RESEARCH ARTICLE

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Resource use efficiency and factors influencing maize production in Kuje Area Council, Federal Capital Territory, Nigeria

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Abstract

This study estimated resource-use efficiency and factors influencing maize production in Kuje Area Council, Federal Capital Territory, Nigeria. The specific objectives were to; determine the socioeconomic characteristics of maize farmers; analyse cost and returns associated with maize production; evaluate factors influencing the output of maize production; determine the resource-use efficiency of maize production and identify the constraints faced by farmers in maize production in the study area. Multistage sampling technique was employed to select 60 sampled maize farmers in the study area. The following tools of analysis were used to achieve the specific objectives of the study. Descriptive statistics; Gross margin analysis; resource-use efficiency and Cobb Douglass production function. The results showed that majority, 75 percent, of the sampled respondents were male while 73.3 percent were married. From the results it can further be deduced that 48.3 percent of the sampled respondents attended secondary school and 31.7 percent attended tertiary institution while the rest stopped at primary school level or did not have any formal education. The results also indicated that about 55 percent of the sampled maize farmers had household size ranges within 6-10. 100 percent of the sampled respondents had no access to credit and 83.4 percent had no access to extension services. From the analysis of cost and returns associated with maize production in the study area, the total revenue (TR) realized on average was N1,269,152.69 and the average total variable cost (TVC) was N188,462.69, the gross margin obtained was N1,080,690. With this result we can say that maize production is profitable in the study area. The results of the resource-use-efficiency revealed that farm size, seed input and labour input were underutilized while fertilizer input and chemical input were over utilized by maize farmers. The results of the Cobb Douglass production function model revealed that the factors influencing total output of maize production in the Study area were farm size ($P<0.1$), labour ($P<0.01$), chemical ($P<0.01$) and Fertilizer $P<0.05$). The major constraints faced by maize farmers in the study area include; inadequate capital, lack of fertilizer and lack of extension agent. Therefore, the study recommends that maize farmers should be encouraged to join the farmers' association, and supported with credit facilities. Government should supply inputs like agrochemical, fertilizer and improved seed varieties to maize farmers at a subsidized rate and at appropriate time and extension agents are to guide the farmers in the usage of these inputs while mechanize farming system should be encouraged by providing tractors to replace local farm implements. Good roads are essential in linking maize production areas with available markets around the study area.

Keywords: Resource-use, Efficiency, Maize, Production, Nigeria

INTRODUCTION

The level of agricultural development in Nigeria has not met the required demand of its teaming population, despite the abundant endowment of the country's different types of natural resources and vast land mass available for agri-

cultural cultivation. Although agricultural production is practiced by both small and large-scale farmers in nearly all parts of the country, majority of farmers especially the small-scale farmers still live in abject poverty (UNDP, 2009). These category of farmers are characterized by low level of productivity, low income level, large family size, lack of formal education, credit facilities, inefficiency in the use of resources available to them, continuous use of crude implements, and low savings and investment (Panwal et al.,2006). The term resource is used in reference to available means for producing goods and services. These goods in return are used to satisfy needs. Major resources used in agriculture are; land, labour, capital and management. Other agricultural inputs include seeds, fertilizers and chemicals. Resource management is the effective and efficient deployment of organization or farm resources at the right time. The importance of management cannot be over-emphasized because its effects could either be positive or negative if properly or carelessly employed respectively.

