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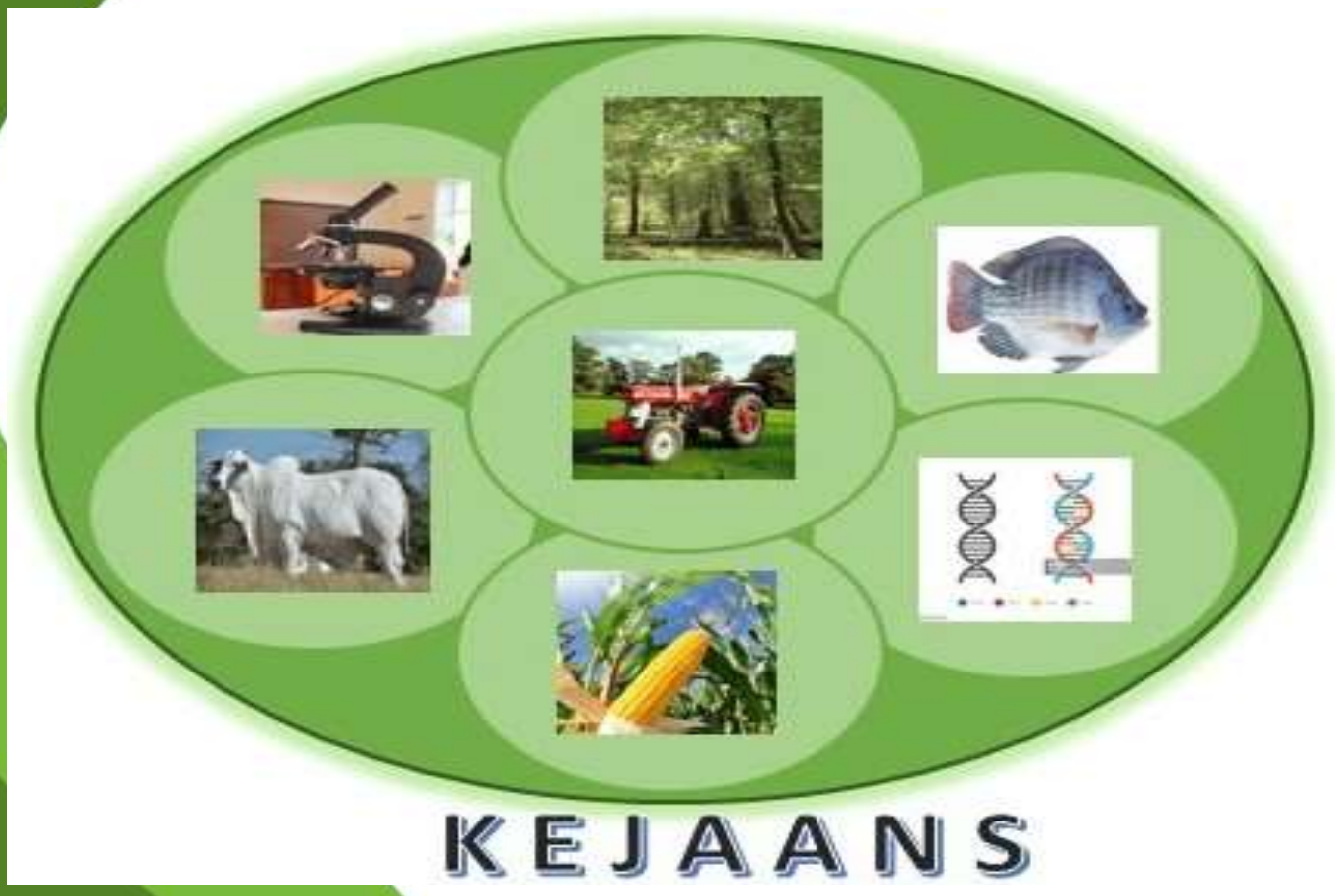

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This official scientific publication of the Faculty of Agriculture, Abdullahi Fodiyo University of Science and Technology Aliero, is a non-profit, open access, double-blind peer-reviewed Journal publishing four issues (January, April, July and October) per annum. The Journal is a platform open to collaborations with researchers, authors, institutions, research agencies and private companies related to Agriculture. The Mission of the Journal is to disseminate scientific knowledge through the publication of original research articles, research notes, book reviews, letters to the editor and reviews of Literature, representing a contribution to scientific and technological knowledge in respective areas covered by the Journal. The Kebbi Journal of Agriculture and Natural Sciences seeks to validate and disseminate new knowledge, making it public in order to strengthen the human capacity, constitute a link in the scientific community to the society and encouraging the expansion of University and academic researches.

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The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

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The first page of the manuscript should contain the title of the article, which should be concise and explicit, typed with upper-case, bold, 14 font size, TNR and not more than 21 words. The surname and forenames (in full) of authors, affiliation of each author should be provided. Phone number and email address of the corresponding author (identified by an asterisk) should be provided. Superscripts should be used to relate authors to their affiliations.

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A conscience introduction of the background to the subject is required and should include a brief statement of the problem, significance and purpose of the research and relationship to earlier works with well acknowledged references.

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Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both Table and figure. In discussion, point out the significance of the results and place the results in the context of other work and theoretical background. Results and Discussion part could be written separately if author so wish.

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Abbreviations
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Avoid the use of figures /numbers at the beginning of a sentence. Write out one through nine unless a measurement, a designator, or a range (e.g five seeds, 8cm, 3yr, 5-11 flowers)

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EVALUATION OF PROFIT EFFICIENCY OF ONION (*Allium cepa* L.) AMONG VALUE CHAIN ACTORS IN KEBBI STATE, NIGERIA

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ABSTRACT

Onion is a market sensitive vegetable crops that generates undulations in trade with retarding issues like perishabilty, pricing inefficiency, market coordination gaps etc , however a vital source of revenue. This study aimed to evaluate profit performance of onion value chain actors in Kebbi State, Nigeria. Multistage and simple random sampling procedures were used to select 366 respondents from the study area based on sampling frame. Primary data was obtained using questionnaires and focal group discussion from ten local government areas and two notable onion markets in the State. Gross margin analysis reveals that efficiency ratios of all the actors were less than one indicating, onion production and marketing is profitable. The Cobb-Douglas production function results revealed that producer's profit efficiencies varied from 56% to 89% averaging 89% frontier profits, meaning 11% of the profit was lost due to combination of technical and allocative inefficiencies. Wholesalers' profit efficiencies varied between 55% and 95% averaging 80% frontier profits, suggesting 20% of the profit was lost due to combination of technical and allocative inefficiencies and educational level, distance to market influence wholesalers' profit efficiency. Exporters' profit efficiencies varied from 55% to 95% averaging 80% frontier profits, indicating 20% of the profit was lost due to combination of technical and allocative inefficiencies, whereas age, market-distance, unfavourable weather significantly influence profit efficiency. Onion is a viable agribusiness for the unemployed youths and a means of reliable livelihood. Therefore, sustainable interventions through government support policies to encourage adult basic business education system are paramount.

