	1			
access_infor	-0.0937	0.0183	0.7951	-0.0352	0.4103	0.0907	1		
factor1	-0.1331	0.0425	0.0961	-0.0862	0.3846	0.1378	0.1834	1	
factor2	-0.0162	0.054	-0.0576	-0.0025	-0.0015	-0.1074	-0.096	0.2718	1

Note: HHpos=household position of the respondent, AWAREsolar= respondent aware of solar dried TAVs, consun= consume open sun dried TAVs, consolar= consume solar dried TAVs, Buydry= buy dried vegetables, access_infor= access information on solar dried TAVs, factor1=market quality attributes, factor2=product intrinsic qualitie

4.3.2 Determinats of consumption frequencies of sun and solar dried TAVs (bivariate ordered probit estimates)

Table 12, represents the estimated coefficients for the model. Estimated coefficients and standard errors are reported for consumption of each of the traditional African dried vegetables. From the results there is an overall goodness fit with appropriate chi-square. The model strongly fits and is statistically significant with p>chi2 = 0.000 and a log likelihood of -112.313.

For open sun dried TAVs gender of the respondent was significant at 10% significance level. Males were less likely to consume open sun dried TAVs. Females were more likely to consume open sun dried TAVs. Females are mainly involved in food preparation including drying and cooking. This can also be attributed to the role women play in food purchase and food preparation. The results concur with the findings of Ngigi *et al.* (2011) who argued that women were major purchasers of vegetables. Presence of adults above 64 years was also significant at 10% which is an age bracket of old people. Old people consider open sun dried TAVs as their traditional food; it is what they have grown up consuming. In light of consumer behaviour studies they tend to be conservative in nature and reluctant to new products. They would therefore, prefer to frequently consume open sun dried TAVs as opposed to solar dried TAVS. Old people tend to stay at home thus have limited information on solar dried TAVs. However, some who are aware cannot afford as they have a lot of financial needs to meet.

Market quality attributes were significant at 1%. Market quality attributes, that is, price, drying method, colour, freshness, nutritional value, packaging and hygiene were more likely to influence consumption frequency of open sun dried TAVs. This can be attributed to affordability and storability. Consumers develop trust on a product if regularly consumed. Considering open sun drying being old practice consumers have developed trust on it. Solar dried TAVs are relatively expensive compared to open sun dried. Consumers tend to make choices based on price thus the low cost of open sun dried TAVs can be driving factor. Boisseau (2019) identified high cost as a barrier to increasing consumption of vegetables among consumers with poor socio-economic background. These results confirm the findings of Davidson *et al.* (2012) who indicated that market quality attributes such as price, product freshness and nutritional value influenced consumers’ purchasing decisions.

Table 12: Determinats of consumption frequencies of sun and solar dried TAVs(bivariate ordered probit estimates)

	Open sun dried TAVs		Solar dried dried TAVs	
Variable	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Socio-economic characteristics				
Age of household head(years)	-0.020	0.019	0.030	0.020
Gender	-0.923*	0.560	1.239*	0.741
Education in years	-0.025	0.080	0.498	0.386
Household size				
Children below 4 years	0.068	0.250	0.016*	0.092
Children between 5- 14 years	-0.029	0.140	0.543**	0.288
Adults between 15 - 64 years	0.161	0.134	-0.320**	0.161
Adults above 64 years	0.748*	0.429	-0.339	0.150
Household income in us dollars	0.002	0.001	0.034	0.468
Cultivate own land Hactors	0.011	0.054	-0.050	0.057
Cultivate rented land in hactors	-0.116	0.231	0.130	0.249
Attitudes and perceptions				
Market quality attributes	0.799***	0.232	0.885***	0.267
Product attributes	-0.015	0.197	-0.290	0.214
Climatic characteristics				
Prolonged drought	0.194	0.341	-0.256	0.372
Institutional characteristics				
Access to information			-7.310***	1.990
Mpwapwa	0.550	0.475	0.710	0.507
Kongwa	0.178	0.418	0.224	0.431

No of observations	55
Log likelihood	-112.313
Wald ch2	314.99
Prob.>ch2	0.000

Note: ***: significant at 1% level;** significant at 5% level; * significant at 10%. Iramba is the base. TAVs-Traditional African vegetables

For solar dried TAVs gender was significant at 10%. Unlike for open sun dried males were more likely to frequently consume solar dried TAVs. In rural setting males have high purchasing power as they have resources like land ownership at their disposal. Males considering their role in vegetable purchase and preparation have little knowledge on their quality thus would use price as an indicator of quality. Solar dried considering its high quality is a bit expensieve compared to open sun dried TAVs. Presence of children of ages below 4 and 5 to 14 years was significant at 10% and 5% respectively. This is an actively growing group therefore got high food and food nutrition demands. Solar dried TAVs are nutritious therefore a preference for this segment. The green colour is also also attractive to consumers.The results are consistent with the findings of Albani *et al*. (2017) who points out the need for consuming vegetables among children aged between 5 and 14 years. Number of adults between 15 and 64 years was significant at 5% significance level. They had a negative association thus were less likely to consume it. They are likely to consume a variety of foods apart from vegetables thus reduction in their consumption frequency. This age category is active and productive. This implies they are able to produce the fresh vegetables. The results are consistent with findings of Senyolo *et al.* (2014) who argued that individual who produced fresh vegetables were less likely to purchase vegetables from the market.

Market quality attributes was significant and positive at 1% significance level. Though consumers were likely to consume open sun dried based on market quality attributes , there was a higher likelihood for solar dried based on the same attributes. Market attributes is a blend of characteristcs for instance price can attract consumers to purchase open sun dried while colour,freshness and packaging can influence the consumer to purchase solar dried TAVs. Access to information on solar dried TAVs was very significant at 1%. Majority of the respondents (80%) had not accessed information on solar dried TAVs. Lack of information explains negative relationship on consumption frequency of solar dried TAVs and information access. Consumers make choices based on information on nutrition. It was therefore expected that if consumers had little information they would consume less of the product. Oparinde *et al*.(2016) points out the importance of information access in consumption of new products.

4.4 Estimation of households' willingness to pay for solar dried traditional African vegetables.

4.4.1.Contingent valuation estimation

In contingent valuation method consumers were provided with two products;open sun dried TAVs readily available in the market and a new product innovatively dried (solar dried TAVs). They were then given information on the differences between what was readily available in the market (open sun dried TAVs) and the new product (solar dried TAVs) as printed on the cards used for choice experiment. The market price for open sun dried TAVs was Tsh 800/ 50g . Considering its desirable characteristics consumers were provided with an initial bid of Tsh 1500/50g. Those who accepted the initial bid were provided with a higher bid of 1700, corresponding to 13.3%, followed by 1800 (20%) premium and finally 2000 which was equal to 33.3 %. Those who did not accept the initial bid were provided with discounted rate starting with 13.3% discount, that is, 1300, followed by 20% discount, that is, Tshs 1200 and finally 33.3% discount equal to Tsh 1000. The same procedure was repeated with open sun dried TAVs starting with the market price as the initial bid.

The mean of solar dried TAVs was calculated directly using double bounded dichotomous choice model and results presented in Table 13. The mean WTP was calculated for each district and the overall mean. The mean of 2238.68 Tsh/50g calculated initially did not take into consideration the covariates. Consumers in Mpwapwa had the highest mean of 2521.42 Tsh/50g while Iramba had the lowest mean of 2098.37 Tsh/50g. For Iramba it was expected to be low since no training on solar drying technology had been done. The high deviation between Kongwa and Mpwapwa was not expected as training had been done in the two districts. It was expected that according to a study by Kansiime *et al. (*2018) initial training on solar drying technology would enhance their awareness and eventually their willingness to pay. The deviation between the two districts in Dodoma (Kongwa and Mpwapwa) and Iramba in Singida region can be attributed to training by World Vegetable Center (WorldVeg) on solar drying technology.

Table 13: Mean willingness of solar dried TAVs based on contingent valuation method

Dried TAV type	**Mpwapwa (n=81)**	**Kongwa (n=81)**	**Iramba (82)**	**Total (244)**
Solar driedTAVs	2521.42	2180.49	2098.37	2238.68
Mean wtp	(273.70)	(192.22)	(132.60)	(107.16)
Open sun dried TAVs	878.38	915.99	908.02	898.07
Mean wtp	(62.68)	(61.00)	(108.09)	(41.56)

Mean in Tanzanian shillings (1 USD= 2500 Tsh) per 50g(1kg=1000g) of solar dried TAVs; Standard errors in brackets

Inclusion of covariates helps overcome systemic bias, thus the mean was calculated with covariates (Atsiaya, 2017). When the covariates were added the mean willingness to pay was Tsh 2035.61. However, the predicted mean was the highest at Tsh 2278.42. The mean willingness to pay for solar dried TAVs (Table 14).

Table 14: Parameters of mean estimate for solar dried TAVs

Parameters of the mean	**Estimates (Tshs)**
Mean without covariates	2238.68
Mean with covariates	2035.61
Predicted mean	2278.42
Number of observations	244

Mean in Tanzanian shillings (1 USD= 2500 Tsh) per 50g(1kg=1000g) of solar dried TAVs

4.4.2 Choice experiment

Choice experiment was hypothetical in nature with choices based on product attributes. The difference was printed on the cards with each card having price associated with the dried TAV type. Each consumer had to make a choice among the three choices. Consumer had a choice either to pick solar dried TAVs, open sun dried or pick none choice card represented by a plain card. Based on the choice it indicated what consumers were willing to pay as displayed on the cards , that is, Tsh 1500 , 800 and zero shillings for solar dried TAVs, open sun dried TAVs and none choice respectively.

