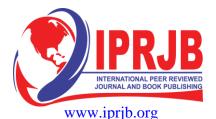# Farmers' Demonstrate Rationality and Transitivity in Variety Choice: Empirical Evidence From two Rice Growing Niches in Coastal Kenya

Kengo Danda M.[1]*, John M. Kimani*[2]*, and* Lee Sang-Bok[3]

Farmers' Demonstrate Rationality and Transitivity in Variety Choice: Empirical Evidence From two Rice Growing Niches in Coastal Kenya.

Kengo Danda M.[1], John M. Kimani[2], and Lee Sang-Bok[3]

1=Agricultural Economist with the Kenya Agricultural and Livestock Research Organization

2= Rice Breeder with the Kenya Agricultural and Livestock Research Organization

[3]RDA = Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI), Africa Rice Training Center, Saint-Louis, Senegal

Abstract

Purpose: A cross-sectional survey was designed to study farmers' preference and choice framework for rice varieties in Kwale and Taita-Taveta counties of coastal lowland Kenya.

Methodology: The survey used a multi-stage sampling technique; systematic selection for the study counties/niches, a purposive sampling approach for the study population (rice growers only) and a systematic random sampling for the respondents on an nth occurrence. Data was collected with the aid of a semi-structured questionnaire and key informant interviews from key rice value chain actors; including farmers as producers as well as consumers and agricultural extension service providers (AESPs) and other stakeholders. A total of 137 individual respondents were interviewed using the semi-structured questionnaire while the key informant interviews engaged a total of 29 AESPs. Data analysis focused on exploring on the varieties that farmers grew and whether they had a criteria or pattern for choosing the varieties to grow and seed source.

Findings: Results confirmed that the Kwale rice growing niche had a higher rice variety diversity (more than 12 varieties) while Taita-Taveta had only around seven (7) common varieties. Rice was more traditionally grown in Kwale with low acreage and low yields compared to Taita-Taveta. Common varieties grown were Pachanga, Supa, Kitumbo, Makonde and Kibawa in Kwale while in Taita-Taveta, Japan, Supa and Hybrid 6444 rice varieties were common (with prevalence rating of 44.8%, 25.4%, 22.4%, 20.9 and 17.9% in Kwale respectively and 55.7%, 54.3% and 18.6% in Taita-Taveta respectively). Varieties grown by farmers in Kwale had a long history of seed recycling and were characterized by low productivity (less than 6, 90-kg bags per acre) and subsistent in nature than in Taita-Taveta. The general picture for variety prevalence in both (Kwale and Taita) growing niches was that farmers mostly relied on traditional (own-preserved, farmer-to-farmer exchange or market) seed systems for the recycled rice varieties. Variety choice by farmers who are both producers and consumers demonstrated a rational and transitive behavior with land resource allocation.

Contribution to theory, practice and policy: The study provided evidence of an urgent need for strategic interventions towards improving the production system through on-farm researcher-led demonstrations for superior rice varieties, agronomic practices as well as an input subsidy and sustainable market linkages. Formation of farmer producer groups and strategic facilitation of the groups with rice certified seed and mills are proposed as positive drivers to improving rice marketing and increased productivity.

Key Words: Rice Varieties, Farmers, Producer, Consumer, Choice, Rationality, Seed, Transitivity and Utility

1. INTRODUCTION

Farmers make production decisions in order to address their own or their household immediate and future needs. In other words, household and market demand are key drivers to the farmers' production decisions (Huffman, 2010. On one hand, it is common knowledge that all production decisions must bear conscious efforts of aligning the necessary factors for production as a pre-requisite to expected outputs or products. These products must however satisfy the demand side of the equation from an economic point of view.

