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FARMERS' WILLINGNESS TO INCUR BIG DATA RELATED EXPENSES: OPPORTUNITIES FOR MITIGATING LOSSES IN MANGO VALUE CHAIN IN BENUE STATE

***[1]Ajibade, T.B., [1]Falola, A. [1]Ibrahim, H.K., [2]Bankole, F.A. and [1]Ajibade, E.T.**
[1]Department of Agricultural Economics and Farm Management, University of Ilorin, Nigeria
[2]Department of Agronomy, University of Ilorin, Ilorin, Nigeria
Corresponding author's email: ajibade.tb@unilorin.edu.ng

ABSTRACT

This study was carried out to examine mango farmers' willingness to incur BIG DATA related expenses in Benue state. Primary data and secondary information were used for the study. The survey instrument was structured questionnaire which was administered to 60 mango farmers randomly selected in a four-stage sampling procedure. The generated data were analyzed using descriptive statistics, contingent valuation method and regression technique. The results revealed that 25% of the farmers were willing to invest a one –off cost of ₦8,000 in an internet enabled handheld device meant to facilitate linkage between them, other farmers and the industries who may off-take mango products from their farms. About 38% of the respondents were willing to make such payment if only the prices were subsidized up to 75% while 72% of the farmers would opt for such interventions only with subsidies that would halve the price. At 1% level, the mango farmers' understanding of the BIG Data concept and benefits was statistically significant while at 5% level, monthly income, years of mango farming experience, educational status, bid price and the scale of farm operations were statistically significant. The study recommends the implementation of affordable technologies targeted at linking mango farmers in Benue state and the industries considering the high level of mango production viz-a-viz the ensuing colossal post harvest waste. It is also recommended that the government should provide such interventions at subsidized rates to farmers such as to endear them to adopt such.

Key words: *Big data, Contingent valuation method, Mango, Postharvest loss, Willingness to pay*

1.0 INTRODUCTION

The need for increased food production has been strongly advocated given the nexus of increasing population with a rising food demand and the lowering and ageing population in the agrarian sector. According to Parfitt, Barthel and Macnaughton (2010), a main challenge for agricultural research, development and policy is how to feed over 9.1 billion people with safe food by the year 2050. One pertinent question that arises is the scenario of hunger among the global population is: "Where are all the foods from the current production levels going?"

The amount of food losses post-harvest in Sub Saharan Africa is staggering given the observable evidences across various regions. According to Aulakh and Regmi (2014), total food losses in Sub-Saharan Africa are estimated to be worth $4 billion per year (FAO, 2013). Losses in perishable products such as fruits, vegetables and root crops

account for as high as 50% of the harvests (Voices Newsletter 2006).

Food waste and loss is a large and increasingly urgent problem and is particularly acute in developing countries where food loss reduces income by at least 15% for 470 million smallholder farmers and downstream value chain actors, most of whom are a part of the 1.2 billion people who are food insecure (Rockefeller Foundation, 2015). Beyond the resultant income losses by the small holder farmers characterizing agricultural production in developing countries, the planet is likewise left at a further deplorable state given the imminent environmental and waste management issues which is still a major challenge in developing countries.

According to Salami *et al.* (2010), about 30-40% of fruits and vegetables are lost or discarded after leaving the farm gate. Kader (2002) also estimated that postharvest losses in fresh fruits and vegetables are 5 to 35% in developed countries and 20 to 50% in developing countries. Fresh fruits and vegetables are wasted throughout the food supply chains, from initial agricultural production down to final household consumption. Wargovich (2000), stated that fruits and vegetables provide different benefits and play a significant role in human nutrition, especially as sources of vitamins, minerals, and dietary fiber.

Mango (*Mangifera indica* L.) is one of the two most delicious and admired tropical fruits in the world along with pineapple. Likewise, it is a highly nutritious and healthful fruit containing rich quantities of pre-biotic fiber, vitamins A and C along with smaller quantity of vitamin B, protein, and minerals (NoorMmemon, 2015). Mango is a major tropical fruit commonly grown in Nigeria and as a matter of fact the crop is so well adapted to the soil and climatic conditions such that seedlings may germinate from seeds even without necessarily nor intentionally planting them. Ugese *et al.* (2012) stated that, most of the mango fruits produced are consumed as fresh fruit although Nigeria occupies the 9th position among the ten leading mango producing countries of the world. (FAOSTAT, 2007).