Keywords: Onion, Value chain actors, efficiency, inefficiency, Profit,

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops produced and consumed (Pande *et al*., 2024) worldwide since at least 4000 BC. Onion is an important horticultural crop serving as a source of revenue for smallholder producers (Yeshiwas *et al*., 2024). Onion is cultivated in 170 countries across the globe with China, India and USA leading the world production by 20,507,759; 13,372,100; and 3,320,870 tons respectively (FAO, 2021) and in Africa; Egypt, Nigeria, Morocco, Algeria, and South Africa led the continent's production by 2,208,080, 1,346,218, 1,001,304, 821,072 and 518,284 all in tons respectively.

Globally, the estimated area of land annually put under onion production is over 4,955,432ha producing about 93,168,548 tons making it the second most vital vegetable crop behind tomatoes (Hanci, 2018). According to KNOEMA (2022), agricultural indicators of onions in Nigeria estimated 658,233ha of land put into anion production annually, producing 20,996kgha[1]. In Nigeria, onion is one of the most significant commercial horticultural vegetable mostly produced in the northern part of the country due to favourable climatic condition of the region and the largest producing States include; Kebbi, Sokoto, Kano, Jigawa, Kaduna, Katsina, Plateau and Bauchi (Marahazu, 2023). Kebbi State is one of Nigeria's top producers of onions, employing thousands of farmers to grow onions as a major vegetable crop during the dry season and a very small amount of onions during the wet season (Kebbi State Government, n.d) for both domestic consumption and economic gain with annual production figures of 694, 000 tons and estimated hectares of about 17, 360ha. Some of the largest onion traders are also based in the State's northern and southern local government areas.

Notwithstanding the adoptability, potentiality and economic viability of onion production and marketing in the study area and Nigeria at large, issues such as pricing inefficiency, market coordination gaps, improper market facilities, careless handling of produce by the onion producers and marketers, etc, thus onion business productivity is significantly reduced than it should be, particularly profit expansion of the actors. Therefore, in order to uplift onion profitability in terms of production and marketing it becomes paramount to undertake profit efficiency evaluation at all major onion actor level under the existing technological know-how to improve the contribution of the crop with the aim to compare value added and gross margin share of onion actors along the value chain and to ascertain the extent of profit efficiency and the factors that determined the efficiency level of the major onion value chain actors in the state. Information obtained would be useful in appropriate policy formulation in enhancing profit efficiency level of the onion actors in the study area.

Presently, study carried out on profit efficiency in respect of the major onion value chain actors as single work along the onion value chain in the study area is still scanty. However, only limit research works were done in the state and others far apart like; economic analysis, resource use efficiency, risk attitude, disease perception, marketing, profitability and constraints, Technical efficiency in onion production, Economic efficiency of onion production, evaluation of onion value chain actors (producers and retailers) (Grema, and Gashua, 2014; Abdu *et al*., 2015; Dauda *et. al*., 2016; Illo *et al*., 2016; Ayinde and Obalola, 2017; Yahaya *et al*., 2019; Magaji *et al*., 2021; Kaka *et al*., 2021; Kaka and Gindi, 2021). Consequently, there is a need to bridge the existing knowledge gap by proving information that is very essential in understanding the extent of various actors' profit efficiency in the production and marketing of the crop in Kebbi State.

Materials and Methodes

The study area

The study was conducted in Kebbi State which is located at the extreme North-Western corner of Nigeria on latitudes 10^0 8'and 13^0 15'North and longitudes 3^0 30'E and 6^0 2' East. In the North and West, it shares borders with Niger and Benin Republics respectively, Niger State to the South and Sokoto and Zamfara States to the east and south-east (Kebbi State Government, 2013). Kebbi State occupies an area of about 37,698,685 square kilometers (3.7million hectares) out of which 36.46% is made up of farmland (Kebbi State Government, 2018). The State has a projected population of about 5, 563, 900 million (NPC,

2022). Kebbi State has tropical weather conditions with three seasons: rainy, dry and hot. The annual rainfall is variable between the range of 600 mm and 850 mm with an average of 650 mm. The monthly temperature in the region ranges from 25^0C to 45^0C (Usman *et al*., 2016). The State possesses two important agricultural lands namely: dryland (arid-prolonged dryness) and fadama (floodplains-significant alluvial clay particles). These two lands remained the key source of income to millions of people in the state (Usman *et al*., 2016). Agriculture is the most important economic activity, with riverine floodplains producing crops like groundnuts, cotton, rice, millet, sorghum and vegetables such as tomato, pepper, onions etc. Majority of the farmers in Aliero, Maiyama, Jega and Birnin Kebbi Local Government Areas in Kebbi State cultivate onion as dry season crop, while Yauri and Shanga Local Government Areas cultivate in both seasons (Dauda *et al.*, 2016). Most of the land in the State is used for grazing livestock (Kebbi State Government, 2013). The major ethnic groups in the State are the Fulani, Hausa, Dakarkari, Kambarawa, Zabarmawa, and Dandawa.

Sampling procedure and sample size

The population for this research work comprised of sole onion actors (producers and marketers) in Kebbi State from 10 Local Government Areas out of 13 that are predominantly sole onion producers in the study area viz; Aliero, Jega, Maiyama, Birnin Kebbi, Yauri, Gwandu, Shanga, Ngaski, Augie, and Bagudo Local Government Areas. Based on high concentration of sole onion marketers at onion central markets in Aleiro and Yauri attracted by many buyers and sellers from regional and international places and available throughout the year who are fused into one body addressed Kebbi State Onion Producers and Marketers Cooperative Association characterized the beneath unit procedure. The procedure recommended by Adam (2020) was adopted to obtain 366 respondents from sample frame of 6,321(i.e. onion farmer-4828, middlemen-176, wholesalers-423, retailers-752 and exporters-142) of registered members of the association. Multistage and simple random sampling procedures were used to select 366 respondents from the study area based on sampling frame. The number of respondents drawn from each level of participating actor was determined by using sample size formula as in equation (1) adopted from (Shaikh*et al*., 2016) shown in Table1 below.