The cards were randomized and repeated severally. The results showed that 74.18% chose solar dried TAVs, 25% chose open sun dried while 0.82% chose the card with no description , that is, the plain card. Each choice selected was replicated thrice to enable estimation by conditional logit model. Consumers are rational and would chose a product that would give them maximum utility. This explains why solar dried TAVs choice was the most preferred choice.

The mean willingness was calculated by dividing the coefficient of each choice with the coefficient of the price. For solar dried TAVs, consumers were willing to pay an overall premium of 110. 20 Tsh / 50g. However, respondents from Mpwapwa would accept the highest premium of 124.61 Tsh / 50 g of solar dried TAVs. The premium was based on initial price of Tsh 1500/50g of solar dried TAVs. Consumers were therefore willing to pay an overall mean price of Tsh 1610.20/50g. This implies they were more willing to pay a premium as compared with respondents from Kongwa and Iramba. For respondents in Mpwapwa, previous training had been done. This imply that their knowledge on solar dried TAVs significantly influenced their willingness to pay. The results are as shown in Table 15.

Table 15: Premium based on choice experiment

	Estimation	**Mpwapwa**	**Kongwa**	**Iramba**	**Total**
Regression	Price(x_p)	0.0024 (5.03)	.0123 (0.02)	.0123 (0.02)	.0033 (6.82)
	Solar dried TAVs(x_s)	-0.3036 (-)	-0.3994 (-)	-0.3942 (-)	-0.3586 (-)
	Sun dried TAVs(x_d)	.5174 (1.30)	6.9969 (0.01)	7.0162 (0.01)	0.81962 (2.29)
	Log-likelihood	-57.0287	-44.3892	-44.1237	-148.235
Calculation	WTP solar dried TAVs(x_s/x_p)	124.61	32.53	32.11	110.20
	WTP sun dried TAVs (x_d/xp)	-212.39	-569.82	-571.54	-251.91

Premium in Tanzanian shillings (1 USD= 2500 Tsh) per 50g**(**1kg=1000g**)** of dried TAVs; Standard errors in brackets

For open sun dried consumers were willing to accept an overall discount of Tsh 251.91 below the market price, that is Tsh 800/50g . Open sun dried TAVs are readily available and majority of the consumers traditionally dry their own vegetables. They would therefore purchase open sun dried vegetables if given a discount. Respondents from Mpwapwa were willing to purchase at the lowest discount of Tshs 212.39/50g of open sun dried TAVs while consumers from Iramba were willing to accept the the highest discount of Tsh 571.54 for the same product.

4.4.3 Becker Degroot Mechanism

On experimental auction solar dried and open sun dried TAVs were used. Respondents explicitly understood the consequences of overestimation and the importance of revealing their truthful WTP. To enhance their understanding a test round was done using tomatoes grown with pesticides and those grown without pesticides. A random price was drawn and respondents asked to elicit their WTP. Those whose WTP was above the random price won and could have the products after paying for them. Though this was a test round , Khan *et al.* (2019) indicated that consumers are willing to pay a premium price for pesticide free fruits because of the safety attribute, thus it brought out attribution aspect. After understanding, bidding was done with with solar and open sun dried TAVs.The binding product was dried cow pea leaves.Respondents were given some money to participate in the auction thus if a respondent won a bid for product, they paid for the product and were given the product.

The mean willingness to pay for solar dried TAVs was a bit lower than the set market price (Tsh 1500/50 g) with respondents willing to pay a mean of Tsh 1311.48/ 50 g (Table 16). Respondents from Iramba were willing to pay a slightly higher mean of Tsh 1360.49/ 50g. Mpwapwa had the lowest mean at Tsh 1227.16/ 50g. The unexpected higher willingness in Iramba as opposed to Mpwapwa and Kongwa can be attributed to respondents anxiety to learn and taste the new product (solar dried TAVs).This means consumers anticipated higher utility from it unlike traditionally open sun dried TAVs. The mean willingness to pay based on experimental auction is lower than in choice experiment and contigent valuation technique. This means in a real market setting where real product and real money is used consumers reveal their truthful WTP. However, this contradicts findings by Skuza *et al.* (2015) who found out that compensating individuals makes them to offer willingness to pay value that is higher than the market value.

Table 16: Mean willingness to pay based on experimental auction.

Dried TAV type	Mpwapwa	Kongwa	Iramba	Total
Solar dried TAVs	1227.16	1346.34	1360.49	1311.48
	(56.95)	(61.95)	(50.02)	(32.88)
Open sun dried TAVs	595.68	546.95	662.96	601.64
	(34.78)	(24.85)	(34.01)	(18.43)

Mean in Tanzanian shillings (1 USD= 2500 Tsh) per 50g(1kg=1000g) of dried TAVs;Standard errors in brackets

4.5 Comparison (contingent valuation method (CVM), choice experiment (CE) and Becker Degroot mechanism (BDM).)

Premiums differ with different elicitation techniques. It is also worth noting that they differ across districts. Results from contingent valuation method had the highest premium. It was followed by choice experiment and finally experimental auctions. This can be attributed to the hypothetical nature of contigent valuation method and choice experiment. Some respondents might give strategic response with an expectation of either getting the product or money. Based on contigent valuation technique Mpwapwa recorded the highest premium while Iramba had the lowest (Table 17). Since trainings had been done on solar drying technology, respondents in Kongwa and Mpwapwa were aware of the nutritional benefits of solar dried vegetables and were willing to pay a higher premium. It was expected that Iramba would record the lowest mean willingness. The results indicate that training had an influence in enhancing consumer willingness for solar dried TAVs.

Furthermore, choice experiment results show that consumers were willing to pay a premium but lower than contigent valuation method but higher than experimental auction. Respondents from Mpwapwa were willing to pay the highest premium. Though traininings had been done in both Mpwapwa and Kongwa , the impact in Kongwa was low . Iramba had no prior knowledge on solar drying technology thus the premium corroborates with their knowledge. However, it is worth noting that consumers are more likely to pay a premium price for improved products (Chege *et al.,* 2019). The results are consistent with the findings of Alphonce *et al. (*2015) who reported that commodity attribute determined consumers' willingness to pay for dried fruits.

Contrarily from experimental auction the consumers were willing to pay a mean lower than the market price. Consumers could only purchase it if they were discounted.This might be attributed to it being real and practical where consumers purchase real products with actual money. Deviation across the districts was also low. Consumers in Mpwapwa recorded the highest discounted rate while consumers in Iramba accepted the lowest discount. The results are in agreement with the findings by Alphonce and Alfines (2015), where results from choice experiment showed consumers were willing to pay higher premium as compared to experimental auction while comparing various elicitation techniques to pay for tomato attributes. The results contadicts with the findings of Skuza *et al.* (2015) who indicted that individuals who were compensated tend to provide larger willingness to pay values than those from the individuals who were not compensated.

Experimental auction recorded the lowest premium, followed by choice experimental technique. As expected contingent valuation technique recorded the highest premium (Table 17). These results are consistent with the findings by Shi *et al*. (2018) where experimental auction recorded the lowest premium. These results are similar with the findings of Kimenju *et al.*(2005) who found out that contigent valuation method had the highest premium followed by choice experiment and finally experimental auction had the lowest premium.

Table 17: Premium based on CVM, CE and BDM

Dried TAV	Method	Mpwapwa	Kongwa	Iramba	Total
Solar dried	CVM	1021.42	680.49	598.68	738.68
	CE	124.61	32.53	32.11	110.2
	BDM	-272.84	-153.66	-139.51	-188.52
Open sun dried	CVM	78.38	115.99	108.02	-98.07
	CE	-212.39	-569.82	-571.54	-251.91
	BDM	-204.32	-253.05	-137.04	-198.36

Premium in Tanzanian shillings (1 USD= 2500 Tsh) per 50g(1kg=1000g) of dried TAVs

However according to Alphonce and Alfnes (2015), Krinsky and Robb confindence interval is useful in comparing the relative efficiencies of the elicilitation techniques. This is calculated by dividing the mean willingness to pay of each technique by the confindence interval as illustrated in Table 18. According to this technique the most efficient elicitation method is the one with the lowest ratio. For solar dried TAVs , contigent valuation has the highest ratio followed by choice experiment with a ratio of 1.1193 and 1.0735 respectively.

Table 18: Comparison based on Krinsky and Robb confidence interval at 95% level

Dried TAV type	Elicitation technique	Mean WTP	Lower limit	Upper limit	Breadth	Efficiency
Solar dried	CVM	2238.68	0	2000	2000	1.1193
	CE	1610.2	0	1500	1500	1.0735
	BDM	1311.48	100	3000	2900	0.4522
Open sun dried	CVM	898.07	0	1300	1300	0.6908
	CE	548.09	0	800	800	0.6851
	BDM	601.64	200	2000	1800	0.3342

Efficiency= mean WTP/breadth

Becker Degroot Marshack mechanism had the lowest ratio of 0.4522 thus the most efficient technique. For open sun dried there was similar trends among the three elicitation technique showing that experimental auction is the most efficient.

4.6 Determinants of willingness to pay for solar dried traditional African vegetables.

Double bounded dichotomous model was used to estimate factors influencing consumer willingness to pay for solar dried TAVS.

From Table 19, it showed an overall goodness of fit with prob>chi2 =0.000 and a log likelihood of -205.561. There is a significant positive relationship between age and willingness to pay at 10% significance level. As people grow older they tend to learn new technologies and expand their scope of consumption. Age is an important factor as it attributes to the length one has been consuming dried vegetables. The knowledge of food preservation increases with age. As one grows older distinction of attributes like taste and colour becomes easier. It can also be attributed with desire and awareness of nutritious foods. As one grows quality of foods becomes of essence. The results contradicts the findings of other researches which indicates that young people are more willing to pay for preserved products as compared to old people (Butt, *et al.*, 2013; Romano *et al.*, 2016; Zaikin & McCluskey, 2013).