In this paper, an evaluation of rice farmers' variety choice decision making pattern was done using cross-sectional data collected over one growing season in two production niches of coastal lowland Kenya. Cross-sectional data provides information about a subject of interest at a particular point in time (Thomas, 2020). The context under which cross-sectional studies are useful in research was in line with the underlying objectives of this study which sought to establish whether there is a pattern that influences farmers to consistently make the decisions they make in their rice growing activities or efforts. These two regions have enormous potential for rice production but rice enterprises have largely remained unfocused and thus rice production is remote with broadcasting being the major planting style or pattern. Farmers in the two niches also practice little or no weeding with almost all (97%) not using fertilizer.. This kind of scenario has resulted into meagre rice production of late and highly mixed up landraces that require further research in order to improve both vertical and horizontal growth and thus create good socio-economic wellbeing of the farming communities and thus make rice enterprise an attractive and profitable venture in face of emerging climate change and agri-food system compounded by emergent of COVID-19 pandemic.

1.1 A review of the farmers' variety choice framework

Rice production is a practice which is largely influenced by agro-ecological setting based on the agronomic requirements of the crop (Kega, et al., 2015). Apart from rice requiring an ambient agro-climatic/ecological setting, with water (either under irrigation, rainfall or seasonal flooding), as a pre-condition for growth other critical considerations must also be taken into account when deciding which rice variety to grow. The utility function that growing rice must satisfy; the farmers' household or the market (other households and/or industry) is one other most important factor. From these two considerations (agro-ecological setting and the utility function) for rice growing and in particular, variety choice, we can develop an econometric relationship with the following algebraic expression in (i) below;

(i) $\mathbf{R}_{gd} = f\,(Ae,\ U_{ij}..e_{ij})$ where;
$R_g d$ = the rice growing decisions as being a function of
Ae = Agro-ecological requirements and
U = the utility function to be satisfied (households or the market)
e_{ij} = the associated error terms for the agro-ecological requirements and the utility function

We further take into consideration the farmers' circumstances and plight in making variety choices from a welfare perspective noting that a social welfare function (SWF) compels an

individual (consumer or business oriented) to make choices that provide a win-win rating in providing satisfaction (Hacker and Grundmann, 2021). The SWF is a tool which can be used by decision makers to make choices based on ranking of social states, objects and/or subjects as being less desirable, more desirable or indifferent for every pair of items to be compared. The tool also makes total assumption that farmers making variety choices are rational, consistent and transitive such that their decisions follow the following algebraic expressions;

(ii) $PVty_{ij} = f(Pa_1, Pa_2, Pa_3....Pa_n)$/ordered, where;

$PVty_{ij}$ = preferred variety (or variety the farmer chooses to grow) being a function of;

$Pa_1, Pa_2...Pa_n$ = are preferred variety attributes which follow a particular order to farmers who double to be producers as well as consumers

The preferred variety attributes include grain recovery rate, flavor/taste, aroma, swelling and friability on cooking among others (Musila, et al, 2018). The farmers from Central part of rice growing Kenya had a contrary criteria of high yielding and easy to thresh varieties, Hybrids rice, varieties with less fertilizers use and pest and disease resistance (Kimani et al., 2011). These are among the selection criterion for varieties that farmers will grow and are rational in their choice framework to ensure that the varieties satisfy them through providing the preferred utility attributes.

For transitivity, farmers in their positions as producers and consumers demonstrate a decision framework which translates the choice for variety A to B and B to C as implying that variety A will remain preferred to C which means that the utility function satisfied by variety A cannot in anyway be satisfied or perfectly substituted by B or C. Hence the algebraic representation below;

(iii)   If $A \succsim$ and $B \succsim C$, then A, $\succsim C$, A;

In the representation, the assumption implies that if at first an individual chooses variety A over variety B, and if in a second time he chooses variety B over variety C, with B being the same in both cases, then it is logical that the consumer will select variety A over variety C. This is the concept of transitivity of preference. In practical economic terms, the farmer is transitive based on informed knowledge of the attributes that he as a consumer as well as the market requires to see are satisfied.

On the overall, study sought to establish whether rice farmers' have a pattern that influences choice of varieties to grow as well as resource allocation to the rice production. Further, the study was designed to provide evidence of the "invisible hand" in variety choice as dictated by economic principles that dictate on rational producers and consumers who wish to maximize production, productivity and utility as documented by (Dwicahyani, et al, 2019).