At stage I, ten local government areas were purposively selected based on their intensity in sole onion production and two notable onion markets based on the concentration and availability of onion marketers throughout the year. At stage II, two dominant villages in sole onion production were purposively selected from each of the ten local government areas selected giving a total of 20 villages. In stage III, in each of the 20 villages, 14 producers were selected using simple random sampling procedure to obtain a sample size of 280 onion producers used in the study (Table 1). At stage IV, Simple random sampling techniques was adopted to select 12 wholesalers, 22 retailers, 5 middlemen and 4 exporters from each of the onion central markets at Aliero and Yauri where sole onion marketers precipitated and operate both in off and on onion seasons making a total of 86 onion marketers considered for the study.

$$\mathrm{NI} = \frac{n}{N} \times Ni \qquad (1)$$

Where

NI= sample size in each actor level

n=total number of actors' sample sizes

N=total number of actors in the target population (i.e. sample frame)

N*i*=total number of actors at each level

Data collection

The data were collected through the use of structured questionnaire administered to the major onion stakeholders. Two different sets of questionnaire were used in consonance with Maharazu, (2023); one set was for the sole onion producers and the other was for the marketers, each was aligned with the respondent's activities.

Table: 1. Distribution of Actors' Sample Size at different levels in the Study Area

Actor	Sample frame	NI $= \frac{n}{N} \times Ni$	Sample size
	(Ni)		**(NI)**
Onion farmers	4828	(366/6321) X 4828	280
Retailers	752	(366/6321) X 752	44
Wholesalers	423	(366/6321) X 423	24
Exporters	142	(366/6321) X 142	08
Middlemen	176	(366/6321) X 176	10
Total	**6, 321**		**366**

Source: Kebbi State Onion Producers and Marketers Cooperative Association

The constituent of the questionnaire had section/sub-sections that allowed the researcher to collect the information required from the targeted respondents. The questionnaires were administered by the researcher to the respondents with the help of ten hired ad-hoc enumerators from Local Government Department of Agriculture and primary school teachers proximate to the selected study location. The enumerators were properly trained (round table) by the researcher on the purpose of data collection, the skills in administering the questionnaires including ethical considerations acknowledged by Frankline (2023) to serve as the go-between the researcher and the respondents to ensure high percentage return. In view of the low level of read and write in English language amongst the respondents, the enumerators translated/asked the questions in Hausa language and recorded the responses of the interviewees accordingly.

Methods of data analysis

The collected data were analyzed using the following tools of analysis; descriptive statistics. Gross margin analysis was used to compare value added and gross margin share of onion actors (producers and marketers) along the value chain in the study area. Stochastic frontier production function approach was use to estimate profit efficiency of the onion actors (producers and marketers) along the value chain in the study area.

Gross margin analysis

Gross Margin (GM) can be defined as the difference between the Gross Farm Income (GFI) and the Total Variable Cost (TVC). It is an essential planning tool for fixed capital

Gross margin analysis model specification

GM=TR-TVC (2)

Where;
GM=Gross Margin (₦),
TR=Total Revenue (₦), and
TVC=Total Variable Cost i.e. the cost of variable inputs used (₦),

Gross ratio

This is a profitability ratio that measures the overall success of the farm, the lower the ratio, the higher the return per Naira. It shows how much profit the firm generates after deducting

its cost of revenue. And cost of revenue is the total expenses incurred from production to delivering a product or service to the customer.

Gross ratio analysis model specification

$$GR = \frac{TFE}{GI} \quad (3)$$

Where
GR = Gross Ratio
TFE = Total Farm Expenses
GI = Gross Income.

Operating ratio

The operating ratio is a measure that determines the operational efficiency of a business. It shows how good the business manages expenses concerning the revenue generated. In other words, operating ratio is directly related to the farm variable input usage. The rule of thumb is that the lower the ratio the higher the profitability of the farm business.

Operating ratio analysis model specification

$$OR = \frac{TOC}{GI} \quad (4)$$

Where
OR = Operating Ratio
TOC = Total Operating Cost
GI = Gross Income

Return on capital invested

Return on capital invested refers to a computation used to assess a business's efficiency in allocating capital to profitable investments. It provides a sense of how well a business is using its capital to generate profit. This is defined as gross margin divided by total variable cost.

Return on capital analysis model specification

$$RI = \frac{GM}{TVC} \quad (5)$$

Where
RI = Return on Capital Invested
GM = Gross Margin
TVC = Total Variable Cost
(Adopted from; Ojo *et al*., 2009; Sulumbe *et al*., 2015; illo *et al*., 2016).

Net farm income

Net Farm Income (NFI) which measures the returns to unpaid family labour, operator's land, labour, capital and management (Olukosi and Erhabor, 1998).

Net farm income analysis model specification

$$NFI=TR-(TVC+TFC) \quad (6)$$

Where
NFI= Net Farm Income (₦)
TR= Total Revenue (₦)
TVC= Total Variable Cost (₦)
TFC= Total Fixed Cost (₦)
TR= p_yY(unit price of output multiplied by the total output)
Y= Quantity of output (₦)
P_y= Unit price of input (₦)
X= Quantity of input

Farmer's stochastic frontier Profit function model specifications

Stochastic frontier profit function model was used to estimate the profit efficiency among onion producers following Tanko and Obalola (2013) explicitly specified as;

$$Ln\pi^*_{pft}=\beta_0+ \beta_1 lnP^*_1+ \beta_2 lnP^*_2+ \beta_3 lnP^*_3+ \beta_4 lnP^*_4+\beta_5 lnP^*_5+ \beta_6 lnP^*_6+ \beta_7 lnP^*_7+ (Vi-Ui) \quad (7)$$

Where:
Ln= the natural logarithm
Π^*_{pft}= Normalized profit in Naira per onion farm; defined as gross revenue less total costs divided by output price
B_0= Constant term
β_1-β_9= Regression coefficients to be estimated
P^*_1= Normalized price of labour input; defined as price of labour divided by output price (₦)

P^*_2= Normalized price of seeds; defined as price of seed divided by output price (₦).
P^*_3= Normalized price of inorganic fertilizer; defined as price of inorganic fertilizer divided by output price (₦)
P^*_4= Normalized price of organic manure; defined as price of organic manure divided by output price (₦)
P^*_5= Normalized price of pesticide; defined as price of pesticides divided by output price (₦)
P^*_6= Normalized price of f herbicide; defined as price of herbicide divided by output price (₦)
P^*_7= Normalized price of fuel and lubricant; defined as price of fuel and lubrication divided by output price (₦)
P^*_8= Normalized price of marketing; defined as price of marketing divided by output price (₦)
Vi= Random error outside the farmers control
Ui= Economic inefficiency effects

Positive coefficients of independent variables in the profit functional models as in equation (7) [i.e. $P_1 – P_{8]}$ indicate that profit function with positive coefficients will lead to increase in the normalized profit realized from onion production and vice-versa (Tanko and Obalola, 2013).