Gender was significant at 5% significance level for initial premium and also for a higher premium. Males based had a positive association with willingness to pay for solar dried TAVs as compared to their female counterparts. In a rural set up males have higher ownership rigths and access to multiple sources of income. They therefore have high purchasing power which is directly linked with willingness to pay. This was as expected since the role of purchase and preparation of vegetables is considered feminine in rural Africa set up. Females tend to produce their vegetable and participate in traditional open sun drying. This results agrees with the findings of Senyolo *et al.* (2014) who indicated that females were less willing to pay for leafy vegetables due to being constrained in terms of financial resources.

Household position of the person involved in vegetable purchase was very important, that is, being the head or the spouse to the household head. It was significant at 1% significance level. If the person involved in purchase of vegetables was the head or the spouse then it significantly influenced the decision to purchase solar dried TAVs. The association between household position and willingness to pay can be due to the role the head and the spouse play in household food consumption decision making. For instance, the spouse may assume the purchasing role after making a joint decision with the head concerning the type of food to be bought. Household position also determines the main income earner who provides for the household.The results concurs with the findings of Khan *et al*. (2018) that points out the critical role played by household head in financing household food budget.

Education was significant at 5%. Education is associated with knowledge acquisition. Educated respondents have knowledge on nutritional value of well dried TAVs. They also appreciate the importance of drying technology that retains high level of nutrients. Education comes with lot of benefits like access to online knowledge on drying technology, access to well-paying job opportunities thus higher purchasing power. These results are consistent with the findings of Oniang'o *et al.* (2008) and Ngigi *et al*. (2011) who indicated that high level of education increased consumers' willingness to pay for a product. However, other studies have indicated that increase in education level lowers consumers' willingness to pay for a product (Domonko *et al.,* 2018; Lee & Yoo, 2011; Stubbe & Yang, 2011; VanTra *et al.,* 2011).

Household income was significant at 5 %. It had a positive association with the willingness to pay for solar dried TAVS. Higher income is associated with higher purchasing power therefore consumers with higher income can easily pay for solar dried TAVs. The results of this study concur with Nandi *et al*. (2017) and Zhang *et al*. (2018) and who indicated that consumers with high income were more likely to pay a premium price for leafy vegetables. Embracing price discrimination to target such consumers can enable vegetables marketers to realize high profit margin. However, the results contradict the findings of Oyawole *et al.* (2015) who reported that increase in consumer income was unlikely to increase the willingness to pay for leafy vegetables. The implication was that increase in consumer income would not have a significant effect on consumer's willingness to pay for the vegetables.

Table 19: Results of double bounded dichotomous choice model for the factors influencing willingness to pay for solar dried TAVs among rural households

willingness to pay			discount/ premium	
	Coeff.	**Std. Er**	**Coeff.**	**Std. Er**
Socio-economic characteristics				
Age of household head(years)	0.0154*	0.0086	0.0071	0.0086
Gender	0.4932*	0.2868	0.5705*	0.3101
Education in years	0.0717*	0.0385	0.0737*	0.0379
Position of decision maker	0.9049***	0.2601	0.3230	0.2539
Cultivate own land in Hectares	0.0067	0.0331	0.0223	0.0451
Cultivate rented land in hectares	-0.0234	0.1377	-0.0657	0.1291
Household income in us dollars	0.0056**	0.0025	0.0026	0.0018
Institutional characteristics				
Access to solar dried information	0.2041	0.3875	0.3817	0.4042
Aware of solar dried TAVs	0.4745	0.3650	0.4798	0.3802
Mpwapwa	0.0600	0.2564	0.0319	0.2586
Kongwa	0.3557	0.2841	0.1591	0.2845
Attitudes and perceptions				
Market quality attributes	0.0094	0.0957	-0.1429	0.1008
product intrinsic qualities	-0.0255	0.1328	0.0724	0.1367

Note: ***: significant at 1% level;** significant at 5% level; * significant at 10%.Coeff=coefficient, Std. Er= standard errors. Iramba is the base. TAVs-traditional African vegetables

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

i) Consumers consider both intrinsic and extrinsic characteristics when purchasing dried TAVs. Market qualities as well as own product qualities are important as per the factor analysis results.

ii) Gender, product marketable characteristics and access to information is important in consumption of dried traditional African vegetables and highly influence the consumption frequency.

iii) Contingent valuation method gave the highest mean willingness of Tsh 2238.68 followed by choice experiment at Tsh1610.20 and finally Becker-Degroot mechanism (BDM) at Tsh 1311.48 for 50g of solar dried TAVs. Comparison based on Krinsky and Robb efficiency ratio concluded that BDM was the most efficient technique. However, Consumers were willing to pay a premium to consume solar dried TAVs irrespective of the elicitation technique.

iv) Consumers were willing to pay premium to consume solar dried TAVs. Age of the household head, gender of the respondent , education level and household income were some of the Socio-economic factors positively influencing consumption and willingness to pay for solar dried traditional African vegetable.

5.2 Recommendations

From this research the following recommendations are important;

i) There should be training on importance of various product attributes. Training will help change the attitudes and perceptions on preconceived attributes about a new product or a new technology. Free samples should also be given and consumers requested to give feedback after consuming solar dried TAVs. Processors should focus on marketable characteristics, that is, having the dried TAVs retain fresh vegetable characteristics as possible.

ii) Segmentation is important and gender specific targeting is important. Women groups should be targeted if the product is to penetrate among rural households considering their role in food purchase and preparation. Extension agents and nutritionist should consider segmentation in their trainings.

iii) Results from the three elicitation techniques showed that consumers were willing to pay a premium for solar dried TAVs. However, based on Krinsky and Robb efficiency ratio I would recommend Becker-DeGroot Marshack as the best method for eliciting consumer willingness to pay. There is therefore, a need to invest in solar drying technology both as an income generating activity and in meeting the nutritional needs of rural households in arid and semi-arid areas. The government under ministries of agriculture and industrialization should invest on solar dryers in partnership with other stakeholders in ensuring availability of high quality vegetables throughout the year. Use of different elicitation techniques showed that the mean willingness vary with elicitation technique. Researchers should therefore apply different elicitation techniques to check robustness in the results.

iv) Lack of information was the major determinant of consumers unwillingness to pay. The partners could embrace radio, social media like twitter or use of flyers in enhancing access to information.

5.3 Areas of further research

Further research should be done to evaluate the level of penetration of solar dried traditional African vegetables among rural households. The current study focussed on consumption pattern and consumer willingness. Understanding the level of penetration would determine the acceptability of solar dried vegetables and the necessary course of action to be taken. Government intervention like certification could also influence the consumption of solar dried vegetables. Assessing effect of certification on purchase decisions of a new product is an area to explore. A focus on contribution to household income in TAVs value chain is an intresting area of study.

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APPENDICES

Appendix I: Questionaire

Question	Answer	
"This survey is conducted by the World Vegetable Centre, Eastern and Southern Africa. The purpose for this survey is to understand the existing potential around vegetable drying in Tanzania in order to make recommendations to policymakers and the rural community as to how to improve small scale processing industries. The information to be collected will not be reported at the individual level, and thus will be fully anonymous, without revealing the identity of respondents. Do you wish to continue with the interview? 1=Yes 2=No. *RESPONDENTS SHOULD BE PEOPLE IN THE HOUSEHOLD WHO PARTICIPATE IN FOOD PREPARATION AS WELL AS DECISION MAKING ON FOOD PREPARATION AND PURCHASE.*		
Date of survey		
Region	1	Dodoma
	2	Singida
District	1	Kongwa
	2	Mpwapwa
	3	Iramba
Ward name		
Village name		
Household ID		
Name of respondent		
SECTION A: SOCIO-ECONOMIC INFORMATION		
Age of respondent in years *The respondent should be at least 15 years*		
Gender of respondent	1	Male
	0	Female
Specify the marital status		
Position in the household	1	Head
	2	spouse

Question	Answer	
Education level of the respondent in years		
Members of your household *Only consider members living in the household in the past 6 months*		
Total number of people in the household you are living in		
Number of young children (under 4 years)		
Number of children (between 5 and 14 years)		
Number of adults (15-64 years)		
Number of adults older than 64 years		
ENUMERATOR WARNING: The sum of children and adults should be add upto the total number of people living in the household		
Who does most of the food purchase in your household? *SELECT ALL OPTIONS THAT APPLY*	1	Head of household
	2	Partner of head of household
	3	House help
	4	Daugther/son
	5	Others
SPECIFY, who does most of the food purchase in your household?		
Employment status of the respondent	1	Formally employed
	2	Self-employed
	3	Unemployed
	4	Student
	5	Retired
	888	Other specify
Specify employment status		
Gross income per month (TSH)		
SECTION B: DEMAND FOR DRIED VEGETABLES BY INDIVIDUAL CONSUMERS		
Are you aware of SUN DRIED vegetables?	1	Yes
	0	No
Are you aware of SOLAR DRIED vegetables?	1	Yes
	0	No
Do you consume sun dried vegetables?	1	Yes
	0	No
Do you consume solar dried vegetables?	1	Yes
	0	No
How often do you consume sun dried vegetables?	1	More than twice a

Question	Answer	
		Day
	2	Once a day
	3	1-2 times a week
	4	3-5 times a week
	5	Once in a month
How often do you consume solar dried vegetables?	1	More than twice a Day
	2	Once a day
	3	1-2 times a week
	4	3-5 times a week
	5	Once in a month
How long (YEARS) have you been consuming dried vegetables?		
What are the reasons for consuming dried vegetables (both sun/solar) in general?	1	Traditional food
	2	Climate change (prolonged drought)
	3	Readily available
	4	Easier to prepare
	5	No alternative
	888	Other specify
Specify other reason for consuming dried vegetables		
Please select the five major dried vegetables preferred for consumption	1	Tomato
	2	Amaranth
	3	African eggplant
	4	Night shade
	5	Okra
	6	Cowpea leaves
	7	Spider plant
	8	Cassava leaves
	9	Ethiopian Mustard
	10	Sweet potato leaves
	11	Jute mallow
	12	Pumpkin leaves
	13	Cabbage
	14	Onion
	15	Carrots
	16	Egg plant
	17	Chinese cabbage