Maize (Zea mayz) is among most of the widely planted and cultivated cereal crops in the world. It is the fourth most consumed cereal ranked below sorghum, millet, and rice (FAOSTAT, 2008). In Nigeria, there is an increasing demand for maize on daily basis (Sadiq et al., 2013). This is because maize grains are jointly utilized for feeding poultry livestock and as food by many families (Ogunniyi, 2011). Nigeria is reported as the Africa's second largest producer of maize only after South Africa (FAOSTAT, 2018; PWC, 2021). As earlier mentioned maize is one of the best ingredients used in preparation of animal feeds. The cereal serves as industrial raw material in developed countries for different purposes. Maize has not only served as a source of food for man and livestock for years, but it has also served as a means and source of income generation and foreign exchange earnings for the country (Alabi and Abdulazeez, 2018). In addition, it is as an essential raw material for the industrial production of fuel, starch, medicines and food sweeteners. Levulinic acid, a chemical derived from maize is equally used as an anti-freeze ingredient, and can replace toxic petroleum-based ingredients. Ethanol produced from maize is used as a biomass fuel. maize straw serves as a cheap source of energy in homes for heating furnaces (Egwuma et al, 2019; Amaza, et al, 2021). Nigeria's maize production stood at about 11 million metric tons in 2021 (Amaza, et al, 2021). However, due to low productivity, current yields are unable to meet domestic demand which is estimated at about 12 – 15 MMT. That is, a supply gap of nearly 4 MMT exists per annum. This gap necessitated the export ban on maize in Nigeria to encourage domestic production and supply of the commodity (PWC, 2021).

Smallholder farmers in rural areas continue to face poor economic conditions which affect their living standards and maize production situation. The returns to land in terms of output have been on the decrease especially where increased population and non-agricultural use compete for land use (Babatunde et al.,2007). To achieve optimum production level, resources must be used efficiently. Successful planning and result-oriented policies require the technical knowledge of the productivity of farm resources to know the necessary adjustment to achieve a correct input mix (Assa et al, 2020). Despite its importance, maize production in Nigeria is predominated by traditional smallholders who rely on traditional methods of production. Resources are underutilized in addition to use of low amenities, which gives rise to low output and hence, low farm income. The supply of maize has also not been able to meet its demand despite the adoption of improved packages for maize production (Babatunde et al., 2008). For example, improved variety, recommended planting date, recommended fertilizer rate, recommended planting depth and spacing have not significantly increased productivity. Despite the introduction of hybrid maize, sufficient production has not been achieved as there is still a significant drop in the output of maize (Ayindea et al., 2011). According to Assa et al, (2020), low yield variety, lack of incentives, high cost of inputs, price fluctuation, diseases and pest, lack of storage facilities are the causes of low maize production in Nigeria. Given that the rate of population growth in Nigeria is increasing rapidly, there must be an increase in maize production to meet the growing demand (Ike and Amusa, 2004). Since the present maize output has not measured up to its potential yield of 5-8 tonnes per hectare, it is pertinent to ascertain if the resources available for the farmers are efficiently utilized to increase their present level of maize production. This is required to make Nigeria self-sufficient in maize production to the extent of having large surpluses for export and foreign exchange earnings.

Research Questions

This study intended to provide answers to the following research questions: -

(i) What are the socio-economic characteristics of maize farmers in the study area?
(ii) What are the costs and returns associated with maize production in the study area?
(iii) What are factors influencing output of maize production in the study area?
(iv) What are the resource-use efficiencies of maize production in the study area?
(v) What are the constraints of maize production faced by farmers in the study area?

Objectives of the Study

The broad objective was to evaluate resource-use effi-

ciency and factors influencing maize production in Kuje Area Council, Federal Capital Territory, Nigeria. The specific objectives were to;

(i) Determine the socio-economic characteristics of maize farmers,
(ii) Analyse the costs and returns associated with maize production,
(iii) Evaluate factors influencing output of maize production,
(iv) Determine the resource-use efficiency of maize production,
(v) Identify the constraints faced by farmers in maize production in the study area

MATERIALS AND METHODS

The Study Area

The study was conducted in the Federal Capital Territory (FCT), in Kuje Area Council. Kuje is located within Latitudes 8^0 53^I 47^{II} North and Longitudes 70 14^I 35^{II} East. The council has a total land area of about 1,644 Km2. It is located 40 Km towards the south-west part of Abuja and is bounded by Nasarawa State. The temperature of the area is generally high especially around February and March. The climate of the area is that of tropical wet and dry with wet season lasting for about five to seven months (5-7 months). Total annual rainfall ranges from 1000 – 1500 mm. Potential evapotranspiration rates is slightly high, value reaching up to 3.5mm/day. The north-east trade wind sweeps the zone between October to March bringing dryness to the area. The land in the Area Council is sloppy-plane topography which is about 410 mm above mean sea level. The Area Council also has a population of 97,367 people (NPC, 2006) predominantly made up of farmers hey cultivate crops such as; maize, sorghum, rice, beans, groundnut, millet, yam, vegetables.