2. Materials and Methods

2.1 The Study Area

The study was conducted in two rice growing niches of Kwale and Taita-Taveta Counties specifically Lungalunga and Taveta sub-counties of the respective counties. The Kwale county rice growing niche where data was collected lies between $4^0.25$ to $4^0.49$ South of the Equator and $39^0.15$ and 39^0 39' East of the Greenwich Meantime (GMT) while the Taita-Taveta rice growing

niche lies between 3^0, 20' to 3^0, 35' South and 37^0, 28' to 37^0, 41' east of the GMT.   The sub-counties host rice production largely on rain-fed production systems and therefore the production calendar varies over the calendar year. Taveta rice growing niche however has relatively high water abundance than the Lungalunga production niche in Kwale.

2.2 Survey design and sampling

The survey followed a cross-sectional design where all respondents (across age and gender) were interviewed at once and within the same time (a lapse of only seven days). A multistage sampling procedure was used where sites were selected systematically based on intensity of rice growing activities; hence settling largely on one administrative division of Lungalunga in Kwlae county and Taveta in Taita-Taveta county. Thereafter, a purposive selection of farmers (only those that grow rice) was done and a list established through the assistance of local opinion leaders and the agricultural extension service provider (AESP). A systematic random selection/identification of respondents was then used to identify individual respondents for a one-to-one verbal engagement based on the nth occurrence of farmers on a designated transect and direction. Replacements for missed target respondents.

2.3 Data collection techniques

The survey used three approaches namely; (i) key informant interviews (KIIs) which engaged agricultural extension service providers (AESPs) and other value chain actors such as grain-rice store managers and (ii) one-to-one interviews with farmers guided by a semi-structured questionnaire and lastly (iii) desk-top research as sources of secondary data for triangulation of the primary data from the first two approaches. The questionnaire survey formed the climax of the data collection as enumerators maximized on the dual property of the farmers who are both producers and consumers of rice.

2.4 Data management and analysis

Data was keyed-in through the Statistical Package for Social Scientists (SPSS) cleaned for outliers and analyzed through descriptive statistics (mainly frequencies and percentages). Further analysis which basically involved attributions was done through cross-tabulations.

3. Results and Discussion

The results documented herein are original to the survey procedures and findings and are interpreted in line with the subject of this paper. All generalizations are part of the inferential analysis as part of the underlying objectives of the study.
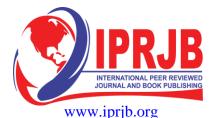
3.1 Respondents' descriptors

Table 1: Socio-demographic descriptors of the respondents

Sample size (N)	137
Gender composition (percent)	
Male	44.5
Female	55.5
Age brackets (percent)	
<26 years	1.5
26 - 35 years	20.4
36– 45 years	32.1
46– 55 years	27.0
>55 years	19.0
Education (percent per level)	
None	26.3
Primary	54.0
Secondary	17.5
College	2.2
Occupation (percent)	
Full-time farmer	92.0
Other (off-farm)	0.7
Farming and Off-farm	7.3
Group Membership	
Membership/affiliation to group/s	17.9

Source: Survey data, April 2021

The demographic data indicates that rice enterprise is mainly undertaken by female farmers probably because it is labour intensive and thus not friendly to men. This scenario is evident in western and Nyanza especially where rice enterprise is not yet highly commercialized and remain more or less at subsistence level. In areas where it is considered a business, the crop management is high and use of inputs and mechanization is evident thus attracting more men. Generally, men get attracted to those farming activities that are mechanized thus less drudgery and with good economic return for their labour input (Kimani, 2010). Here at coast region, rice is largely traditional with majority of farmers just preparing their land manually thus taking long followed by broadcasting of their either farm saved seeds or from the local market leading to highly heterogeneous crop fields in terms of maturity, admixtures and very low yields. The crop is rarely weeded and use of fertilizer is not practiced. These farmers therefore require support in terms of training on good agricultural practices, mechanization for farm operations and milling as well as organized marketing for social economic wellbeing. Such interventions could make the enterprise attractive to both gender for sustainability.