Question	Answer	
	18	Mixed vegetables (different types together)
	19	Nsonga
	888	Others, specify1
	889	Others, specify2
Specify other dried vegetable, first		
Specify other dried vegetable, second		
Preferred form of [B20_name]	1	Powder
	2	Crisp (dried leaves/fruit)
	3	Mixed with other types
SECTION C: ATTITUDE, PERCEPTION AND CONSUMPTION OF DRIED VEGETABLES		
Generally how do you rate the importance of consuming vegetables?	1	Least important
	2	Slightly important
	3	Important
	4	Very important
Do you buy dried vegetables?	1	Yes
	0	No
Are you able to g*et al*l dried vegetables from above throughout the year?	1	Yes
	0	No
If you don’t buy dried vegetables, WHY?	1	I dry my own vegetables
	2	I get freely from friends/neighbour
	3	I get freely from NGO/Institutions
Are you aware of the health hazards from vegetables that are poorly dried?	1	Yes
	0	No
What are the three health hazards which can results from the use of poor drying methods on vegetables?	1	Can transmit diseases
	2	Poor nutrition due to nutrient loss
	3	Can lead to choking/organ damage
	4	Can cause damage to teeth and gums
	888	Other specify
Specify other health hazard		

Question	Answer	
How important to you are the following factors in determining your decisions to purchase dried vegetables?	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Taste	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Price	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Drying method	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Colour	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Easy of cooking	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Freshness	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Texture	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important

Question	Answer	
Nutritional Value (vitamins and minerals).	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Packaging	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Timely availability	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
Hygiene	1	Not important
	2	Slightly important
	3	Neutral
	4	Important
	5	Very important
How do you rate the taste of fresh cowpea leaves compared to dried cowpea leaves?	1	Better
	2	Same
	3	Worse
	4	Don't know
Based on your knowledge, please rank the nutritional content of cowpea leaves	1	Not Nutritious
	2	Low Nutrients
	3	Neutral/Not sure
	4	Moderately Nutritious
	5	High nutritious
Sun dried Cowpea leaves	1	Not Nutritious
	2	Low Nutrients
	3	Neutral/Not sure
	4	Moderately Nutritious
	5	High nutritious
Solar dried cowpea leaves	1	Not Nutritious
	2	Low Nutrients
	3	Neutral/Not sure
	4	Moderately Nutritious
	5	High nutritious

Question	Answer
Fresh cowpea leaves	1 Not Nutritious 2 Low Nutrients 3 Neutral/Not sure 4 Moderately Nutritious 5 High nutritious
SECTION D: CONSUMPTION OF DRIED VEGETABLES IN THE LAST 7 DAYS	
Please select all the DRIED vegetables you have consumed in the past one week *SELECT ALL SOURCES THAT APPLY*	1 Tomato 2 Amaranth 3 African eggplant 4 Night shade 5 Okra 6 Cowpea leaves 7 Spider plant 8 Cassava leaves 9 Ethiopian Mustad 10 Sweet potato leaves 11 Jute mallow 12 Pumpkin leaves 13 Cabbage 14 Onion 15 Carrots 16 Egg plant 17 Chinese cabbage 18 Mixed vegetables (different types together) 19 Nsonga 888 Others, specify1 889 Others, specify2 0 None
Specify other dried vegetable consumed, FIRST	
Specify other dried vegetable consumed, SECOND	
Do you dry your own?	1 Yes 0 No
Quantity of OWN dried consumed in the past 7 days	

Question	Answer	
Unit of measurement- OWN DRIED	1	Kijiko
	2	Fungu
	3	Pishi/kopo la lita moja
	4	Sado(4 litre)
	5	Ndoo ndogo (10 litre)
	6	Ndoo kubwa (20 litre)
	7	Grams
	8	Kg
Method used in drying - home dried	1	Sun drying on the ground
	2	Sun drying using mats
	3	Sun drying under shade
	4	Sun drying using raised platforms under direct sun
	5	Sun drying using raised platforms covered with white and black cloth
	6	Solar drying
What was the OTHER SOURCE of consumed in the past 7 days *CONSIDER OTHER SOURCE RATHER THAN OWN DRYING AND PURCHASED*	1	Obtained freely from friends/neighbour/relatives
	2	Obtained freely from NGO/Institutions
CONSTRAINTS FOR CONSUMPTION OF DRIED VEGETABLES		
What are the barriers for consumption of SOLAR dried vegetables	1	Solar dried vegetables are expensive
	2	Solar dried vegetables are not readily available
	3	Limited awareness about solar dried vegetables
	4	Perception that there is no difference between sun and solar dried vegetables in terms

Question	Answer	
		of nutritional content
	5	Perception that sun dried vegetables taste better than solar dried vegetables
	6	No cash to buy solar dried vegetables
	888	Other specify
Specify other barrier		
Do you have access to information about SOLAR dried vegetables?	1	Yes
	0	No
Where do you get this information from?	1	Friends/Neighbours
	2	Radio
	3	Newspaper
	4	Television
	5	Traders
	6	Farmers who dry vegetables
	7	Public extension officers
	8	NGOs
	9	Nutritional office
	10	AVRDC
	888	Other specify
Where do you get this information from?, SPECIFY		
WILLINGNESS TO PAY		
Which pack of dried cow pea leaves would you choose?- CHOICE EXPERIMENT	1	SOLAR dried cowpea leaves, 50 grams at a price of TSH 1500
	2	SUN dried cowpea leaves, 50 grams at a price of TSH 800
	3	None
F2A: CONTIGENT VALUATION- SOLAR DRIED COWPEA LEAVES		
Would you be willing to purchase solar dried Cow pea leaves at the current average price of TSH 1500 per 50 grams?	1	Yes
	0	No
Would you be willing to purchase solar dried Cow pea	1	Yes

Question	Answer
leaves at a HIGHER price of TSH (1700, 1800, 2000) per 50 grams?	0 No
Mention HIGHER price from the list (1700, 1800, 2000) *This is the HIGHER price the consumer is willing to pay for SOLAR dried*	
Would you be willing to purchase solar dried Cow pea leaves at a LOWER price of TSH (1000, 1200, 1300) per 50 grams?	1 Yes 0 No
Mention LOWER price from the list (1200, 1300, 1400) *This is the LOWER price the consumer is willing to pay for SOLAR dried*	
Why are you not willing to buy solar dried cow pea leaves at a lower price?	1 Expensive 2 Product is low quality 3 I don't like the taste 4 They have chemicals 5 I don't trust the way they are processed 6 I don't like the colour 888 Other specify
Why are you not willing to buy solar dried cow pea leaves at a lower price?, SPECIFY	
F2B: CONTIGENT VALUATION- SUN DRIED COWPEA LEAVES	
Would you be willing to purchase SUN dried Cow pea leaves at the current average price of TSH 800 per 50 grams?	1 Yes 0 No
Would you be willing to purchase SUN dried Cow pea leaves at a HIGHER price of TSH (900, 1000, 1100) per 50 grams?	1 Yes 0 No
Mention HIGHER price from the list (900, 1000, 1100) *This is the HIGHER price the consumer is willing to pay for SUN DRIED*	
Would you be willing to purchase SUN dried Cow pea leaves at a LOWER price of TSH (500, 600, 700) per 50 grams?	1 Yes 0 No
Mention LOWER price from the list (500, 600, 700) *This is the LOWER price the consumer is willing to pay for SUN dried*	
Why are you not willing to buy SUN dried cow pea leaves	1 Expensive

Question	Answer
at a lower price?	2 Product is low quality 3 I don’t like the taste 4 They have chemicals 5 I don’t trust the way they are processed 6 I don’t like the Colour 888 Other specify
Why are you not willing to buy SUN dried cow pea leaves at a lower price?, SPECIFY	
EXPERIMENTAL AUCTION- BECKER-DEGROOT-MARSCHAK (BDM)	
TEST ROUND WITH TOMATOES	
Bid 1: (Pestcide use)	
Bid 2: (No pestcide use)	
Binding product	1 Tomatoes grown WITH pestcides 2 Tomatoes grown WITHOUT pestcides
Random price- tomatoes	
Whether has won the test auction?	1 Yes 0 No
DRIED COWPEA LEAVES AUCTION	
Bid 1: (SOLAR dried)	
Bid 2: (SUN dried)	
Binding product (dried cowpea leaves)	1 SOLAR dried cowpea leaves 2 SUN dried cowpea leaves
Random price- dried cowpea leaves	
Whether has won the dried cowpea leaves auction?	1 Yes 0 No
Phone number of respondent	

Appendix II: Stata Output

FACTOR ANALYSIS

```
. factor Taste price Drymethod colour Easecook freshness texture nutritvalue packaging timeavail hygiene
(obs=244)

Factor analysis/correlation                        Number of obs    =        244
    Method: principal factors                      Retained factors =          4
    Rotation: (unrotated)                          Number of params =         38
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	5.10165	3.60413	0.8251	0.8251
Factor2	1.49752	1.40724	0.2422	1.0673
Factor3	0.09028	0.03453	0.0146	1.0819
Factor4	0.05575	0.05648	0.0090	1.0909
Factor5	-0.00074	0.01139	-0.0001	1.0908
Factor6	-0.01213	0.03542	-0.0020	1.0888
Factor7	-0.04755	0.01272	-0.0077	1.0811
Factor8	-0.06027	0.03385	-0.0097	1.0714
Factor9	-0.09413	0.05875	-0.0152	1.0561
Factor10	-0.15288	0.04139	-0.0247	1.0314
Factor11	-0.19427	.	-0.0314	1.0000