The determinants of profit inefficiencies are defined by:

$$U_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 \quad (8)$$

Where:
Ui= Inefficient effects (i.e. the deviation from maximum potential output attributable to resource use inefficiency).
δo= Constant
$\delta_1 – \delta_9$= Parameters to be estimated
Z_1= Age of farmer (years)
Z_2=Formal education (years of formal schooling)
Z_3=Farmers experience (number of years in onion production)
Z_4=Household size (number of people)
Z_5=Distance to market (km)
Z_6=Labour availability dummy (value ‘1’ for labour availability at harvest and ‘0’ Otherwise)
Z_7=Weather condition dummy (value ‘1’ for unfavourable weather, and ‘0’otherwise)
Z_8=Storage ability dummy (value ‘1’ for inadequate storage facility and ‘0’ otherwise)
Z_9=Transportation effectiveness (value ‘1’ for inadequate transportation and ‘0’otherwise)

The specification of the model for the inefficiency effects in equation (8) implies that, if the independent variable of the inefficiency model has a negative value on an estimated parameter, then the associated variable has a positive influence on efficiency while a positive sign indicates that the reverse is true. Thus, the *a priori* expectation is that the coefficients of the whole independent variables of the inefficiency model (i.e. Z_1 to Z_9) should all be negative (i.e. less than zero). Therefore, each variable is expected to have positive effect on technical efficiency.

Marketers’ stochastic frontier cost and profit model specifications

The explicit Cobb-Douglas functional form of the stochastic frontier profit model as specified below was fitted in respect of each onion marketing actor (i.e. wholesaler, exporter and retailer) in the study area adopted from (Shettima *et al*., 2016; Abah, 2020).

Wholesalers’ stochastic frontier profit function model specifications

$$Ln\pi^*_{pft} = \beta o + \beta_1 lnQ_1 + \beta_1 lnP^*_1 + \beta_2 lnP^*_2 + \beta_3 lnP^*_3 + \beta_4 lnP^*_4 + \beta_5 lnP^*_5 + \beta_6 lnP^*_6 + (Vi - Ui) \quad (9)$$

Where:

Π^*_{pft}= Normalized profit in Naira per onion trader; defined as gross revenue less total costs divided by selling price
B_0= Constant term
β_1-β_6= Regression coefficients to be estimated
B_0= Constant term β1-β6= Regression coefficients to be estimated
Q_1=Price of quantity of onion purchased normalized by price of onion (₦/kg)
P^*_1= Price of parking materials (bagging) normalized by price of onion (₦/kg)
P^*_2= price of on/offloading normalized by price of onion (₦/kg)
P^*_3= Price of transportation normalized by price of onion (₦/kg)
P^*_4= Price of storage normalized by price of onion (₦/kg)
P^*_5= Price of telephone normalized by price of onion (₦/kg)
P^*_6= Price of marketing levies/commission normalized by price of onion (₦/kg)
Vi= Random error outside the farmers control
Ui= Economic inefficiency effects

Exporters' stochastic frontier profit function model specifications

$$Ln\pi^*_{pft}=\beta o+ \beta_1 lnP^*_1+ \beta_2 lnP^*_2+ \beta_3 lnP^*_3+ \beta_4 lnP^*_4+\beta_5 lnP^*_5+ \beta_6 lnP^*_6+(Vi-Ui) \quad (10)$$

Where:
Π^*_{pft}= Normalized profit in Naira per onion trader; defined as gross revenue less total costs divided by selling price
B_0= Constant term
β_1-β_6= Regression coefficients to be estimated
B_0= Constant term β1-β6= Regression coefficients to be estimated
P^*_1= Price of parking materials (bagging) normalized by price of onion (₦/kg)
P^*_2= price of on/offloading normalized by price of onion (₦/kg)
P^*_3= Price of transportation normalized by price of onion (₦/kg)
P^*_4= Price of storage normalized by price of onion (₦/kg)
P^*_5= Price of telephone normalized by price of onion (₦/kg)
P^*_6= Price of marketing levies/commission normalized by price
Vi= Random error outside the farmers control
Ui= Economic inefficiency effects

Retailers' stochastic frontier profit function model specifications

$$Ln\pi^*_{pft}=\beta o+ \beta_1 lnP^*_1+ \beta_2 lnP^*_2+ \beta_3 lnP^*_3+ \beta_4 lnP^*_4+\beta_5 lnP^*_5+ \beta_6 lnP^*_6+ (Vi-Ui) \quad (11)$$

Where:
Π^*_{pft}= Normalized profit in Naira per onion trader; defined as gross revenue less total costs divided by selling price
B_0= Constant term
β_1-β_6= Regression coefficients to be estimated
B_0= Constant term β1-β6= Regression coefficients to be estimated
Q_1=Price of quantity of onion purchased normalized by price of onion (₦/kg)
P^*_1= Price of parking materials (bagging) normalized by price of onion (₦/kg)
P^*_2= price of on/offloading normalized by price of onion (₦/kg)
P^*_3= Price of transportation normalized by price of onion (₦/kg)
P^*_4= Price of storage normalized by price of onion (₦/kg)
P^*_5= Price of telephone normalized by price of onion (₦/kg)
P^*_6= Price of marketing levies/commission normalized by price
Vi= Random error outside the farmers control
Ui= Economic inefficiency effects

The determinants of profit inefficiencies in respect of each actor in equation 9- 11are defined by:

$$U_i= \delta_o+ \delta_1 Z_1+ \delta_2 Z_2+ \delta_3 Z_3+ \delta_4 Z_4 +\delta_5 Z_5 +\delta_6 Z_6 +\delta_7 Z_7 +\delta_8 Z_8 +\delta_9 Z_9 \quad (12)$$

Where:

Ui= Inefficient effects (i.e. the deviation from maximum potential cost or profit attributable to resource use inefficiency).
δo= Constant
δ1 –δ4= Parameters to be estimated
Z_1= Age of marketer (years)
Z_2=Formal education (years of formal schooling)
Z_3=Marketing experience (number of years in onion production)
Z_4=Household size (number of people)
Z_5=Distance to market (km)
Z_6=Labour availability dummy (value '1' for labour availability at harvest/marketing and '0' Otherwise)
Z_7=Weather condition dummy (value '1' for unfavourable weather, and '0'otherwise)
Z_8=Storage ability dummy (value '1' for inadequate storage facility and '0' otherwise)
Z_9=Transportation effectiveness (value '1' for inadequate transportation and '0'otherwise)