3.2 Purpose for Growing Rice

The reason for growing food crops cannot be over-emphasized. Farmers usually grow any and/or all crops for one or more reasons that is food or for sale to generate some revenue. Even when sold, food crops end up serving the same purpose of contributing to food security (Atera, *et al*., 2018). The reasons are most often influenced by own or household consumption objectives or cash income/business objectives. Consumption objectives follow consumer preferences and are therefore dictated by preferences for certain consumption attributes within rice varieties such as aroma, taste/flavor, and/or grain friability after cooking among others (Musila, et al, 2018). On the other hand, and for business objectives, attributes such as high grain recovery and density among others are also most preferred. Rice growing in Kwale and Taita-taveta counties is largely dictated by both consumption and business objectives but at varying proportions. In Kwale County, the survey confirmed that over 90% (92.5) of farmers grew rice primarily for household consumption while in Taita-Taveta, 78.6% was for home consumption. The combined score (for Kwale and Taita) was 85.4%. These results confirm that rice growing in the Kwale niche is more subsistent than in Taita-Taveta. This subsistent nature partly arise from the fact that farm produce is low leaving very little or surplus for market need. One way to change this situation is to take rice enterprise as a agri-business venture that could then mean use of certified seeds, proper land production activities and good crop care and good post-harvest management for quality paddy that could in turn fetch market premium price translating into better socio-economic livelihoods.

3.3 *Varieties Grown by Farmers*

Farmers often represent consumers in choosing which rice variety to grow for two reasons; (i) they are *producers* and therefore production decisions are dictated by the resource framework available to them (*Rapsomanikis*, G., 2015) and (ii) they are themselves consumers and therefore decide what to grow based on existing knowledge of the different and available variety yield and consumer attributes that satisfy their utility function (Ghimire, et al. 2015). Empirical evidence adduced from a cross-sectional survey data (of April, 2021) confirm that all production efforts target satisfying consumption needs by 92.5% in Kwale and 78.6% for Taita-Taveta counties respectively. There were significant differences in number and types of varieties grown in Kwale County compared to those grown in Taita-Taveta County. In Kwale, the list of varieties was large enough (more than 14 including those that had a frequency of below 5%) while in Taita-Taveta County, significant varieties with a frequency score of more than 5% were hardly more than 5 in number. The Kwale region which has huge potential for irrigated and rainfed lowland as well as upland rice production especially at Simba hills was dominated by traditional landraces. The main reason for this situation was that rice as an enterprise has not been adequately promoted and new improved varieties introduced together with their management practices to replace the landraces. The landraces according to the farmers have high resilient for local conditions as they just broadcast them and only return to harvest without any input such as fertilizer or pesticides and fungicides use as pest and diseases are not a major problem for now. Ratoonability was the other reason for use of some landraces as this gives extra yield at minimum effort. It therefore came out clearly that Taveta had new varieties including hybrid rice but Kwale was yet to reap from such benefits of improved technologies such as Komboka, CSR36, MWIR2, MWUR4, 08FAN10 etc.
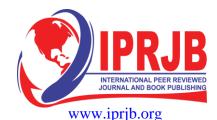
Table 2: Commonly grown rice varieties in Kwale and Taita rice growing niches by percentage

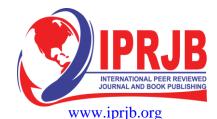| Kwale rice growing niche		Taita-Taveta rice growing niche	
Variety name	Prevalence score (%)	Variety name	Prevalence score (%)
Pachanga	44.8	Japan	55.7
Supa	25.4	Supa	54.3
Kibawa-cha-inzi	22.4	Hybrid-6444	18.6
Kitumbo	20.9	Other ****	4.3
Makonde	17.9		
Pishori	14.9		
Mtumbatu	13.4		
Kioo	11.9		
Macho-macho	10.4		
Moshi	10.4		
Others****	9.0		

Legend: **** *Other varieties in Kwale County included Niwai, Basmati, Kubwa-jinga and Riziki among others while in Taita-Taveta County, others included Mbeya, Komboka, Kienyeji and hybrids among others.*

There were significantly more varieties grown in the Kwale rice growing niche than in Taita-Taveta. In Kwale, *Pachanga*, *Supa* and *Kibawa-cha-inzi* stood out as the priority varieties and therefore the most grown varieties while in Tata-Taveta, Japan, Supa and Hybrid-6444 were the most dominant in farmers' fields.