With a production of about 850,000 metric tonnes annually, Nigeria contributes a little less than 3% to the Global Production. Data from FAO (2013) suggested that Nigeria has an average productivity of 6.88/Ha while the India, the highest world producer have a productivity of 6.50/Ha and with 114,900ha and 2,312,300ha under cultivation of mangoes in Nigeria and India respectively. Mango Export Fact Sheet (2011) suggested that Nigeria does not rank among the top twenty mango exporter but would be seen to rank 132nd on the list of importers. By implication, Nigeria has not leveraged on the power as a producer to adequately position itself to benefit from the opportunities abounding in mango export valued at about USD1.5 Billion annually. A background has therefore been set which prompts research question as to where the bulk of mangoes produced in Nigeria go to. The high level of post-harvest losses in mango production erodes bulk of it in Nigeria even though there are no vivid information and knowledge as to the extent and magnitude of losses in mango production due to the nature of disjointedness in the production of mango in Nigeria which makes the aggregation of such post-harvest losses data from the numerous small-holder farmers dominating Nigerian agricultural production and other actors along the Value Chain a herculean task. The lack of data has also proven to be a challenge when it comes to mitigating related losses. It therefore becomes needful that opportunities in The Big data be explored in order to be able to appropriately position the small holder farmers such that they are able to mitigate

production loss which is counter-productive to food security mandate.

Empirical review has shown that The BIG DATA has been explored in the developed countries to tackle various agricultural challenges however this has not been the case in most developing Countries. Boyd and Crawford, 2012 opined that Big Data is an important field of study, for the era of big data has begun. Various scholars have defined Big Data, however in this study, the definition given by Gartner.com (2013) was adopted which states that Big Data are high-volume, high-velocity and high variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making.

Big Data proponents promise a level of precision, information storage, processing and analysing that was previously impossible due to technological limitations (Bronson & Knezevi, 2016). Kshetri (2014) mentioned that Big Data is likely to be of tremendous benefit to developing countries. It is anticipated that geo-locating a rural African farmer working in his farm with the help of an application installed in his cell phone, identifying the soil type and needs of the field, and offering advice regarding appropriate seeds, where they can be purchased, and how they can be planted and harvested is not far in the future (Patel, 2013). The importance of this technique is even more pronounced considering the fact that there are no reliable statistics in many developing countries. It is however unsurprising that there is an enormous gap between the developing and developed worlds in the utilization of Big Data (Kshetri, 2014).

In the context of the small holder farmers and other value chain players in the mango production examined in this study, Big Data is regarded as certain basic small devices and software which enhances the marketing ability of local farmers. Such internet-enabled simple handheld devices are to create a linkage between the farmers, traders and industries along the value chain. Some of the opportunities therein lie in the ability of the farmers to access market information, initiate contact with buyers, transporters and even other farmers where the need may arise to assemble products for ease of transporting by the buyers. Given the state of Information and Communication Technology in Nigeria, such handheld devices will require subscription plans for which the farmers will have to sign to enable them access the platforms and apps on the internet. This study is conceptualized as shown in Figure 1.