Results and Discussions

Comparability of value added and gross margin share of onion actors

Table 2 indicates different levels of value addition and gross margin related to the onion transaction by producers, wholesalers, exporters, and retailers in the study area, except the middlemen who principally perform mediation activities for the other actors, hence could not be assessed based on any of the profit efficiency along the value chain. In terms of value added per 120kg bag (i.e. selling price less purchase/production cost) of onion emanating from different average transaction costs associated with onion production and marketing process of a single onion bag until it reached the next actor/user shows that onion exporters had the highest (42%) share followed by producers with 28% while wholesalers (20%) and the retailers had the least (10%) value addition role. The highest value addition by the onion exporters may be aligned with the high transportation cost required to move the commodity to other distanced neighbouring countries, special bagging materials used and unavoidably road levies/taxes/security settlements. The difference between the total revenue from onion sells and the costs incurred in the onion production or marketing (i.e. selling price less [purchase/production cost + marketing cost]) provide the gross margin (actor's profit) in onion transaction amongst the value adding actors as revealed in Table 2. The table shows that exporters and producers had 37.20% and 36.90% gross margin share per 120kg bag of onion respectively, whereas, wholesalers and retailers had the least gross margin of 15.20% and 10.70% respectively. This implies that onion exporters and producers have made a good gross margin from onion sells. From business point of transaction the highest marketing profit was taken by onion exporters and producers. The profit made by both actors may continue to be an impetus for the expansion in production and marketing of onion as well as attracting the potential ones to go into production and exportation of the commodity in the study area. The results fail to tally with the report by Hailegiorgis (2017) asserting that retailers and wholesalers had the highest share of value addition role and profit whereas producers incurred a loss in revenue, however, in conformity with (Hailu *et al*.,2017) who reported that onion producers obtained highest profit share.

Measure of production performance (profitability and efficiencies) for the onion producers is shown in Table 2. The result shows that the estimated values for both gross ratio and operating ration of the producers, wholesalers, exporters and retailers were 0.29, 0.80, 0.67 and 0.81 respectively.
All of the ratios were less than unity in which case their operations were efficient and had a positive impact on onion producers and traders, indicating the profitability of onion business in the study area. Onion producers in particular

obtained lower gross and operating ratios of 0.29 indicating a higher profitability of the farm business amongst the onion actors. This finding is in agreement with the report of previous study by Kaka *et al*. (2019) who said that onion production is a profitable enterprise. However, operating ratios of the onion marketing actors shows that the ratios were 0.80 and above except for the exporters who had 0.67. This means that the total business cost was 80% and above for the retailers and wholesalers, while 67% for the exporters. According to Olukosi and Erhabor (1998) a ratio less than one (<1ratio) is desirable for any business, a higher ratio but less than one (< 1ratio) might be tolerated for a large business and a ratio greater than one (> 1ratio) is disastrous and indicates over utilization of certain resources. It can be suggested that there is the need for the retailers and wholesalers in particular to watch and improve on their application of variable inputs in terms of reducing costs or increasing gross income.

Table 2: Comparability of Value Added and Gross margin Share of Onion actors in the Value Chain of the Study Area

	Chain Actors				
Indicators	Producers	Wholesalers	Exporters	Retailer	Total
Volume of sales (bag)	117.50	1244.58	6881.00	215.20	
Variable cost of production (₦/bag)	8855.12	-	-	-	
Fixed cost of production (₦/bag)	0095.38	-	-	-	
Total farm expenses (₦/bag)	8950.50	-	-	-	
Purchase price (₦/bag)	-	28820.83	31625.00	24285.70	
Marketing cost (₦/bag)	0957.25	06484.14	11140.56	1556.20	
Total cost (₦/bag)	9907.75	35304.97	42765.56	25841.90	
Selling price (₦/bag) (**GI**)	30340.63	43750.00	63375.00	31784.30	
Value added (₦/bag)	21390.13	14929.17	31750.00	7498.60	75567.90
Share of value added (%)	28.00	20.00	42.00	10.00	100
Gross margin (**GM**)(₦/bag)	20432.87	8445.03	20609.44	5942.40	55429.74
Gross margin share (%)	36.90	15.20	37.20	10.70	100
Performance ratios					
Gross ratio (GR)	0.29	0.80	0.67	0.81	
Operating ratio (OR)	0.29	0.80	0.67	0.81	
Return on capital investment (RI)	2.30	0.23	0.48	0.22	

Source: Research survey result, 2023

In terms of returns on capital investment obtained as indicated in Table 2 in respect of onion producers, wholesalers, exporters and retailers were 2.30, 0.23, 0.48, and 0.22 respectively. These values suggest that for every ₦1 invested by any of the onion actor in

the study area as in the above respective order each gains ₦2.30k, ₦0.23, ₦0.48 and ₦0.22 as profit. This implies that onion producers took the lead in gains among the value chain actors in the study area. For the onion producers, the findings align with that of Khan *et al*. (2022) who reported similar outcome in their study area. However, the result is at variance with Wongnaa *et al.* (2022) who studied structure, conduct and performance of onion markets in southern Ghana asserted that onion farmers in the study area reported a loss of 1.55% on every dollar invested into onion production per hectare. Onion exporters trailed the producers to be more profitable among the marketing actors. In general, this report has confirmed the profitability in onion business as reported by many researchers not limited to Ibrahim *et al*. (2016); Abdulazeez *et al*. (2019) and Ocholi and Udeh (2021).

Profit frontier functions and inefficiency estimates of onion producers in Kebbi State

The estimates of the stochastic frontier profit function for onion producers in Kebbi State, Nigeria are presented in Table 3. The coefficient of the normalized price of labour (0.3328) was positive and significant ($p<0.01$) in consonant with *a priori* expectations, meaning that a unit increase in labour leads to more profit. This finding compares favourably with the outcome of Tanko and Obalola (2013). The estimate coefficient of the normalized price of onion seeds (0.1328) and fertilizer ((0.1513) were positive and statistically significant ($p<0.01$) which follows *a prior* expectation. The results implied that increases in purchase of onion seeds and fertilizer would bring about more profit which is in line with the findings of Elias *et al*. (2023). The estimated coefficient of the normalized price of manure (0.0379) was positive, statistically significant ($p<0.01$) and concurs to *a prior* expectation. This suggests that, increase in the purchase of manure leads to increase profit of onion producers which collaborates with the findings of (Mamboya *et al*., 2022) who obtained similar outcome. The estimated coefficient of normalized price for pesticide (-0.0760) was negative and statistically significant ($p<0.05$) but in contrast to *a priori* expectations. This implies that, any additional purchase of pesticides, decreases onion producers' profit which fails to align with the results obtained by Tanko and Obalola (2013) and Elias *et al*. (2023). This could be as a result of over utilization of the pesticides by the farmers. The estimated coefficient of normalized price for herbicides (0.0899) was positive and significant ($p<0.01$) and in conformity with *a priori* expectations. This means that increase in the purchase of herbicide, increases onion producers' profit level. This result fails to agree with the findings reported by Tanko and Obalola (2013). The estimate coefficient of the normalized prices for fuel/engine oil (0.1581) and Marketing cost ((0.0884) were positive, highly significant ($p<0.01$) and in line with *a prior* expectation. This suggests that, any increase in procurement of these inputs would bring about increase in the producers' profit, hence their wellbeing.