Sampling Techniques and Sample Size

Multi-stage sampling techniques was used to select respondents for the study area. First stage involved simple random selection using ballot box raffle draw method to select Kuje Area Council. Stage two, involved random sampling procedure using ballot box raffle draw method to select two wards in the study area Kuje central and Gaube. Stage three involved using a random sampling ballot box raffle draw method to select 60 maize farmers in the selected areas (Kango and Chukuku villages) for the administration of questionnaire. The total sample size of 60 questionnaires were administered to respondents in the area

Method of Data Collection

Primary data were used for the study. These data were collected by interview method, using structured questionnaires. The questionnaires covered: (a) demographic information such as age, farming experience, marital status, educational level, household size, extension contact, membership of associations, and farm size, (b) production information on maize such as inputs used (land, seeds, labour, fertilizer and agro-chemicals) and output obtained, (c) market information like price of input and quantity sold, and (d) constraints to maize production.

Methods of Data Analysis

Descriptive Statistics

This is the act of summarizing and giving a descriptive amount of numerical information in form of report, charts, and diagrams. The goal of descriptive statistics is to gain information from collected data. The descriptive statistics involved the use of percentages, means, and frequency distribution tables. This was use to achieve specific objectives one (i) and five (v).

Gross Margin Analysis

This analysis was used to estimate the costs and returns analysis of maize production. It is a very important planning tool in situations where fixed capital is a negligible portion of the farming enterprises as is the case of subsistence agriculture (Olukosi and Erhabor,2001). It is used to evaluate the profitability of an individual enterprise and is given as;

GM = TR – TVC .....(1)

Where;

GM = Gross Margin (₦ /Hectare)

TR = Total Revenue (₦/Hectare)

TVC = Total Variable Cost (₦/Hectare)

This was used to achieve specific objective two (ii)

Cobb-Douglas Production Model

The Cobb-Douglas production function represents the relationships between two or more inputs typically physical and labour and the number of output that can be produced.

Mathematically;

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} U_i \quad \text{.....(2)}$$

When linearized, the Cobb-Douglas production model becomes:

$L_n = b_0 + b_1 L_n X_1 + b_2 L_n X_2 + b_3 L_n X_3 + b_4 L_n X_4 + b_5 L_n X_5 + U_i$.....(3)

Where, Ln= Natural Logarithm
Y= Output of Maize (Kg)
b_0Constant Term (Intercept)
X_1= Farm Size (in Hectares)
X_2= Seed Input (Kg)
X_3= Labour Input(Mandays)
X_4= Fertilizer Input (kg)
X_5= Agrochemicals Input (Litres)

b_1-b_5 = Coefficient of Parameters Estimated
U_i= Error Term
This was used to achieve specific objective three (iii)

Resource-use Efficiency of Maize Production

To measure the resource-use efficiency of maize production in the study area, the Marginal Value Products (MVP) of the resources used were estimated by multiplying the Marginal Physical Product (MPP) of the inputs with the price of the output. The values were then compared with the cost of the resources Marginal Factor Cost (MFC) in order to make inference on the efficiency of resource-use. The following was estimated to determine the resource-use efficiency of maize production:

$$r = \frac{MVP}{MFC} \quad \text{----------(4)}$$

Where;
r = Efficiency Ratio (Units)
r = 1, Resources employed by the Farmer were Efficiently Utilized,
r > 1 Resources employed by the Farmers Were Under Utilized, and
r1, Resources employed by the Farmers Were Over Utilized.
The MPPs and, MVPs were derived as follows:
Linear:

$$MPP = \frac{dy}{dx} = b_i; \quad MVP = b_i.P_y \quad \text{.....(5)}$$

Semi – Log:

$$P = \frac{bi}{x}; \quad MVP = \frac{bi}{x}.P_y \quad \text{.....(6)}$$

Double – Log:

$$MPP = \frac{bi}{x}; \quad MVP = \frac{bi}{x}.P_y \quad \text{.....(7)}$$

The Elasticity of Production (E_p) is the regression coefficients. Return to Scale (RTS) was estimated as:

$$RTS = \sum_{i=1}^{n} E_P \quad \text{.....(8)}$$

This was used to achieve specific objective four (iv)