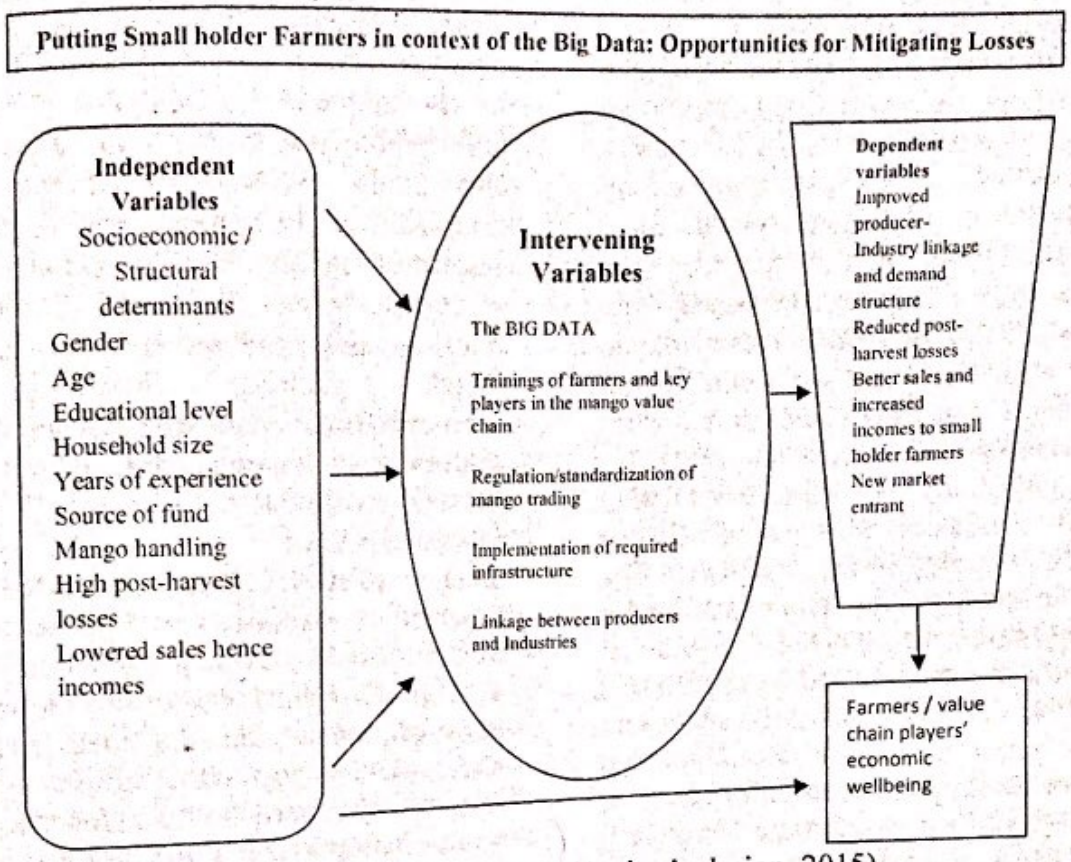

Figure 1: Conceptual Framework (Author's design, 2015)

The research objectives were to describe the socio-economic characteristics of selected key players in the value chain in one of the Mango hubs in Nigeria; to evaluate the respondents' knowledge of opportunities in BIG DATA; to assess the willingness to pay for BIG DATA related opportunities in the study area and to examine the determinants of respondents' willingness to incur BIG DATA related expenses.

This study is justified by the fact that there is an urgent need to reverse the trending huge postharvest losses in Mango production in Nigeria through unconventional means, of which the Big Data is key. The high level of mango production in Nigeria vis-à-vis the very low processing and exporting activities and colossal wastes in the subsector calls for urgent attention.

2.0 MATERIALS AND METHODS

The study was conducted in Benue State, Nigeria. The state is located between longitude 6^0 -10^0 E and latitude 6^0-8^0N and is the nation's acclaimed food basket because of its rich agricultural produce. Agriculture is the mainstay of the economy, engaging over 75% of the state farming population. The State also boasts of River Benue which is one of the longest stretches of river systems in the country with great potential for a viable fishing industry, dry season farming through irrigation and for an inland water highway.

The vegetation of the southern parts of the state is characterized by forests, which yield trees for timber and provide a suitable habitat for rare animal types and species. The state thus possesses potential for the development of viable forest and wildlife reserves.

Temperatures are generally very high during the day, particularly in March and April. Makurdi, the state capital, for example, records average maximum and minimum daily temperatures of 35 °C and 21 °C in dry season and 37 °C and 16 °C in rainy season respectively. The vegetation of the State consists of rain forests which have tall trees, tall grasses and oil palm trees that occupy the state's western and southern fringes while the Guinea Savannah is found in the eastern and northern parts with mixed grasses and trees that are generally of average height.