Reasons for growing rice were stated as basically for household consumption in Kwale by 92.5% of respondents and 78.6% for Taita-Taveta. This confirmed that major reason for the high variety diversity in Kwale as source for range of consumption attributes that farmers wish to avail to their households as well as other consumers, including the market. Growing more than one variety was an alternate effort for maximizing on the multiplicity of the preferred consumer attributes from the different varieties. They also demonstrated a high trust of the rice varieties they have grown for a longer time; varieties they now consider as their conventional (Mesfin and Zemedu, 2018). These are varieties for which they have linear expectations in terms of yields as well ability to satisfy their consumption utility function.

3.4 Farmers' Rational behavior in Rice Variety Choice Demonstrated

Rice production systems in the two rice growing niches (Kwale and Taita) are predominantly rain fed which means land preparation must precede on-set of the rains. Under the time constrained production pattern, farmers have to make decisions on which varieties to plant and land sizes that satisfy production objectives which take into account the appropriateness of the variety in terms of its yield potential and the sum total of its preferred consumption and commercial attributes which may include, cooking quality, flavor, grain recovery and density among others. Walters, et al. (2016) asserts that farmers are rational, know their circumstances (including their resource capacities and environment) and therefore will give priority to varieties and allocate resources such as land area based on expectations and experience. They know which

www.iprjb.org

variety to plant based on yield expectations may be from experience or information sharing. Table 3 (1 and 2) below presents the order and production statistics for the first five varieties land allocation for the different varieties visa-vis the stated yields per acre in 90-kg bags.

Table 3: Variety choice for the Kwale production niche

Variety	Prevalence in farmers' fields by %	Stated/observed yields (in 90 kg bags Ha^{-1})	Relative land allocation (mean acreage)
Pachanga	44.8	12.9 (±2.17)	0.45 (±0.06)
Supa	25.4	10.7 (±2.2)	0.71 (±0.16)**
Kibawa-cha-inzi	22.4	7.6 (±1.22)	0.34 (±0.04)
Kitumbo	20.9	7.1 (±1.11)	0.37 (±0.05)
Makonde	17.9	7.5 (±1.28)	0.38 (±0.05)

***the relative high land allocation was due to the fact that the variety was on promotion in the growing niche of Kwale county*

Table 4: Variety choice for the Taita production niche against land resource allocation

Variety	Prevalence in farmers' fields by %	Stated/observed yields (in 90 kg bags Ha^{-1})	Relative land allocation (mean acreage)
Japan	55.7	32.46 (±2.59)	1.21 (±0.11)
Supa	54.3	31.04 (±2.35)	1.03 (±0.09)
Hybrid-6444	18.6	31.21 (±2.65)	0.71 (±0.10)

From the tables (3 and 4) above, a simple mapping of the order of the variety prevalence (by percentage) with the stated or observed yields and the relative land allocation presents a near decreasing pattern of the as you go down the lists of tables 3 and 4. The systematic decreasing pattern across the choice also follows varieties, their stated yields and land allocation clearly confirm the rational behavior farmers have in their decision making framework. This phenomenon explains the ability of farmers to consciously rank enterprises based on their productivity and translate the productivity concept into "value attachment" for the purpose of making resource allocation decisions proportionate to the values assigned. Based on this empirical evidence, we can conclude that farmers are guided by rationality in their decisions for variety choice and land resource allocation.