The analysis of inefficiency profit function in Table 3 also indicates that all the coefficients of inefficiency factors were insignificant and do not contribute to profit inefficiency which fails to agree with the report of Elias *et al*. (2023). The estimated sigma-squared (σ^2) was 1.0585 and not significant and the gamma (γ) value of the MLEs of stochastic frontier profit function model is 0.9341, statistically significant ($p<0.01$). This implies that 93.41% of variability of profit efficiency from onion production is attributed to output and the rest (6.59%) is due to random noises. The presence of technical inefficiency was treated by the likelihood ratio (LR) test which was 33.8552 and less than critical chi-square value at 1% level of significance with 18 degree of freedom χ^2 (1% 18) was 41.636 (given by Kodde and

Palmz, 1986). The null hypothesis of profit inefficiency was rejected.

Onion wholesalers' profit production functions and inefficiency estimates

Table 3 presents results of the stochastic frontier profit function estimates for the onion wholesalers in the study area. The table reveals that the estimated coefficient parameters of the normalized profit function for the product price (1.5531) and storage price (0.5920) are positively signed, statistically significant ($p<0.01$) and in conformity to *a priori* expectations. This implies that as volume of onion purchase and storage increase, profit realize by the onion wholesalers also increases vis-a-vis, increase in storage cost of onion, increases wholesalers' profit level, thus it pays to store onions. Coefficients for transportation price (-0.1562) and phone call price (-0.9800) are negatively signed, significant ($p<0.01$) and at variance to *a priori* expectations, meaning that increases in volume of onion purchase, increases onion wholesalers' profit. The coefficient of transportation (-0.1562) cost was negatively signed and statistically significant ($p<0.01$) which implies that an increase in transportation cost would decrease the profit of the wholesaler. This may be due to the movement of the product to distanced regions attracting more transportation prices and exposing the actors to some level of postharvest losses in onion. Similarly, increase in phone call price, reduces wholesalers' profit. Coefficient of tax/commission (0.6752) cost was positively signed and statistically significant ($p<0.01$) showing a positive linear relation with onion profit of the wholesalers. This result fails to consolidate that of Maharazu (2023) who obtained a negative coefficient.

The inefficiency component of the profit function is presented in Table 3. In the table only three factors of inefficient effects were significantly related to profit inefficiency among onion wholesalers in the study area. These factors are; level of education (1.5785), positively signed and significant ($p<0.01$) which implies that, increase in level of education leads to a decrease in profit efficiency of the wholesalers. Similar finding was reported by Mohammed and Emam (2015). Coefficient of distance to market (-0.0011), negatively signed but significant ($p<0.10$) which implies that decreases in the distance to the market leads to an increase in the profit efficiency of the onion wholesaler by 0.0011 and opposite is true. This suggest that as onion wholesalers are located closer to market, there would be unlimited ease of access to customers, inputs, market information. The coefficient of favourable weather condition (-3.9163), negatively signed but significant ($p<0.01$) meaning that, as the duration of favourable weather condition increases, profit efficiency of the onion actor also increases.

Furthermore, Table 3 shows that the generalized log likelihood function was 23.5880 signifying that inefficiency exists in the set of the data. The variance parameter estimates for sigma-squared (σ^2) and gamma (γ) are 0.4946 and 0.3705, respectively and all statistically significance ($p<0.05$). The sigma-squared (σ^2) indicates the goodness of fit and correctness of the distributional form assumed for the composite error term. The gamma (γ) value of the MLEs of stochastic frontier implies that 37.05% of variability of profit efficiency from onion wholesales is attributed to output and the rest (62.95%) is due to random noises. The presence of technical inefficiency was treated by the likelihood ratio (LR) test which was 21.7081 and less than critical chi-square value at 1% level of significance with 16 degree of freedom χ^2 (1% 16) was 38.566 (given by Kodde and Palmz, 1986). The null hypothesis of profit inefficiency was rejected.

Onion exporters' profit frontier function and inefficiency estimates

Table 3 presents results of the stochastic frontier profit function estimates for the onion

exporters in the study area. The table reveals that, the normalized coefficient price of loading/offloading (2.1881), transportation price (-0.1147), storage price (01134), phone call price (0.4317) and tax/commission charges (-0.3443) are all significant ($p<0.01$). Coefficient of loading/offloading was positive, indicative of positive relation with onion profit. This implies that as volume of onion purchase increases, loading/offloading charges increased and profit realize by the exporter also increases due to the large quantum of onion for disposal. The coefficient (-0.1147) of transportation cost was negatively signed but statistically significant ($p<0.01$). The negative sign associated with the variable implies that an. increase in transportation cost would decrease the profit of the exporter as more and could be spent to deliver the onion product. This may be due to the far distances covered to reach to the destination countries with high volumes of product as common characteristics of the exporters. Coefficient (0.1134) of storage price was positively signed and statistically significant ($p<0.01$) which means, increase in the cost of storage of onion over an extent period of storage time, increases the profit level of the exporters due to time utility when away from period of surplus. Coefficient (0.9800) of phone call charges was positively signed and statistically significant ($p<0.01$). This indicates that an increase in the value of phone calls leads to increases in the profit of the exporters by value of its coefficient. Coefficient (-0.3443) of tax/commission cost was negatively signed but statistically significant ($p<0.01$ and contrary to *a priori* expectations. This implies that increase in the use of mediating agents and other tax paid by the exporters for onion transaction, reduces their profit level. This could be for a reason of the desire to gather enough volumes of onion within a required limited time to meet up export target

The inefficiency component of the profit function is presented in Table 3 and it reveals that none of the parameters was significant. Table 3 shows that stochastic profit production estimates and inefficiency determinants indicated that the generalized log likelihood function was 22.8038 signifying that inefficiency exists in the set of the data. The variance parameter estimates for sigma-squared (σ^2) and gamma (γ) are 0.0017 and 0.9269 respectively and only gamma is statistically significance ($p<0.01$). The value of gamma implies that 92.69% of variability of profit efficiency from onion export is attributed to output and the rest (7.31%) is due to random noises. The presence of technical inefficiency was treated by the likelihood ratio (LR) test which was 12.1692 and less than critical chi-square value at 1% level of significance with 13 degree of freedom χ^2 (1% 13) was 33.823 (given by Kodde and Palmz, 1986). The null hypothesis of profit inefficiency was rejected.