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Sampled Respondents in the Study Area

Table1 presents the analysis of the socioeconomic characteristics of the sampled respondents, the results show that majority of the sampled respondents were male while 25% were female, this result indicates that maize production was dominated by male farmers in the study area. This could be as a result of the labour required for maize production. Majority (73%) of the sampled respondents were married. Married families have an advantage of more supply of labour for maize cultivation which could lead to increase in total output of maize. Also table 1 depicts that 55% of the sampled respondents had 6-10 members per household and 36% had 1-5 members per household while others have more than ten members. This suggests that most of the sampled respondents had at least 6 members per household which shows that they have a significant labour supply for maize production and this could improve the total output of maize in the study area. Furthermore, the results revealed that 33.40% of the sampled respondents had 1-5 years farming experience while 26.70% had 6-10 years of farming experience in the study area. Experience they say is the best teacher. Therefore, there is tendency of increased output due to the fact that majority of the farmers were not newbies in the business since they were familiar with the management practices involved in the maize production cycle. About 48.30% of the sampled maize farmers had secondary education while 31.70% attained tertiary level of education and 1.7% and 18.3% had no formal education and primary education respectively. The implication of this result shows that most of the sampled maize farmers were educated and this could aid them in accessing information about improved methods of maize production which in turn will improve their chances of adopting new technologies and innovations in agriculture. Education level of a farmer could determine how efficient the farmer would be, especially in the area of resource utilization which could lead to output and profit maximization. This result is in line with (Alabi et al, 2020 and Ebukiba et al, 2020) who reported that education is an important factor that can influence small-scale farmers to adopt new innovations and research findings related to their area of production. When a farmer is educated, there is high probability that he will take advantages of innovations and new technologies easily which would eventually lead to improved yield and increase in output. Analysis also shows that 100% of the sampled respondents could not access credit facilities. This implies that there is no provision of credit facilities to help farmers with fund to increase their scale of production in the study area thereby limiting their ability to expand. Majority (83.40%) of the sampled maize farmers could not have access to extension services while only 16.7% had access to extension services. Extension services help farmers to access price information, methods of inputs utilization like chemical and fertilizer application and access to improved seeds which could influence their resource-use efficiency. Most of the sampled farmers were not opportune to these privileges. The result also indicated that only 16.7% of the sampled maize farmers were visited by extension agents. This percentage is too low to inspire other farmers positively. Many of the farmers (66.3%) were members of farmers' association. This could aid group marketing and access to financial facilities among farmers in the study area.

Table 1. Socioeconomic Characteristics of the Sampled Maize Farmers in the Study Area

Variables	Frequency	Percentage	Mean
Gender			
Male	45	75.00	
Female	15	25.00	
Marital Status			
Single	16	26.70	
Married	44	73.30	
Household Size (Units)			7
1-5	22	36.70	
6-10	33	55.00	
11-15	5	23.80	
Farming Experience (Years)			6
1-5	20	33.40	
6-10	16	26.70	
11-15	6	9.90	
16-20	7	11.70	
21-25	6	10.00	
26-30	3	5.10	
31-35	2	3.40	
Educational Level			
No formal education	1	1.70	
Primary education	11	18.30	
Secondary education	29	48.30	
Tertiary education	19	31.70	

Table 1. Socioeconomic Characteristics of the Sampled Maize Farmers in the Study Area (continuous)

Variables	Frequency	Percentage	Mean
Access to Credit			
Yes	0	0	
No	60	100	
Access to Extension			
Services			
Yes	10	16.70	
No	50	83.40	
Number of Visit (Days)			
0	51	85.00	
1-2	9	15.00	
Farmers Association			
Yes	40	66.30	
No	20	33.30	
Farm Size (Hecters)			2.1
1-2	59	98.40	
3-5	1	1.70	
Cropping System			
Sole	49	81.70	
Mixed	11	18.40	
Total	60	100.00	

Source: Field Survey (2021)

Cost and Returns Analysis of Maize Production in the Study Area

Table 2 shows the analysis of cost and returns associated with maize production in the study area. The result shows that the total revenue(TR) was N1,269,152.69 while the total variable cost (TVC) was N188,462.69 respectively. The cost of agrochemicals was N15,611.86 while the average cost of fertilizer was N 25,478.33. The cost of labour was N 142,211.67 and was the highest of the total variable cost. The Gross Margin obtained was N1,080,690. These results showed that maize production is profitable in the study area. The result is consistent with the findings of Ebukiba et al, (2020 who asserted that maize production is a profitable venture.