Benue's topography is mainly undulating plains with occasional elevations of between 1,500m and 3,000m above sea level. The state's main geologic formations are sandy-loam shelf basement complex and alluvial plains. These together with its location in the transition belt between the north and south ecologies and a favourable rainfall pattern account for its support for a wide variety of crops. The choice of Benue state in carrying out this study is premised on the fact that the state is the largest mango producing state Nigeria and also the observed huge amounts of mango post-harvest losses in the area based on experiential review.

2.1 Sampling Procedure

Benue State is divided into 3 agricultural zones by the Agricultural Development Project, namely Northern Zone, Central and Eastern zones. This study engaged a three-stage sampling procedure with the first stage being the purposive selection of the Northern ADP zone as mango farming is highly pronounced in the area. The stage two involved the random selection of two Local Government Areas which were Gboko and Gwer-West. The third stage involved the random selection of three villages from each of the Local Government Areas while the final selection involved the selection of ten mango farmers who also trade in the commodity from each of the selected villages using the snowballing technique to give a total of 60 mango value chain players who were sampled for this study. Secondary information and Primary data were used for the study. Secondary information was sourced from the internet, journals, trade data and publications. The primary data were collected with the use of structured questionnaires and focus group discussion which gathered information on socioeconomic characteristics, farming and trading practices obtainable and value chain players' willingness to incur BIG DATA related expenses.

Data collected were analyzed using descriptive statistics, contingent valuation method (CVM) and regression analysis. The descriptive statistics used to describe the socio-economic data included frequencies and percentages. Contingent valuation method was used to examine the mango value chain players' willingness to incur BIG DATA related expenses in the study area. According to Teshome and Bogale (2015), willingness to pay is defined as the amount that must be taken away from household's income. The willingness data was collected through contingent valuation method (CVM). This method is also suited to solicit consumers' willingness to pay for a product that is not yet on the market. CVM is now increasingly used in developing countries (Alberini and Cooper, 2000).

Binary Logistic regression was used to examine the determinants of mango value chain players' willingness to pay for BIG data related expenses targeted at enhancing their trading ability.

This function for the Binary Logistic regression is expressed as: $Y = \beta Xi + e$

$Y = \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6 + \beta X_7 + \beta X_8 + \beta X_9 + e$

Where, Y which is a dichotomous response variable (1 for consumers that are willing to pay
and 0 otherwise), X_1 = average monthly income, X_2 = understanding of the BIG DATA concept and benefits, X_3 = years of experience, X_4 =educational status, X_5= Household size, X_6 = magnitude of estimated postharvest losses X_7 = Bid price, X_8 =Gender, X_9 = Operational scale

3.0 RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of the mango value chain players in the study area. The study revealed that the mango farming and bulk trading in the study area is male-predominated with about 93.33% of the actors being male. One may attribute this to the land tenure system in Nigeria in which males are mostly rightful owners of farm lands as it is passed down from one generation to another. The study further revealed that 66.66% of the respondents were above 60 years, with the mean age being 63.4years. This is an indication that the population of the farmers is aging and this may have implications for sustainability of the ventures in the near future except if the youth and young adult are encouraged to take on the activities. As about 88% of the respondents were observed to be married, this may imply high level of dependency which may even be a basis that will keep individuals in farming mangoes considering their obligations to family members. Up to 66.33% of the respondents do not have any form of formal education and this may be a limiting factor to their being open to better farm management practices amongst them. With an average of 2.73years, the respondents' average schooling years fall below the National average which may be because majority of the respondents too to farming from their early ages. The modal income range of the respondents was N10,000- N19,999 while the average monthly income was estimated at N18,997.80 which interestingly is slightly above the minimum wage for civil servants in Nigeria which is an indication that the farmers are not doing poorly in terms of remuneration when compared to some of the educated counterparts. The mean household size of the respondents was 5.06 individuals while the mean years of experience in mango production was estimated at 16.72 years which may be an indication of high expertise amongst the mango farmers in the study area given the level of experience.