```
    LR test: independent vs. saturated:  chi2(55) = 1665.05 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
Taste	0.2445	0.5848	0.1390	0.0180	0.5786
price	0.7629	-0.0818	0.0455	0.0131	0.4091
Drymethod	0.8631	-0.0541	0.0619	-0.0786	0.2421
colour	0.8348	-0.2337	0.0707	-0.0769	0.2375
Easecook	0.5823	0.3775	-0.0918	0.0085	0.5099
freshness	0.8647	0.0116	-0.0906	-0.0868	0.2365
texture	0.3814	0.5555	-0.1431	-0.0532	0.5226
nutritvalue	0.6132	0.2743	-0.0598	0.1502	0.5226
packaging	0.8062	-0.0915	0.0643	0.0485	0.3352
timeavail	-0.1656	0.6801	0.1229	-0.0218	0.4945
hygiene	0.8558	-0.3064	0.0123	0.0856	0.1662

.

```
. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
Taste	0.7799
price	0.9641
Drymethod	0.9397
colour	0.9247
Easecook	0.9219
freshness	0.9314
texture	0.7979
nutritvalue	0.9219
packaging	0.9535
timeavail	0.7096
hygiene	0.8923
Overall	0.9114

```
. alpha Taste price Drymethod colour Easecook freshness texture nutritvalue packaging t
> imeavail hygiene

Test scale = mean(unstandardized items)
Reversed item:  timeavail

Average interitem covariance:     .6391492
Number of items in the scale:           11
Scale reliability coefficient:      0.8862
```

CONFIRMATORY FACTOR ANALYSIS (CFA): Generating factor for further analysis

Gen factor1=0.7629/6.2074*price+0.8631/6.2074*Drymethod+0.8348/6.2074*colour+0.5823/6.2074*Easecook+0.8647/6.2074*freshness+0.6132/6.2074*nutritvalue+0.8062/6.2074*packaging+0.8558/6.2074* hygiene

Gen factor2=0.6281/1.8819*timeavail+0.6182/1.8819* texture+0.6356/1.8819* Taste

```
. sum factor1 factor2
```

Variable	Obs	Mean	Std. Dev.	Min	Max
factor1	244	3.503385	1.123172	1	5
factor2	244	3.763732	.7894098	1.937889	5

Obejetive two

Pairwise correlation

```
. pwcorr Gender HHpos AWAREsolardried consun consolar Buydry factor1 factor2
```

	Gender	HHpos	A~rdried	consun	consolar	Buydry	factor1
Gender	1.0000						
HHpos	-0.5723	1.0000					
AWAREsolar~d	-0.0431	-0.0272	1.0000				
consun	0.0508	0.0932	-0.1200	1.0000			
consolar	-0.2382	-0.0553	.	-0.1136	1.0000		
Buydry	0.1321	-0.1539	0.0917	-0.0120	0.2257	1.0000	
factor1	-0.1331	0.0425	0.0961	-0.0862	0.3846	0.1378	1.0000
factor2	-0.0162	0.0540	-0.0576	-0.0025	-0.0015	-0.1074	0.2718

	factor2
factor2	1.0000

Bivariate ordered estimates

```
. bicop ( freqconsun= Mpwapa Kongwa Age Gender EducYrs CHILD1 CHILD2 Adult1 Adul
> t2 A9_USD A10_Hactors A11_Hactors factor1 factor2 climate)( freqconsolar= Mpwa
> pa Kongwa Age Gender HHpos EducYrs CHILD1 CHILD2 Adult1 Adult2 A10_Hactors A11
> _Hactors factor1 factor2 access_infor climate ),iterate(10)
LogL for independent ordered probit model -114.43785

initial:       log likelihood = -129.91884
rescale:       log likelihood = -129.91884
rescale eq:    log likelihood = -112.49682
Iteration 0:   log likelihood = -112.49682
Iteration 1:   log likelihood = -112.31368
Iteration 2:   log likelihood = -112.31338  (not concave)
Iteration 3:   log likelihood = -112.31338  (not concave)
Iteration 4:   log likelihood = -112.31338  (not concave)
Iteration 5:   log likelihood = -112.31338  (not concave)
Iteration 6:   log likelihood = -112.31338  (not concave)
Iteration 7:   log likelihood = -112.31338  (not concave)
Iteration 8:   log likelihood = -112.31338  (not concave)
Iteration 9:   log likelihood = -112.31338  (not concave)
Iteration 10:  log likelihood = -112.31338  (not concave)
convergence not achieved
```

Generalized bivariate ordinal regression model (copula: gaussian, mixture: none)

	Number of obs	=	55
	Wald chi2(31)	=	314.99
Log likelihood = -112.31338	Prob > chi2	=	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
freqconsun						
Mpwapa	.5503781	.4748042	1.16	0.246	-.380221	1.480977
Kongwa	.1781796	.4177246	0.43	0.670	-.6405455	.9969047
Age	-.0201299	.018621	-1.08	0.280	-.0566264	.0163666
Gender	-.9233458	.5597563	-1.65	0.099	-2.020448	.1737563
EducYrs	-.0252488	.0797897	-0.32	0.752	-.1816337	.131136
CHILD1	.0684837	.249944	0.27	0.784	-.4213976	.5583649
CHILD2	-.0290511	.1404933	-0.21	0.836	-.3044129	.2463108
Adult1	.1611634	.1341689	1.20	0.230	-.1018028	.4241297
Adult2	.7481635	.4285127	1.75	0.081	-.091706	1.588033
A9_USD	.0020097	.0013785	1.46	0.145	-.0006921	.0047116
A10_Hactors	.0110639	.0541629	0.20	0.838	-.0950934	.1172212
A11_Hactors	-.1163005	.2313814	-0.50	0.615	-.5697997	.3371987
factor1	.79894	.232042	3.44	0.001	.344146	1.253734
factor2	-.0150808	.1969049	-0.08	0.939	-.4010073	.3708456
climate	.1936335	.3413648	0.57	0.571	-.4754293	.8626962
freqconsolar						
Mpwapa	.7100224	.5067542	1.40	0.161	-.2831977	1.703242
Kongwa	.2238845	.4314593	0.52	0.604	-.6217601	1.069529
Age	.0297215	.0204022	1.46	0.145	-.0102661	.0697091
Gender	1.23889	.7407452	1.67	0.094	-.2129443	2.690724
HHpos	.4979231	.3863134	1.29	0.197	-.2592372	1.255083
EducYrs	.0158001	.091786	0.17	0.863	-.1640971	.1956974
CHILD1	.5433967	.2881811	1.89	0.059	-.0214279	1.108221
CHILD2	-.3203708	.1613433	-1.99	0.047	-.636598	-.0041437
Adult1	-.3394021	.1498574	-2.26	0.024	-.6331171	-.045687
Adult2	.0340244	.4684887	0.07	0.942	-.8841967	.9522454
A10_Hactors	-.0497478	.0571884	-0.87	0.384	-.161835	.0623394
A11_Hactors	.1304838	.2486078	0.52	0.600	-.3567786	.6177461
factor1	.8848372	.2665207	3.32	0.001	.3624662	1.407208
factor2	-.2901358	.2135327	-1.36	0.174	-.7086521	.1283806
access_infor	-7.310295	1.989974	-3.67	0.000	-11.21057	-3.410017
climate	-.2556498	.3720116	-0.69	0.492	-.9847792	.4734796
/cuteq1_1	.9566797	1.547366	0.62	0.536	-2.076101	3.989461
/cuteq1_2	1.490806	1.534389	0.97	0.331	-1.516542	4.498153
/cuteq1_3	2.965842	1.544267	1.92	0.055	-.0608659	5.992549
/cuteq1_4	4.354464	1.577611	2.76	0.006	1.262403	7.446526
/cuteq2_1	-6.84003	.7899824	-8.66	0.000	-8.388367	-5.291693
/cuteq2_2	-5.487366	.3975469	-13.80	0.000	-6.266543	-4.708188
/cuteq2_3	-3.821745	.2307752	-16.56	0.000	-4.274056	-3.369434
/cuteq2_4	-2.840854	.	.	.	.	.
/depend	.3659208	.179695	2.04	0.042	.013725	.7181166
theta	.3504186	.1576297				

```
. bioprobit freqconsun freqconsolar Mpwapa Kongwa Age Gender EducYrs CHILD1 CHILD2 Adul
> t1 Adult2 A9_USD A10_Hactors factor1 factor2

group(freqc |
   onsolar) |      Freq.     Percent        Cum.
------------+-----------------------------------
          1 |          1        1.82        1.82
          2 |          4        7.27        9.09
          3 |         17       30.91       40.00
          4 |         14       25.45       65.45
          5 |         19       34.55      100.00
------------+-----------------------------------
      Total |         55      100.00

initial:        log likelihood = -119.80618
rescale:        log likelihood = -119.80618
rescale eq:     log likelihood = -118.78447
Iteration 0:    log likelihood = -118.78447
Iteration 1:    log likelihood = -118.74635
Iteration 2:    log likelihood = -118.74633
Iteration 3:    log likelihood = -118.74633

Bivariate ordered probit regression               Number of obs     =         55
                                                  Wald chi2(13)     =      25.79
Log likelihood = -118.74633                       Prob > chi2       =     0.0181