Table 2. Cost incurred and Return Obtained from Maize Production in the Study Area

Variables	Average Value(Naira)	Percentage
A. Variable Cost		
a. Seed Cos	5,160.83	2.74
b. Labor Cost	142,211.67	75.46
c. Fertilizer Cost	25,478.33	13.52
d. Agrochemical Cost	15,611.86	8.28
B. Total Variable Cost	188,462.69	
C. Total Revenue	1,269,152.69	
D. GM= TR-TVC	1,080,690.00	

Source: Field Survey (2021)

Resource-use Efficiency of Maize Production in the Study Area

Table 3 shows the resource-use efficiency of maize production in the study area. r=1 shows that resources employed by the farmers were efficiently utilized; r>1 shows that resources employed by the farmers were underutilized while r <1 shows that the resources employed by the farmers were over utilized. The farm size ratio was -2.24 which shows that the land resource used by maize farmers in the study area were over utilized. The seed input ratio was 3261.62 which revealed that the resource was underutilized by maize farmers in the study area. The labour input ratio was 5467.57 which depicts that the labour resource was underutilized by maize farmers in the study area this is in comformity with Assa et al, (2020). Also the fertilizer input ratio was 0.57 which indicates that fertilizer was over utilized by sampled maize farmers. The agrochemical ratio was 0.16 which shows that agrochemicals were over utilized by maize farmers. This result is in agreement with (Ume et al, 2016) who reported in a research on the impact of resource utilization on output that the efficient utilization of available resources determines the rate of output that will be obtained. The results are also in line with Ume et al, (2018) who reported that the over-utilization of resources implied that less profit was maximized. The possible reasons for the over utilization of the resources, could be because of the inability of farmers to allocate their resources efficiently as a result of lack of technical-know-how.

Table 3. Resource-use Efficiency of Maize Production in the Study Area

Value Factor Unit	MVP	MFC	MVP/ MFC	Remarks
Farm Size	170.93	76.22	2.24	Under utilized
Seed	8134477.58	24.94	3261.62	Under utilized
Labour	4417850.31	808.01	5467.57	Under utilized
Fertilizer	3094.84	5455.42	0.57	Over utilized
Chemical	271.82	1781.54	0.16	Over utilized

Source: Field Survey (2021)

Factors Influencing Total Output of Maize Production in the Study Area

Table 4 presents the results of the analysis of Cobb Douglass production functional model to determine factors influencing total output of maize production in the study area. The results show that there are four statistically significant factors influencing maize production in the study area. These include farm size, labour input, chemical input and fertilizer. Farm size influenced the total output of maize positively and it was statistically significant at (P<0.1) probability level. The coefficient of farm size was 0.092 which implies that a unit change in farm size will result in 9.2% increase in the total output of maize in the study area. As a result of the expansion of farm size by maize farmers will results in the increase in total output of maize due to increase in farm size. This result is in agreement with Erabor (2001) who reported that large farm size leads to positive increase in total output. Labour input influenced total output of maize positively and it was statistically significant at (P<0.01). The magnitude of the coefficient of labour input (0.974) implies that a unit increase in labor supply in maize production will result in 97.4% percent increase in the total output of maize in the study area holding other variables constant. More supply of labour leads to significant increase in the total output due to the high number of labour involved in the farm operation. This result agrees with (Assa et al, 2020) who reported that the level of output can be measured by the level of labor input involved in the cause of production cycle. Also chemical input influenced the total output of maize negatively in the study area and it was statistically significant at (P<0.01) probability level. The magnitude of chemical input is -0.0353 implying that a unit increase in the chemical applied to the maize farm by farmers will result in the decrease in the total output of maize in the study area. The implication of this