Table 1: Socio-economic characteristics of sampled mango value chain players

Variable	Category	Frequency	Percentage	Mean
Gender	Male	56	93.33	
	Female	4	6.67	
Age	21-30	2	3.34	63.4yrs
	31-40	6	10.00	
	41-50	8	13.33	
	51-60	4	6.67	
	>60	40	66.66	
Marital Status	Single	1	1.67	
	Married	53	88.33	
	Divorced	0	0.00	
	Widowed	6	10.00	
Educational Status	Primary	16	26.67	2.73yrs
	Secondary	5	8.33	
	Tertiary	1	1.67	
	Adult	0	0.00	
	Quaranic	0	0.00	
	None	38	63.33	
Average income/month	10,000 -19,999	42	70.00	N18,997.80
	20,000- 29,999	10	16.67	
	30,000- 39,999	4	6.67	
	40,000- 49,999	3	5.00	
	≥50,000	1	1.67	
Household size	1-3	2	3.33	5.06individuals
	4-6	42	70.00	
	7-9	12	20.00	
	10-12	4	6.67	
Years of farming Experience	1-5	0	0.00	16.72years
	6-10	3	5.00	
	10-15	6	10.00	
	15-20	7	11.67	
	>20	44	73.33	

3.1 Willingness-to-pay for Big Data Related Expenses by Mango Value Chain Players

The results generated from analysis carried out on the willingness to pay for a hypothetical intervention which involves provision of handheld devices with pre-installed apps and monthly data subscription meant to facilitate linkage between and amongst the Mango farmers with industrial off-takers requiring mangoes is as shown in Table 2. For the purpose of this study, the benchmark of the cost of internet-enabled handheld device was valued at ₦7,500 while the cost of monthly data subscription and is stated at ₦500 to give a total of ₦8,000 based on the cheapest values of the these available at the time of carrying out this study.

Results from the Willingness-to-pay revealed that 25% of the farmers were willing to invest a one–off cost of ₦8,000 in an internet enabled handheld device which is meant to facilitate linkage between them, other farmers and the industries who may off-take mango products from their farms. About 38% of the respondents were willing to make such payment if only the prices were subsidized up to the tune of 75% while about 72% of the farmers would opt for such interventions only with subsidies that would halve the price.

With respect to the monthly subscription fees which was valued at ₦500, majority of the farmers were repulsive to the idea of having to subscribe for data monthly, saying they may end up investing the initial cost in such devices and afterwards neglecting it based on the attendant cost. Only about 12% of the respondents were willing to incur a monthly data subscription fee of ₦500 which translates to less than half of those willing to make the initial cost outlay of ₦8,000 on the handheld devices at the onset.

With the cost of monthly data subscription halved, 20% of the mango farmers were willing to pay while a better percentage of 60% were willing to pay ₦125 monthly for such data subscription which is meant to better position them by facilitating linkage between the farmers, other farmers and the industries such as to enhance trading of their commodities and in a timely and more structured manners.

Table 2: Results of Willingness–To-Pay for Handheld devices and Data Subscription by mango farmers in the Study Area

	Willingness to pay		Willingness to pay		Willingness to pay	
Hypothetical Intervention	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Provision of internet enabled hand held devices with built in apps and one month data subscription	15	25.00	23	38.33	43	71.67
Average one–off amount WTBP by mango farmers	₦8,000		₦ 6,000		₦ 4,000	
Payment of monthly subscription	7	11.67	12	20	36	60
Amount willing to be paid monthly	₦ 500		₦ 250		₦ 125	