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
freqconsun   |
      Mpwapa |   .5916235   .4687517     1.26   0.207     -.327113     1.51036
      Kongwa |   .1734309   .4167346     0.42   0.677    -.6433539    .9902157
         Age |  -.0160648    .017764    -0.90   0.366    -.0508816     .018752
      Gender |  -.9313054   .5520438    -1.69   0.092    -2.013291    .1506806
     EducYrs |  -.0237648   .0792752    -0.30   0.764    -.1791414    .1316118
      CHILD1 |   .0562518   .2479294     0.23   0.821    -.4296808    .5421845
      CHILD2 |  -.0442468   .1380122    -0.32   0.749    -.3147458    .2262522
      Adult1 |   .1468364    .131843     1.11   0.265     -.111571    .4052439
      Adult2 |   .6647852   .4070835     1.63   0.102    -.1330838    1.462654
      A9_USD |    .001598   .0013883     1.15   0.250     -.001123     .004319
 A10_Hactors |   .0089741   .0538378     0.17   0.868    -.0965461    .1144943
     factor1 |   .7876427   .2313722     3.40   0.001     .3341614    1.241124
     factor2 |  -.0044096   .1959051    -0.02   0.982    -.3883766    .3795574
-------------+----------------------------------------------------------------
freqconsolar |
      Mpwapa |   .4982438   .5150924     0.97   0.333    -.5113188    1.507806
      Kongwa |   .3976725   .4251095     0.94   0.350    -.4355268    1.230872
         Age |   .0165614   .0183282     0.90   0.366    -.0193611     .052484
      Gender |   .9697333   .6046779     1.60   0.109    -.2154135     2.15488
     EducYrs |   .0409166   .0800012     0.51   0.609     -.115883    .1977162
      CHILD1 |   .7139954   .2813144     2.54   0.011     .1626294    1.265361
      CHILD2 |  -.3238244   .1454877    -2.23   0.026     -.608975   -.0386738
      Adult1 |  -.2957631   .1354047    -2.18   0.029    -.5611515   -.0303747
      Adult2 |   .3956713   .4099244     0.97   0.334    -.4077658    1.199108
      A9_USD |  -.0008138   .0014185    -0.57   0.566    -.0035941    .0019664
 A10_Hactors |  -.0388774   .0545749    -0.71   0.476    -.1458423    .0680875
     factor1 |   .5624192   .2132555     2.64   0.008     .1444461    .9803923
     factor2 |  -.3106852   .1965667    -1.58   0.114    -.6959489    .0745785
-------------+----------------------------------------------------------------
athrho       |
       _cons |   .2759613   .1716003     1.61   0.108     -.060369    .6122916
-------------+----------------------------------------------------------------
      /cut11 |   .9117336   1.498043                     -2.024376    3.847843
      /cut12 |    1.47037   1.485026                     -1.440227    4.380968
      /cut13 |   2.948287   1.487884                      .0320882    5.864486
      /cut14 |    4.32647   1.521527                      1.344331    7.308609
      /cut21 |  -1.341832   1.488655                     -4.259542    1.575879
      /cut22 |  -.3639712   1.509203                     -3.321954    2.594011
      /cut23 |   1.130016   1.537444                      -1.88332    4.143351
      /cut24 |   2.039856   1.534837                     -.9683697    5.048082
-------------+----------------------------------------------------------------
         rho |   .2691631    .159168                     -.0602958    .5457382
------------------------------------------------------------------------------
LR test of indep. eqns. :           chi2(1) =      2.64    Prob > chi2 = 0.1043
```

```
. mfx

Marginal effects after bioprobit
      y  =  (predict)
         =  .00025691
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
 Mpwapa* |  -.0003775      .00068   -0.55   0.579  -.001712  .000957        .2
 Kongwa* |  -.0002678      .00051   -0.52   0.600   -.00127  .000734   .236364
     Age |  -4.03e-06      .00002   -0.22   0.822  -.000039  .000031      46.8
 Gender* |  -.0002328      .00045   -0.51   0.609  -.001124  .000659   .145455
 EducYrs |  -.0000173      .00008   -0.22   0.823  -.000168  .000134   6.87273
  CHILD1 |  -.0005167      .00088   -0.59   0.556  -.002237  .001204   .654545
  CHILD2 |   .0002429      .00042    0.58   0.565  -.000585  .001071   1.78182
  Adult1 |   .0001361      .00026    0.53   0.594  -.000364  .000636   2.72727
  Adult2 |  -.0005765      .00102   -0.56   0.572  -.002578  .001425   .290909
  A9_USD |  -1.72e-07      .00000   -0.13   0.896  -2.8e-06  2.4e-06   115.455
A10_Ha~s |   .0000226      .00006    0.37   0.711  -.000097  .000142   2.13818
 factor1 |  -.0007474      .00123   -0.61   0.544  -.003163  .001668   3.93899
 factor2 |   .0002157      .00039    0.56   0.578  -.000544  .000975   3.69999
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. doubleb  price1 price2 F2_1 res2 Age Gender EducYrs CHILD1 Adult1 CHILD2 Adult2 HHpos
>  A9_USD Total_Land factor1 factor2 AWAREsolardried access_infor if district

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -39618.247
rescale:       log likelihood = -178.27182
rescale eq:    log likelihood = -167.79148
Iteration 0:   log likelihood = -167.79148  (not concave)
Iteration 1:   log likelihood = -155.10461  (not concave)
Iteration 2:   log likelihood = -147.05376
Iteration 3:   log likelihood = -141.51898
Iteration 4:   log likelihood = -139.57947
Iteration 5:   log likelihood = -139.55479
Iteration 6:   log likelihood = -139.55474
Iteration 7:   log likelihood = -139.55474

                                                Number of obs     =        163
                                                Wald chi2(14)     =      17.40
Log likelihood = -139.55474                     Prob > chi2       =     0.2357

---------------------------------------------------------------------------------
                |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
Beta            |
            Age |  -1.710155   10.48273    -0.16   0.870    -22.25593    18.83562
         Gender |   86.34454   322.4272     0.27   0.789    -545.6012    718.2903
        EducYrs |   90.15745   36.72534     2.45   0.014     18.17711    162.1378
         CHILD1 |  -175.6444   125.2967    -1.40   0.161    -421.2215     69.9326
         Adult1 |   22.25131   77.18187     0.29   0.773    -129.0224     173.525
         CHILD2 |   92.55909   80.03071     1.16   0.247    -64.29822    249.4164
         Adult2 |   439.9339   278.6598     1.58   0.114    -106.2292    986.0971
          HHpos |   337.7052   297.7377     1.13   0.257      -245.85    921.2604
         A9_USD |   3.942224   1.946222     2.03   0.043     .1276997    7.756748
     Total_Land |   24.33472   32.19925     0.76   0.450    -38.77466     87.4441
        factor1 |  -110.7854   109.0079    -1.02   0.309     -324.437    102.8661
        factor2 |   144.3791   148.4604     0.97   0.331    -146.5979    435.3561
AWAREsolardried |   362.2823   397.9942     0.91   0.363    -417.7719    1142.337
   access_infor |   183.4742   428.1971     0.43   0.668    -655.7767    1022.725
          _cons |   528.8273   1035.263     0.51   0.609    -1500.252    2557.906
----------------+----------------------------------------------------------------
```

Objective 3

Contigent valuation mehod estimates

Solar dried TAVs

```
. doubleb  price1 price2 F2_1 res2

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood =  -54227.93
rescale:       log likelihood = -282.88324
rescale eq:    log likelihood = -263.73748
Iteration 0:   log likelihood = -263.73748  (not concave)
Iteration 1:   log likelihood = -252.98722  (not concave)
Iteration 2:   log likelihood = -243.43317
Iteration 3:   log likelihood = -241.20732
Iteration 4:   log likelihood = -239.88219
Iteration 5:   log likelihood = -239.87773
Iteration 6:   log likelihood = -239.87772

                                                Number of obs     =        244
                                                Wald chi2(0)      =          .
Log likelihood = -239.87772                     Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   2238.676   107.1604    20.89   0.000     2028.646    2448.707
-------------+----------------------------------------------------------------
Sigma        |
       _cons |   938.3813   116.4958     8.06   0.000     710.0538    1166.709
------------------------------------------------------------------------------

First-Bid Variable:             price1
Second-Bid Variable:            price2
First-Response Dummy Variable:  F2_1
Second-Response Dummy Variable: res2

. doubleb  price1 price2 F2_1 res2 if site==1

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -20966.232
rescale:       log likelihood = -101.59982
rescale eq:    log likelihood = -96.556101
Iteration 0:   log likelihood = -96.556101  (not concave)
Iteration 1:   log likelihood = -90.426267  (not concave)
Iteration 2:   log likelihood = -86.050982
Iteration 3:   log likelihood = -83.025898
Iteration 4:   log likelihood = -82.611586
Iteration 5:   log likelihood = -82.611474
Iteration 6:   log likelihood = -82.611474

                                                Number of obs     =         81
                                                Wald chi2(0)      =          .
Log likelihood = -82.611474                     Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   2098.374   132.6034    15.82   0.000     1838.476    2358.272
-------------+----------------------------------------------------------------
Sigma        |
       _cons |   733.0298   135.5139     5.41   0.000     467.4274    998.6323
------------------------------------------------------------------------------

First-Bid Variable:             price1
Second-Bid Variable:            price2
First-Response Dummy Variable:  F2_1
Second-Response Dummy Variable: res2
```

```
. doubleb  price1 price2 F2_1 res2 if site==2

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -2901.3113
rescale:       log likelihood = -82.251298
rescale eq:    log likelihood = -78.920816
Iteration 0:   log likelihood = -78.920816  (not concave)
Iteration 1:   log likelihood =  -75.90411  (not concave)
Iteration 2:   log likelihood = -73.672159
Iteration 3:   log likelihood = -71.240272  (backed up)
Iteration 4:   log likelihood = -71.166248
Iteration 5:   log likelihood = -71.162579
Iteration 6:   log likelihood = -71.162572