3.5 Farmers demonstrate Consistence and Transitivity in Variety Choice

Transitivity of preference is a fundamental principle shared by most major contemporary rational prescriptive and descriptive models of decision making (Regenwetter, et al 2011). It basically binds a person's, group's or societal choice of a consumable item with specific attributes that are not either easily transferable. It simply gives an implication of the concept of lack of perfect substitution for variety A with B or C hence the algebraic expression; A $\gtrsim$ and B $\gtrsim$ C, such that we generalize that A, $\gtrsim$C. Tables 3.4 and 3.5 below present empirical evidence of rice variety preference rating as first, second or third choice for growing in their fields.
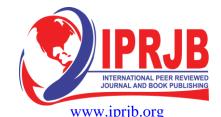
Table 5: Preference rating for rice varieties for farm resource allocation in the Kwale niche

Percent (%) of farmers devoting resources by variety and as first, second or third priority		
Variety Name	1st priority rating (%)	2nd priority rating (%)	3rd priority rating (%)
Pachanga	20.9	4.5	2.5
Supa	17.9	4.5	1.5
Kitumbo	14.9	7.5	4.5
Makonde	9.0	10.5*	0
Kibawa-cha-inzi	4.5	10.5**	3.0

*=The relatively high second priority rating was attributed to its swelling characteristic at cooking, **=this variety was specially preferred for its characteristic aroma

Table 6: Preference rating for rice varieties for farm resource allocation in the Taita-Taveta niche

Percent (%) of farmers devoting resources by variety and as first, second or third priority		
Variety Name	1st priority rating (%)	2nd priority rating (%)	3rd priority rating (%)
Japan	45.7	8.6	1.4
Supa	42.9	7.2	0
Hybrid 6444	3.0	2.9	0

The results demonstrate an ordered preference pattern for varieties as first, second or third selection given on the basis of their individual contribution to the farmers' and consumers' utility function or the SWF earlier discussed. Farmers in their capacities as rice producers and consumers demonstrate a decreasing choice preference as first, second or third choice for the varieties with the preferred attributes as demonstrated above. Exceptions as indicated in table 6 where a second priority was rated high (Makonde and Kibawa-cha-inzi) were qualified as based on varieties having special and distinguishable attributes such as drought tolerance or aroma which were of high rating to farmers. Taita-Taveta farmers had fewer varieties compared to Kwale mainly because farming was targeted to market requirement. The major markets were Kisumu and Tanzania and thus varieties grown were those in demand, indicating that the approach was of agri-business as opposed to Kwale. The fact that Taita-Taveta rice production was in irrigation schemes also contributed to this heterogeneity of few varieties as opposed to Kwale where the main Vanga irrigation scheme had collapsed due to discourse of the river supplying water. The preference pattern so far demonstrated estimates a significant consumer property of transitivity in variety choice.

4. Lessons learnt, Conclusions and Implications for improving the value chain

The study provides an opportunity to understand the rice growing landscape, the varieties grown in the two rice growing niches and particularly variety choice framework and pattern. It further presents a scenario which informs us of the variety diversity in both production niches. Kwale for instance had a higher diversity of recycled varieties and a more traditional production system characterized by low acreage and low yields. Rice production in this niche also targeted household subsistence needs. On the other hand, the Taita niche had fairly improved production system, comparatively better acreage and yields and a near commercialized focus.

In both production niches, variety choice by farmers/producers reflected perfect properties of consumer behavior where rationality and transitivity was seen to prevail in the choice framework. The Taita niche also had a better access to ample water for most part of the year than the Kwale niche. Rice production were more cultural and therefore this affected productivity negatively.
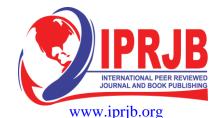
The study further provides evidence in both niches, for the need for participatory research, improved varieties' demonstrations, trainings, mechanization, and marketing intervention. Introduction of superior rice varieties and/or engaging farmers towards improving the productivity of the of the various value chain segments of the agri-food system in a changing climate environment needs to be taken as a priority by the sub-sector improvement teams. Introduction of researcher-led on-farm demonstrations, input subsidies from national and county government, and formation of farmer producer groups to improve on marketing are recommended. Through the farmer producer groups, predictable and prompt paddy payments, introduction of milling factories is also recommended at strategic cost-effective locations as these will act as drivers for increased production, productivity and improved household incomes from rice.