result is that the application of more chemicals to maize farms will lead to 3.53% decrease in the total output of maize in the study area. This could be as a result of wrong usage of chemical (herbicide) on the farmland and it may affect the yield of maize output. This might be as a result of lack of knowledge on method of application by farmers considering the fact that majority did not have access to extension services. This result is contrary to Anthony et al, (2021) who reported that chemical inputs influence total output or yield of crop positively in their study but is in conformity with the results of Assa et al, (2020). Fertilizer influenced the output of maize positively and it was statistically significant at (P<0.05) probability level. The magnitude of the coefficient of fertilizer was 0.098, which implies that a unit change in fertilizer will result in 9.8% increase in the total output of maize in the study area This is in line with Assa et al, (2020). The value of the coefficient of multiple determination (R2) was 0.59 which implies that 59% of the variation in the total output of maize is explained by explanatory variable included in the model, the value of the F-statistic which is the joint contribution of the all explanatory variables was 3.008 and statistical significant at (P<0.01) probability level.

Table 4. Results of the Cobb Douglass Production Functional model for Factors Influencing Total Output of Maize Production in the Study Area

Variables	Coefficients	Standard Error	T- Value	Significant
(Constant)	2.695*	0.675	3.990	0.000
Farm Size Input	0.092***	0.049	1.877	0.650
Seed Input	-0.011	0.037	-0.211	0.990
Labour Input	0.974*	0.336	2.898	0.00
Chemical Input	-0.353*	0.030	-11.767	0.001
Fertilizer	0.098**	0.044	2.227	0.029
R- Square	0.59			
Adjusted R2	0.473			
F-Value	3.008			

Source; Field Survey (2021) *, **, ***, Statistically Significant at (P<0.01) (P<0.05) (P<0.1) Respectively.

Constraint Encountered in Maize Production by Sampled Farmers in the Study Area

Table 5 shows the analysis of constraints of maize production in the study area. The results show that majority 53.3% of the sampled respondents were faced with inadequate capital while 18.3%of the sampled respondents depicts lack of fertilizer as the major constraint in maize production. The result further revealed that 16.7% of the sampled respondents had no access to extension agents who are supposed to teach advanced methods of maize production to farmers in the study area. The result also indicated that about 10% of the sampled maize farmers identified bad roads as one of the major barrier to effective maize production in the study area, and 1.7% of the sampled respondents encountered government policy on land as a challenge to efficient maize production in the study area.

Table 5. Constraints of Maize Production in the Study Area

Variables	Frequency	Percentage Rank
Inadequate capital	32	53.3 1st
Government policy	1	1.7
High cost of input	0	0
Lack of fertilizer	11	18.3 2nd
Lack of extension agent	10	16.7 3rd
Bad roads	6	10
Total	60	100

Source, Field Survey, (2021)

CONCLUSION

According to the findings emanating from this research work, the study revealed that maize production is profitable in the study area with the prospect of increase in production and increase in the income of the maize farmers. The study also holds future prospects of improving the well-being of the farming family in the study area. However, despite the profitability of maize production in the study area, maize farmers encountered the problem of inadequate capital which was ranked first while lack of fertilizer ranked second and lack of extension agent was ranked third. Poor road network was also identified as a constraint of maize production in the study area. Therefore, the study recommends that;

1. Maize farmers should be encouraged to join the farmers' association so they can pool their productive resources for large scale farming. Also, farmers should be encouraged by providing credit facilities to them as a motivating factor to encourage their involvement in maize production for earning income to improve their family wellbeing.
2. Government should supply inputs like agrochemicals to maize farmers at a subsidized rate and at appropriate time. They should also encourage mechanized farming systems because mechanization leads to lower cost of production thereby causing an increase in the proper utilization of resources in order to bring about increase in output.
3. Government should provide good roads linking maize production areas to ease farmers in evacuating their produce and provide adequate market for maize farmers' products.
4. Government and private sector should make available and affordable soft micro credit loan at good times for production activities to farmers.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

The authors declared no conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. The authours contributed in designing the research, data collection, data analysis, interpretation of results and copy editing All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Ethics committee approval is not required.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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