                                               Number of obs     =         82
                                               Wald chi2(0)      =          .
Log likelihood = -71.162572                    Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   2521.422   273.7002     9.21   0.000      1984.98    3057.865
-------------+----------------------------------------------------------------
Sigma        |
       _cons |    1135.59    282.854     4.01   0.000     581.2062    1689.974
------------------------------------------------------------------------------

First-Bid Variable:             price1
Second-Bid Variable:            price2
First-Response Dummy Variable:  F2_1
Second-Response Dummy Variable: res2

. doubleb  price1 price2 F2_1 res2 if site==3

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -1301.0233
rescale:       log likelihood = -101.92303
rescale eq:    log likelihood = -84.842549
Iteration 0:   log likelihood = -84.842549
Iteration 1:   log likelihood = -84.319686
Iteration 2:   log likelihood = -83.991975
Iteration 3:   log likelihood =  -83.99057
Iteration 4:   log likelihood =  -83.99057

                                               Number of obs     =         81
                                               Wald chi2(0)      =          .
Log likelihood =  -83.99057                    Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   2180.492   192.2195    11.34   0.000     1803.749    2557.235
-------------+----------------------------------------------------------------
Sigma        |
       _cons |   1039.674   233.4415     4.45   0.000     582.1375    1497.212
------------------------------------------------------------------------------

First-Bid Variable:             price1
Second-Bid Variable:            price2
First-Response Dummy Variable:  F2_1
Second-Response Dummy Variable: res2
```

Open sundried TAVs

```
. doubleb pricei priceii F2B_1 responseii if site==1

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -15049.763
rescale:       log likelihood =  -93.55783
rescale eq:    log likelihood =  -93.55783
Iteration 0:   log likelihood =  -93.55783
Iteration 1:   log likelihood = -93.145357
Iteration 2:   log likelihood = -92.469378
Iteration 3:   log likelihood = -92.460922
Iteration 4:   log likelihood = -92.460878
Iteration 5:   log likelihood = -92.460878

                                                Number of obs     =         81
                                                Wald chi2(0)      =          .
Log likelihood = -92.460878                     Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   908.0231   108.0919     8.40   0.000     696.1668    1119.879
-------------+----------------------------------------------------------------
Sigma        |
       _cons |    808.383   189.3055     4.27   0.000      437.351    1179.415
------------------------------------------------------------------------------

First-Bid Variable:             pricei
Second-Bid Variable:            priceii
First-Response Dummy Variable:  F2B_1
Second-Response Dummy Variable: responseii

. doubleb pricei priceii F2B_1 responseii if site==2

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -16516.172
rescale:       log likelihood =  -118.1231
rescale eq:    log likelihood = -109.92015
Iteration 0:   log likelihood = -109.92015
Iteration 1:   log likelihood = -108.93614
Iteration 2:   log likelihood = -108.89854
Iteration 3:   log likelihood = -108.89845
Iteration 4:   log likelihood = -108.89845

                                                Number of obs     =         82
                                                Wald chi2(0)      =          .
Log likelihood = -108.89845                     Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   878.3843   62.68272    14.01   0.000     755.5285     1001.24
-------------+----------------------------------------------------------------
Sigma        |
       _cons |     497.85   84.22492     5.91   0.000     332.7722    662.9278
------------------------------------------------------------------------------

First-Bid Variable:             pricei
Second-Bid Variable:            priceii
First-Response Dummy Variable:  F2B_1
Second-Response Dummy Variable: responseii

. doubleb pricei priceii F2B_1 responseii if site==3

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -25454.491
rescale:       log likelihood = -109.91778
rescale eq:    log likelihood = -102.86101
Iteration 0:   log likelihood = -102.86101
Iteration 1:   log likelihood = -102.77514
Iteration 2:   log likelihood = -102.77464
Iteration 3:   log likelihood = -102.77464

                                                Number of obs     =         80
                                                Wald chi2(0)      =          .
Log likelihood = -102.77464                     Prob > chi2       =          .

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Beta         |
       _cons |   915.9854   61.00225    15.02   0.000     796.4232    1035.548
-------------+----------------------------------------------------------------
Sigma        |
       _cons |   466.8956   76.76312     6.08   0.000     316.4426    617.3485
------------------------------------------------------------------------------

First-Bid Variable:             pricei
Second-Bid Variable:            priceii
First-Response Dummy Variable:  F2B_1
Second-Response Dummy Variable: responseii
```

Choice experiment estimates

```
.
. cmclogit choice price, iterate(6)

Iteration 0:   log likelihood = -170.50691  (not concave)
Iteration 1:   log likelihood = -150.81379  (not concave)
Iteration 2:   log likelihood = -148.40288  (not concave)
Iteration 3:   log likelihood =  -148.2647  (not concave)
Iteration 4:   log likelihood = -148.25508  (not concave)
Iteration 5:   log likelihood = -148.24616  (not concave)
Iteration 6:   log likelihood =  -148.2348  (not concave)
convergence not achieved

Conditional logit choice model                Number of obs      =        732
Case ID variable: id                          Number of cases    =        244

Alternatives variable: alternative            Alts per case: min =          3
                                                             avg =        3.0
                                                             max =          3

                                                 Wald chi2(1)    =      46.49
Log likelihood =  -148.2348                      Prob > chi2     =     0.0000
```

choice	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
alternative						
price	.0032536	.0004772	6.82	0.000	.0023184	.0041888
None	(base alternative)					
Sun						
_cons	.8196214	.3584223	2.29	0.022	.1171265	1.522116
Solar						
_cons	-.3585354	.	.	.	.	.

Becker DeGroot mechanism estimates

Solar dried TAVs

```
. sum F3B_bid1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
    F3B_bid1 |        244    1311.475    514.6731        100       3000

. sum F3B_bid2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
    F3B_bid2 |        244    601.6393    288.5279        200       2000

. by site,sort:tobit F3B_bid1 ,ll(0)

-----------------------------------------------------------------------------------------------
-> site = Iramba

Tobit regression                                  Number of obs     =         81
                                                  LR chi2(0)        =      -0.00
                                                  Prob > chi2       =          .
Log likelihood = -609.81042                       Pseudo R2         =    -0.0000

------------------------------------------------------------------------------
    F3B_bid1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   1360.494   50.01689    27.20   0.000     1260.976    1460.012
-------------+----------------------------------------------------------------
      /sigma |    450.152   35.36728                      379.7822    520.5218
------------------------------------------------------------------------------
             0  left-censored observations
            81     uncensored observations
             0 right-censored observations

-----------------------------------------------------------------------------------------------
-> site = Kongwa

Tobit regression                                  Number of obs     =         82
                                                  LR chi2(0)        =       0.00
                                                  Prob > chi2       =          .
Log likelihood = -635.38496                       Pseudo R2         =     0.0000

------------------------------------------------------------------------------
    F3B_bid1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   1346.341   61.94822    21.73   0.000     1223.107    1469.576
-------------+----------------------------------------------------------------
      /sigma |    560.965   43.80401                      473.8249    648.1051
------------------------------------------------------------------------------
             0  left-censored observations
            82     uncensored observations
             0 right-censored observations

-----------------------------------------------------------------------------------------------
-> site = Mpwapa

Tobit regression                                  Number of obs     =         81
                                                  LR chi2(0)        =       0.00
                                                  Prob > chi2       =          .
Log likelihood = -620.32707                       Pseudo R2         =     0.0000

------------------------------------------------------------------------------
    F3B_bid1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |    1227.16   56.95126    21.55   0.000     1113.845    1340.476
-------------+----------------------------------------------------------------
      /sigma |   512.5613   40.27062                      432.4354    592.6872
------------------------------------------------------------------------------
             0  left-censored observations
            81     uncensored observations
             0 right-censored observations
```

Open sun dried TAVs

```
. by site,sort:tobit F3B_bid2 ,ll(0)

-------------------------------------------------------------------------------
-> site = Iramba

Tobit regression                                  Number of obs     =         81
                                                  LR chi2(0)        =       0.00
                                                  Prob > chi2       =          .
Log likelihood = -578.56776                       Pseudo R2         =     0.0000

------------------------------------------------------------------------------
    F3B_bid2 |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |    662.963    34.0098    19.49   0.000     595.2941    730.6318
-------------+----------------------------------------------------------------
      /sigma |   306.0882   24.04856                      258.2391    353.9373
------------------------------------------------------------------------------
             0  left-censored observations
            81     uncensored observations
             0 right-censored observations

-------------------------------------------------------------------------------
-> site = Kongwa

Tobit regression                                  Number of obs     =         82
                                                  LR chi2(0)        =       0.00
                                                  Prob > chi2       =          .
Log likelihood = -560.47801                       Pseudo R2         =     0.0000

------------------------------------------------------------------------------
    F3B_bid2 |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   546.9512   24.84855    22.01   0.000     497.5195    596.3829
-------------+----------------------------------------------------------------
      /sigma |   225.0132   17.57058                      190.0597    259.9667
------------------------------------------------------------------------------
             0  left-censored observations
            82     uncensored observations
             0 right-censored observations

-------------------------------------------------------------------------------
-> site = Mpwapa

Tobit regression                                  Number of obs     =         81
                                                  LR chi2(0)        =       0.00
                                                  Prob > chi2       =          .
Log likelihood = -580.37902                       Pseudo R2         =     0.0000

------------------------------------------------------------------------------
    F3B_bid2 |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |    595.679   34.77887    17.13   0.000       526.48    664.8781
-------------+----------------------------------------------------------------
      /sigma |   313.0098   24.59238                      264.0787    361.9409
------------------------------------------------------------------------------
             0  left-censored observations
            81     uncensored observations
             0 right-censored observations

. tobit F3B_bid2 ,ll(0)