5. Acknowledgements

References:

Atera, E. A., Onyancha, F. N. and Majiwa, E. B. O. (2018): Production and marketing of rice in Kenya: Challenges and opportunities; In the Journal of Development and Agricultural economics; Vol. 10(3), pp. 64-70, March 2018

Dwicahyani, A. R., Cucuk Nur Rosyidi, C. N. and Pujiyanto, E. (2019): Minimizing gap of utility between consumer and producer in a duopoly market considering outsourcing decision, price, and product tolerance; A production & manufacturing research article: 2019, VOL. 7, NO. 1, 23-43: https://doi.org/10.1080/21693277.2019.1571957

Ghimire, J., Wen-chi, H., Shrestha, R. B. (2015): Factors Affecting Adoption of Improved Rice Varieties among Rural Farm Households in Central Nepal. In Science Direct; Rice Science, 2015, 22(1): 35−43

Grundmann, S. and Hacker, P. (2021): Theories of choice: the social science and the law of decision making; ISBN-13: 9780198863175

Huffman, W. E. (2010: Household production theory and models; Working Paper No. 10019, June 2010. Iowa State University, Department of Economics; Ames, iowa, 50011-1070

Jeffrey P. Walters, J. P., Archerb, D. W., Sassenrathc, G. F., Hendricksond, J. R., Hansond, J. D., Hallorane, J. M., Vadasf, P. and Alarcona, V. J. (2016): Exploring agricultural production systems and their fundamental components with system dynamics modelling. In Elsebier journal of ecological modelling 333 (2016) 51–65

Kega, V. M., Gikonyo, E. W., Muriithi, C. W., Macharia, J. M. K. and Muthoni, L. (2015): Rice cultivation manual. KALRO, November 2015 ISBN No. 978-9966-30-035-5

Kimani J. M., Tongoona P., Derera J, and Nyende A.B. 2011. Upland Rice Varieties Development Through Participatory Plant Breeding. ARPN Journal of Agricultural and Biological Science. 6 (9): 39-49. ISSN1990-6145

Kimani, J.M. 2010. Genetic studies of Quantitative Quality Traits in Rice Under Low and High soil nitrogen and phosphorous Conditions, and a Survey of Farmer Preferences for Varieties. A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in Plant Breeding. African Centre for Crop Improvement (ACCI), School of Agricultural Sciences and Agribusiness, Faculty of Science and Agriculture.

Lanas, J. G., Gardenas, J. C., Jarrin, V. A. and Fierro, A. P. (2020): Empirical evidence for intransitivity in consumer preferences. Review article

Mesfin, A. H. and Zemedu, M. (2018): Choices of Varieties and Demand for Improved Rice Seed in Fogera District of Ethiopia; In Science Direct; Rice Science, 2018, 25(6): 350-356

Musila, R. N., Sibiya, J., Derera, J., Kimani, J. M., Tongoona, P. and Danda K. (2018): Farmers' perceptions of, and preferred traits in, rice varieties in the coastal region of Kenya and their implications for breeding. In the journal of International Cooperation for Agricultural Development; *J Intl Cooper Agric Dev 2018; 16: 1–11*

MoA, (2008): National Rice Development Strategy; Government of Kenya

Rapsomanikis, G. 2015: The economic lives of smallholder farmers: An analysis based on household data from nine countries. (FAO, Rome)

Regenwetter, M., Dana, J. and Clintin P. (2011): Transitivity of preference; Psychological Review 2011; In the American Psychological Association 2011, Vol. 118, No. 1, 42–56

Rout, N. R. and Senapati, R. (2005): Population Movement and Changing Consumer Behavior: A Study of Balasore District in India

Thomas, L. (2020): Cross-Sectional Study | Definitions, Uses & Examples; Published on May 8, 2020