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Table 3: Producer MLEs of the Stochastic Frontier Profit Function and inefficiency Estimates

Actor: Producers' level	**Producers profit function**		**Actor: Marketers' level**	**Wholesalers profit function**		**Exporters profit function**		**Retailers profit function**	
Producers' variables	β(t-value)	Standard (error)	Marketers' variables	β(t-value)	Standard (error)	β(t-value)	Standard (error)	β(t-value)	Standard (error)
Constant	3.2231*** (7.4287)	0.4338	Constant	-7.5061*** (-4.3894)	1.7100	0.7604 (0.8982)	0.8465	-8.7879*** (-7.3165)	1.2011
Labour	0.3328*** (7.4059)	0.4494	Purchase cost	1.5531*** (6.4556)	0.2405	-	-	1.8795*** (10.6877)	0.1758
Seed	0.1328*** (4.1549)	0.0319	Parking materials cost	-0.1227 (-0.7659)	0.1602	-0.8509 (-01.1494)	0.05694	-0.3726*** (-3.4542)	0.1078
Fertilizer	0.1513*** (3.558)	0.0425	On/offloading cost	-0.2988 (-1.3236)	0.2257	2.1881*** (33.4124)	0.06548	-0.0505 (-0.4823)	0.1047
Manure	0.03790*** (2.7574)	0.0137	Transportation cost	-0.1562*** (-3.1268)	0.0499	-0.1147*** (-3.4016)	0.0337	-0.2457*** (-3.7053)	0.0663
Pesticides	-0.0760** (-2.1664)	0.0351	Storage cost	0.5920*** (3.7636)	0.1573	0.1134*** (4.5726)	0.02481	-0.1174 (-0.5902)	0.1990
Herbicides	0.0899*** (3.0124)	0.0298	Phone call cost	-0.9800*** (-3.7015)	0.2647	0.4317*** (5.7371)	0.0752	-0.2971 (-0.2600)	0.1142
Fuel/engine oil	0.1581*** (3.9933)	0.0396	Tax/levy/commission cost	0.6752*** (5.0344)	0.1341	-0.3443*** (-27.8722)	0.0123	0.0833 (1.3433)	0.0620
Marketing cost	0.0884*** (2.9520)	0.0299	-	-	-	-	-	-	-

Source: Field survey data, 2023

Note: ***; **; * signify statistically significant at 1%, 5% and 10% level of probability and figures placed in parenthesis are t-value

Table 3 contd…….

Actor Variable	**Producers profit function**			**Wholesalers profit function**		**Exporters profit function**		**Retailers profit function**	
Inefficiency functions	**δ(t-value)**	**Standard error**	**Inefficiency functions**	**Δ(t-value)**	**Standard Error**	**δ (t-value)**	**Standard error**	**δ(t-value)**	**Standard error**
Constant	-4.3062 (-0.4079)	10.5565	Constant	-0.1952 (-0.1878)	1.0393	-0.0349 (-0.0359)	0.9742	2.5026** (2.0936)	1.1953
Age	0.02162 (0.5324)	0.0406	Age	0.0702 (0.6648)	0.1057	-0.0018 (-0.0544)	0.0340	-0.1063*** (-3.1470)	0.0337
Level of education l	0.0266 (0.3260)	0.0818	Level of education	1.5785*** (3.0154)	0.5234	-0.0935 (-0.376)	0.2483	0.1623 (0.7138)	0.2274
Business experience	-0.0264 (-0.5279)	0.0500	Business experience	-0.0106 (-0.1429)	0.0743	0.0794 (0.4084)	0.0194	0.1287*** (3.9410)	0.0326
Household size	0.0412 (0.7595)	0.0543	Household size	-0.1162 (-0.8311)	0.1399	-0.0193 (-0.2006)	0.0962	-0.04613* (-1.8563)	0.0248
Distance to market	-0.0220 (-0.7908)	0.0279	Distance to market	-0.0011* (-1.5756)	0.0007	-0.0349 (0.0359)	0.9742	0.0022 (0.0760)	0.0295
Labour availability	0.3293 (0.5141)	0.6405	Labour availability	0.0000 (0.000)	1.0000	-	-	0.0000 (0.0000)	1.0000
Unfavourable Weather condition	-0.9074 (0.7682)	1.1811	Unfavourable weather condition	-3.9163*** (-4.6671)	0.8391	-	-	3.9968*** (4.025)	0.9928
Availability of storage facility	2.5446 (0.3044)	8.3585	Availability of storage facility	-0.1952 (-0.1878)	1.0393	0.0453 (0.1289)	0.3516	1.0797 (1.1079)	0.9745
Availability of transportatio	-0.5227 -0.9046)	0.5778	Availability of transportation	-0.4692 (-0.7654)	0.6130	0.0001 (0.4939)	0.0003	2.4618*** (3.7768)	0.6518

Source: Field survey data, 2023

Note: ***; **; * signify statistically significant at 1%, 5% and 10% level of probability and figures placed in parenthesis are t-values

Table 3: contd…….

Diagnosis statistics								
Sigma-square (σ^2)	1.0585	1.1853	0.4946**	0.1906	0.0017	0.0023	0.2893*	0.0804
	(0.8930)		(2.5950)		(0.7282)		(3.5973)	
Gamma (γ)	0.9341***	0.06975	0.3705**	0.1383	0.9269***	0.0332	0.3590**	0.6518
	(13.3923)		(2.6790)		(27.8820)		(2.5343)	
Log Likelihood	-138.3417		23.5880		22.8038		-29.3564	
LR test	033.8552		21.7081		12.1692		57.2096	

Source: Field survey data, 2023

Note: ***; **; * signify statistically significant at 1%, 5% and 10% level of probability and figures placed in parenthesis are t-values