Tobit regression                                  Number of obs     =        244
                                                  LR chi2(0)        =      -0.00
                                                  Prob > chi2       =          .
Log likelihood = -1727.9291                       Pseudo R2         =    -0.0000

------------------------------------------------------------------------------
    F3B_bid2 |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   601.6393   18.43321    32.64   0.000     565.3308    637.9479
-------------+----------------------------------------------------------------
      /sigma |    287.936   13.03425                       262.262      313.61
------------------------------------------------------------------------------
             0  left-censored observations
           244     uncensored observations
             0 right-censored observations
```

Objective four

```
. doubleb  price1 price2 F2_1 res2 Age Gender EducYrs HHpos A10_Hactors A11_Hactors Mpwapa Kongwa access_infor A9_USD factor1 factor2 AW
> AREsolardried

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -63749.185
rescale:       log likelihood = -290.59677
rescale eq:    log likelihood = -256.39467
Iteration 0:   log likelihood = -256.39467  (not concave)
Iteration 1:   log likelihood = -235.56926  (not concave)
Iteration 2:   log likelihood = -227.84445
Iteration 3:   log likelihood = -217.38217
Iteration 4:   log likelihood = -215.65341
Iteration 5:   log likelihood = -215.59175
Iteration 6:   log likelihood = -215.59159
Iteration 7:   log likelihood = -215.59159

                                                Number of obs     =        244
                                                Wald chi2(13)     =      28.31
Log likelihood = -215.59159                     Prob > chi2       =     0.0082
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Beta						
Age	10.97759	6.037296	1.82	0.069	-.8552881	22.81048
Gender	418.1393	210.9455	1.98	0.047	4.693687	831.585
EducYrs	63.88761	27.50224	2.32	0.020	9.9842	117.791
HHpos	563.1306	185.946	3.03	0.002	198.6831	927.5781
A10_Hactors	10.85816	24.59781	0.44	0.659	-37.35267	59.06898
A11_Hactors	-48.03102	92.28366	-0.52	0.603	-228.9037	132.8416
Mpwapa	59.91113	179.9351	0.33	0.739	-292.7552	412.5774
Kongwa	243.1388	198.5641	1.22	0.221	-146.0396	632.3172
access_infor	206.2267	273.6237	0.75	0.451	-330.066	742.5194
A9_USD	3.256792	1.466041	2.22	0.026	.3834043	6.13018
factor1	-36.4337	67.88934	-0.54	0.592	-169.4944	96.62697
factor2	7.563183	94.80337	0.08	0.936	-178.248	193.3744
AWAREsolardried	435.8788	259.0729	1.68	0.092	-71.89474	943.6523
_cons	-45.87719	665.3392	-0.07	0.945	-1349.918	1258.164
Sigma						
_cons	810.3732	99.11695	8.18	0.000	616.1076	1004.639

```
First-Bid Variable:             price1
Second-Bid Variable:            price2
First-Response Dummy Variable:  F2_1
Second-Response Dummy Variable: res2

. nlcom (WTP:(_b[_cons]+ Age_m*_b[Age]+ Gender_m*_b[Gender] + HHpos_m*_b[HHpos]+ EducYrs_m*_b[EducYrs]+ A9_USD_m*_b[ A9_USD]+factor1_m*_
> b[factor1]+ factor2_m*_b[factor2]+ AWAREsolardried_m*_b[AWAREsolardried ]+ Mpwapa_m*_b[ Mpwapa]+ Kongwa_m*_b[ Kongwa]+ A11_Hactors_m*_
> b[ A11_Hactors]+ access_infor_m*_b[access_infor]+ A10_Hactors_m*_b[A10_Hactors])), noheader
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	2035.613	118.8586	17.13	0.000	1802.654	2268.571

```
. bioprobit F2_1 res2 Age Gender EducYrs HHpos A10_Hactors A11_Hactors Mpwapa Kongwa access_i
> nfor A9_USD factor1 factor2 AWAREsolardried
```

group(res2)	Freq.	Percent	Cum.
1	52	21.31	21.31
2	192	78.69	100.00
Total	244	100.00	

```
initial:       log likelihood = -210.49705
rescale:       log likelihood = -210.49705
rescale eq:    log likelihood = -210.49705
Iteration 0:   log likelihood = -210.49705
Iteration 1:   log likelihood = -210.00792
Iteration 2:   log likelihood = -210.00684
Iteration 3:   log likelihood = -210.00684

Bivariate ordered probit regression               Number of obs     =        244
                                                  Wald chi2(13)     =      29.86
Log likelihood = -210.00684                       Prob > chi2       =     0.0049
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
F2_1						
Age	.0153562	.008576	1.79	0.073	-.0014524	.0321648
Gender	.493246	.286769	1.72	0.085	-.068811	1.055303
EducYrs	.0716921	.0384779	1.86	0.062	-.0037231	.1471073
HHpos	.9048831	.2600868	3.48	0.001	.3951224	1.414644
A10_Hactors	.0067138	.0330848	0.20	0.839	-.0581312	.0715587
A11_Hactors	-.0233728	.1376773	-0.17	0.865	-.2932154	.2464698
Mpwapa	.0600016	.2564345	0.23	0.815	-.4426008	.5626039
Kongwa	.3556497	.2840659	1.25	0.211	-.2011092	.9124086
access_infor	.2040766	.3874694	0.53	0.598	-.5553495	.9635028
A9_USD	.0055519	.0024716	2.25	0.025	.0007076	.0103962
factor1	.0093851	.0956926	0.10	0.922	-.178169	.1969391
factor2	-.0254663	.1328211	-0.19	0.848	-.285791	.2348583
AWAREsolardried	.4745787	.3650243	1.30	0.194	-.2408559	1.190013
res2						
Age	.0071747	.0085581	0.84	0.402	-.0095988	.0239482
Gender	.57045	.3100705	1.84	0.066	-.037277	1.178177
EducYrs	.0737033	.0379119	1.94	0.052	-.0006026	.1480092
HHpos	.3230348	.2538699	1.27	0.203	-.174541	.8206105
A10_Hactors	.0229484	.0451033	0.51	0.611	-.0654524	.1113492
A11_Hactors	-.0656682	.1291351	-0.51	0.611	-.3187684	.1874319
Mpwapa	.0319369	.258635	0.12	0.902	-.4749785	.5388522
Kongwa	.1590736	.2845389	0.56	0.576	-.3986124	.7167597
access_infor	.3817112	.4042203	0.94	0.345	-.410546	1.173968
A9_USD	.0026146	.0017619	1.48	0.138	-.0008387	.006068
factor1	-.142923	.1008188	-1.42	0.156	-.3405243	.0546782
factor2	.0724102	.1367096	0.53	0.596	-.1955357	.3403561
AWAREsolardried	.4797599	.380234	1.26	0.207	-.265485	1.225005
athrho						
_cons	.6362118	.1486619	4.28	0.000	.3448399	.9275837
/cut11	2.395077	.943029			.5467746	4.24338
/cut21	.8239984	.9144709			-.9683317	2.616328
rho	.5623147	.1016553			.3317914	.7294654

```
LR test of indep. eqns. :           chi2(1) =    21.13   Prob > chi2 = 0.0000

. mfx

Marginal effects after bioprobit
      y  =  (predict)
         =  .07449715
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
Age	-.0017471	.00109	-1.60	0.109	-.003887	.000392	45.6598
Gender*	-.0662243	.02681	-2.47	0.014	-.118771	-.013678	.237705
EducYrs	-.0111714	.00501	-2.23	0.026	-.020992	-.001351	6.2582
HHpos	-.0954713	.03474	-2.75	0.006	-.163562	-.027381	1.5123
A10_Ha~s	-.0022494	.00473	-0.48	0.635	-.011529	.007031	2.25143
A11_Ha~s	.0067643	.01652	0.41	0.682	-.025621	.03915	.488115
Mpwapa*	-.0070389	.03139	-0.22	0.823	-.068569	.054491	.331967
Kongwa*	-.0376217	.03156	-1.19	0.233	-.099483	.02424	.336066
access~r*	-.0414538	.04211	-0.98	0.325	-.123993	.041086	.319672
A9_USD	-.0006332	.00025	-2.54	0.011	-.001122	-.000144	75.9242
factor1	.0099777	.01222	0.82	0.414	-.013976	.033931	3.50338
factor2	-.0034243	.01688	-0.20	0.839	-.036502	.029654	3.76373
A~rdried*	-.0670468	.03953	-1.70	0.090	-.144529	.010435	.364754

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Appendix III: Abstract page of the paper

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Consumption Pattern of Dried Traditional African Vegetables among Rural Households in Tanzania

Wilbon Cheruiyot Yegon[1*], Oscar Ayuya Ingasia[1], Justus Ochieng[2]

[1]Department of Agricultural Economics and Agribusiness Management, Egerton University, Njoro, Kenya
[2]World Vegetable Centre, Duluti, Arusha, Tanzania
Email: *yegonwilbon@gmail.com

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Abstract

Vegetables are known to be nutritious and form part of almost every meal in an African set up. However, they are known to be perishable and seasonal thus scarce during dry period. Drying helps extend their shelf life. The main objective of the study was to determine consumption pattern of dried traditional vegetables (TAVs) in semi-arid rural households. Dried TAVs by open sun drying and solar drying were considered. Cross-section data collected in 2016 among 244 respondents in Dodoma and Singida region through random sampling using semi-structured questionnaire was utilized. Ordered bivariate probit was estimated using STATA software. The results showed that access to information on drying, gender, presence of adults above 64 years, adults between 15 - 64 years, children between 5 - 14 and 0 - 4 years was significant. The information is useful in planning trainings and in determining the consumer segment to target. Strategies that would enhance information access are highly recommended.

Keywords

Open Sun Drying, Ordered Bivariate Probit, Solar Drying, TAVs

Appendix IV: Research Permit

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