Number of observation: 60 WTBP – Willing to be paid

3.2 Determinants of Willingness-to-pay for Handheld Devices and Data Subscription

To identify the determinants of willingness-to-pay for handheld devices and data subscription by mango farmers in the study area, the binary logistic regression model was used. Table 3 shows the result of the analysis and it reveals that the logistic model explains 77.3% of the Mango farmers to pay for Handheld devices and Data Subscription in the study area which means that the model is a good fit. At 1% level, the mango farmer's understanding of the BIG Data concept and benefits was statistically significant. It was revealed knowledge of the big data concept increased the farmers' willingness to pay up to 4.271 times more that those that do not have an understanding of the concept. At 5% level, monthly income, years of mango farming experience, educational status, bid price and the scale of farm operations were statistically significant. The regression result revealed that farmers with higher income were 0.896 times more willing to incur big data related expenses that those with lower incomes. This positive relationship was also observed in the number of years of experience, operational scale and educational status as it could be seen that mango farmers with more experience were willing to pay 0.086 times more than those without experience, whereas those that were more educated and having larger farm holdings were 1.34 times and 1.864 times, respectively, more willing to pay than their uneducated and smaller scale counterparts. In the case of bid price which was that attendant cost of adopting such proposition, it could be seen that mango farmers were 1.465 times less willing to pay as the bid price increased. From the study, it can be deduced that the famers were more willing to make Big data related expenses based on the levels of their income and also the number of years they have practiced farming even though a priori expectation may be that farmers who are more experienced in mango farming may have devised coping strategies and means to get their products to the buyers while minimizing post- harvest losses. The educational status being significant is a pointer to the fact that education plays key roles when it comes to the farmers adopting innovations which are meant to position them in trading of their products. The bid price indicated that the farmers were more reluctant to pay the Big data related expenses probably due to the fact that it would have an initial negative impact on their pockets. Considering the economic hardships in the nation, the farmers may be justified however there is a bigger picture which should be seen as one positioning them for better performance and with promises of improving their welfare and also develop the economy considering the huge proportion of the Nigerian population who are in the agricultural sector.

The scale of farm operations being positively significant implied that the farmers with the bigger farms are the one keener on finding ways of reducing the post-harvest losses by exploring opportunities for linkages with other farmers with whom they may pool products and also the industries whose patronage is highly important in other to avoid losses in products.

Table 3: **Parameter estimate for the Logistic Regression Model**

	Variables	Coefficient	S.E.	Z value	P>/Z/
Step 1[a]	X_1. Average monthly Income	0.896	0.437	2.05	0.013**
	X_2 Understanding the BIG DATA concept and benefits	4.271	1.126	3.79	0.000***
	X_3 - Years of experience	0.086	0.031	2.77	0.048**
	X_4 - Educational Status	1.34	0.504	2.66	0.026**
	X_5 - Household size	0.689	0.574	1.20	0.247
	X_6 - Magnitude of mango postharvest losses	2.644	3.368	0.79	0.626
	X_7 - Bid price	-1.465	0.512	-2.86	0.004**
	X_8 - Gender	1.372	2.498	0.55	0.584
	X_9 - Farm Operational Scale	1.864	0.792	2.35	0.019**
	Constant	-25.409	-4.631	-5.49	0.039

Variable(s) entered on step 1: X_1, X_2, X_3, X_4, X_5, X_6 X_7 X_8 X_9

a. Overall case correctly predicted 77.3%

b. Model Chi-square 51.42

4.0 CONCLUSION

This study concludes that mango farmers in the study area need interventions in the area of sales and distribution of their product. This can be said to be highly critical considering the colossal wastes to which mangoes go in Nigeria viz-a-viz the export opportunities that abound for Nigeria in mango production. Opportunities exist in The BIG data which developing and emerging economies are supposed to harness. However certain major setbacks exist such as the fragmented nature of agriculture, the poverty level, low technological advancement amongst others which largely prevents the exploring of Big data opportunities to a large extent. It is therefore, pertinent to look into the various ways which are low costing in which the Big data may be useful especially in agriculture and food.

5.0 RECOMMENDATION

This study recommends the implementation of affordable technologies in form of interventions such as applications and devices which are meant to bridge the gap, being a linkage between the mango farmers in the study area and the industries considering the high level of production going on in the study area and the colossal waste to which mango goes despite the export opportunities that Nigeria is supposed to enjoy considering the place of the Nation amongst the top world producers. There is the need to advocate such interventions as well to ensure the farmers are able to access them.

The study also recommends that the government should provide such interventions at subsidized rates to the farmers in order to endear them to sign up for such opportunities when available. The need for a proper data base of mango farmers is also crucial at this time in Nigeria in order to ensure the proper harnessing of the subsector.

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