Onion retailers' profit frontier function and inefficiencies estimates

Table 3 presents results of the stochastic frontier profit function estimates for the onion retailers in the study area. The table reveals that, the coefficient of the normalized profit function for product price (1.8795), positively signed and statistically significant ($p<0.01$) and in line with *a priori* expectations. It infers that as onion retailers purchased large volumes of onions, the higher the profit enjoyed could be due to economics of scale. The estimated coefficient of parking material (-0.3726) has a negative sign, significant ($p<0.01$) and follows *a priori* expectations which shows that increases in price of parking materials, decreases the level of retailers' profit which could be due petty sells that requires different sizes of parking material to serve its levels of customers. The coefficient price (-0.2457) of transportation cost was negatively signed but significant ($p<0.01$). The negative sign associated with the variable implies that an increase in transportation cost would decrease the level of profit of the retailers. The inefficiency component of the profit function is presented in Table 3. The table reveals that coefficient of age (-0.1063) negatively signed, but significant ($p<0.01$), meaning that increase in age leads to a decrease in profit inefficiency (increase profit efficiency). This may be due to increase in practice that makes significant understanding of marketing strategy for proper expenditure that assists in reducing financial wastages as age goes with experience and practice. This finding affirms the outcome of Agbugba and Aymam (2018) who reported similar outcome. Coefficient of household size (0.1287) is positive and significant ($p<0.01$) which implies that with increase in the number of individual household of the onion retailer, increases profit inefficiency (decrease profit efficiency) of the trader. Coefficient of distance to market (-0.04613), negatively signed but significant ($p<0.01$) depicting that decreases in the distance to the market leads to an increase in the profit efficiency of the onion retailers. This suggests that as onion retailers are located proximate to market, there would be unlimited ease of access to customers, inputs, market information etc. Coefficient of unfavourable weather condition (3.9968), positively signed and significant ($p<0.01$) suggesting that as the duration of favourable weather condition increases, it leads to the decrease in the profit efficiency of the onion actor and coefficient of availability of transportation (2.4618) signed positive and significant ($p<0.01$) meaning that as lack of available transportation means increases, it leads to a decrease in the profit efficiency of the onion actor as may be influenced by postharvest losses in onions at hand.

Table 3 reveals, stochastic profit production estimates and inefficiency determinants of the onion retailers indicated that the generalized log likelihood function was -29.3564, meaning, inefficiency exists in the set of the data. The variance parameter estimates for sigma-squared (σ^2) and gamma (γ) are 0.2893 and 0.3590 and statistically significance ($p<0.10$) and ($p<0.05$) respectively. The sigma-squared (σ^2) indicates the goodness of fit and correctness of the distributional form assumed for the composite error term. The value of gamma implies that 35.90% of variability of profit efficiency from onion retails is attributed to output and the rest (64.1%) is due to random noises. The presence of technical inefficiency was treated by the likelihood ratio (LR) test which was 57.2096 and more than critical chi-square value at 1% level of significance with 16 degree of freedom χ^2 (1% 16) was 37.005 (given by Kodde and Palmz, 1986). The null hypothesis of profit inefficiency was accepted.

Levels of profit efficiency scores of onion actors in the study area

The results in Table 4 indicated that the average profit efficiency of onion producers in

the study area was 0.89 and the profit efficiency ranged between 0.62 and 0.96. By implication, an average onion producer in the pooled sample to achieve the profit efficiency of his best counterpart, the producer could realize a cost savings of approximately 7% (i.e.1-[0.89/0.96]*100). A similar computation on the most profit inefficient onion producer in the study area could realize cost savings of about 35% (i.e.1-[0.62/0.96]*100) to attain the most profitably efficient producer. This finding is in conformity with the findings Elias *et al*. (2023) who reported a mean profit efficiency level of 81%. Based on this study results it can be concluded that onion producers in the study area are generally profit efficient notwithstanding for the need for further improvement if productive inputs are further optimally utilized.

The results in Table 4 also portrays that the average profit efficiency of onion wholesalers in the study area was 0.80 and the profit efficiency ranged between 0.55 and 0.95. By implication, an average onion wholesaler in the pooled sample to achieve the profit efficiency of his best counterpart, the trader could realize a cost savings of approximately 15% (i.e.1-[0.80/0.95]*100). A similar computation on the most profit inefficient onion wholesaler in the study area could realize cost savings of about 42% (i.e.1-[0.55/0.95]*100) to attain the most profitably efficient producer.

The results in Table 4 indicate that the average profit efficiency of onion exporters in the study area was 0.87 and the profit efficiency ranged between 0.57 and 0.99. This implies that, an average onion exporters in the pooled sample to achieve the profit efficiency of his best counterpart, the trader could realize a cost savings of approximately 11.12% (i.e.1-[0.87/0.99]*100). A similar computation on the most profit inefficient onion wholesaler in the study area could realize cost savings of about 39% (i.e.1-[0.60/0.99]*100) to attain the most profitably efficient exporter. Based on this study results it can be adduced that onion exporters in the study area are generally profit efficient and can further be improved if productive inputs are optimally utilized.

The results in Table 4 also indicate that the average profit efficiency of onion retailers in the study area was 0.78 and the profit efficiency ranged between 0.45 and 0.98. This implies that, an average onion retailer in the pooled sample to achieve the profit efficiency of his best counterpart, the trader could realize a cost savings of approximately 20% (i.e.1-[0.78/0.98]*100). A similar computation on the most profit inefficient onion wholesaler in the study area could realize cost savings of about 54% (i.e.1-[0.45/0.98]*100) to attain the most profitably efficient exporter. Based on this study results it can be adduced that onion retailers in the study area are generally profit efficient and can further be improved if productive inputs are optimally utilized.

Conclusion

Production and marketing of onion among onion actors were generally efficient and profitable; however, there is room for improvement in terms of business knowledge. Notwithstanding the profitability of the onions as established by this study, there was a high ratio cost incurred in onion transaction by most of the onion marketing actors at tolerance level. Hence, Federal Government in collaboration with Kebbi State Government should subsidize some production inputs aiming at decreasing the cost of production and to include in its transportation policy to help onion actors to reduce their transportation cost as well as effective and efficient onion transport handling vehicles.

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Table 5: Frequency Distribution Onion Actors according to Profit Efficiency level in the Study Area.

	Producers' profit function		Wholesalers' profit function		Exporters' profit function		Retailers' profit function	
Efficiency interval	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
≤0.59	01	00.4	03	12.5	1	12.5	26	59
0.60-0.69	10	03.6	04	17.0	0	00	00	00
0.70-0.79	37	13.2	09	37.5	0	00	05	11
0.80-0.89	42	15.0	06	25.0	6	75.0	11	25
0.90-0.99	190	67.9	02	08.0	1	12.5	02	05
Total	**280**	**100.00**	**24**	**100**	**8**	**100**	**44**	**100**
Mean Efficiency	0.89		0.80		0.87		0.78	
Max. Efficiency	0.98		0.95		0.99		0.98	
Min. Efficiency	0.56		0.55		0.57		0.45	

Source: computed from MLE result, 2023

There is a need to strengthen onion actors by providing continuous capacity building on production and marketing of onion. Hence, it is recommended that adult field and basic business schools should be organized to onion value chain actors by the Kebbi State Ministry of commerce in collaboration with the Ministry of Agriculture and Natural Resources to build in their business experience oriented towards cost effective, profit efficiency and be more of informed business decision making.

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