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Production Scale and Manure Management of Pig Farmers in Ifo Local Government Area of Ogun State

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Abstract: Over the years, structural changes in pig production has led to obvious increase in scale of production through the establishment of medium to large industrial sized pig farms. This has given rise to monumental increase in pig dung with attendant waste management challenges that need to be addressed. This study analyzed the effects of fundamental changes in pig management and how they affect manure fructification practices. Data were collected from three hundred pig farmers in Ifo local Government Area using well-structured questionnaire. These data were analysed using mean, standard deviation and multinomial logit regression. The results showed that the proportion of pig production has an important effect on how farmers device use for the ensuing pig dung or manure. Clearly, the results from descriptive statistics and multinomial estimation show that smaller holders are more likely to use pig manure in their farms, while larger scale pig producers have higher probability of trading the manure or find other ways to deal with it. Unleashing agnate environmental policies that stimulate manure treatment prescriptions is advocated.

[Olowa, Omowumi A, Olowa, Olatomide W. and Umoru, John I. **Production Scale and Manure Management of Pig Farmers in Ifo Local Government Area of Ogun State**. *Nat Sci* 2021;19(5):46-52].ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature 7.doi:10.7537/marsnsj190521.07.

Key Words: Pig manure, Environmental Management, Farmers, Production Scale

1. Introduction

Historically, many rural households in Southern part of Nigeria raised between one to five pigs, typically on a free range. Ordinarily, one pig would sufficiently furnish the table of a sizeable rural household provided pork can be stored to last. Although households would trade pork in exchange for other products when pigs were slaughtered to provide meat. Thus, the pork from these operations served dual purpose; for consumption and sales in the market. However, as markets broadens, households bolstered their production and sold their pigs beyond the village settings. These local commercial activities in pig production and marketing became an expanded operations over the years and a good income source for numerous farmers and traders, especially small-holders in rural areas.

Today, the world population of pigs runs into billions. For example, in the United States of America alone where one farmer rears as much as 4,000 to 5,000 sows, more than ten million pigs are slaughtered each year (Bruno *et al.,* 2008). Similarly, in Vietnam with a human population of 80 million, pig population, has shot up to a recognizable 19 million pigs within a decade (Gerd'de and Tondeur, 2001). In Nigeria, the population of Pigs is estimated to be 7.1million as at 2016. There has been consistent growth in pork demand over the years, and continuous expansion is anticipated via increasing number of pigs per farm.

Throughout the country, especially in many southern states, the demur of pig dung handling has been recognized as primary to sustaining the growth of the industry (Okoli *et al.,* 2006). The environmental and health concerns in all pig production businesses therefore, have to do with the waste management problems. Besides foul odor, the hydrogen sulphide, ammonia and other gases emitted by stored pig manure can diminish air quality (Spence *et al.,* 2008). The disagreeable odor can also lead to tension between pig producers and their neighbours, which can evoke litigations and risk of possible shut down of production (Oseghale, 2010). Another serious concern is the unscrupulous behavior of some pig farmers who would indiscriminately dump faecal matter into nearby natural water sources, thus making them not proper for human consumption. Furthermore, manure generates heat as it decomposes, and can in fact ignite spontaneously when stored in a massive pile, (State News, 2007). Emissions or smoke from ignited large pile of manure fouls the air over a very expansive area and requires major effort to extinguish, thus polluting the air with attendant greenhouse gas effect. This calls for effective measures to contend systematically, the accumulation of pig dung from large feedlots, as there is no risk of spontaneous combustion in smaller operations

Changes in pig manure management due to fundamental changes in pig production is an additional underpinning reflection triggering the

heated public opinion on disposal and pollution of pig manure. Traditionally, pig producers in Nigeria are small-holders. This size of farms characteristically generates manure or dungs that easily utilized as fertilizers by the pig producers or their neighbouring crop farmers on their farms. However, manure/dungs generated by commercial pig producers are significantly huge, requiring innovative management practices or ideas for proper disposal in order to avoid environmental violations and the resulting agitations.

With the recent favourable policy environment and various lending programmes of central bank to farmers which includes but not limited to anchor borrowing scheme and Nigerian Risk-Sharing System of Agricultural Lending (NIRSAL), Nigeria's pig production has experienced changes both in size and technical-know-how with ensuing growth generating increasing concerns on waste or dung management practices or disposal.

This study is novel in that, empirical studies on the impact of structural changes in pig production on manure or pig dung generation and management on the environment in Nigeria are very rare or non-existent. Previous studies partially documented certain changes, or concentrated on the identification of factors responsible for their emergence or compilations of pig dungs. This paper explore the manure management implications of expanding pig production and the consequences on the rural environment if attention is not paid to it. Specifically, the paper seek to: first, summarise several practices in the pig manure handling by pig farmers at the study area, pinpointing how farm size affect or influence the kind of practice pig farmers adopt in disposing their pig dung. Second, to appraise the net effect of further concentration in pig production on manure management. Third, to discuss the effects continuous expansion of pig farms can have on the environment.

2. Methodology

2.1 Study Area

Ifo Local Government Area (LGA) of Ogun State has the headquarters in Ifo town with total area of 521km^2 and a population of 524,837 according to 2006 census. It is the home to Oke-Aro Farm settlement which has the largest concentration of pig farmers in Nigeria spanning an area of 30 hectares and has patronage from as far as Republic of Benin.

2.2 Data

Purposive sampling technique was used to gather information from pig farmer as pig farming is a popular enterprise in Ifo local government area. Thus, Ifo LGA was selected due to rising status of pig farming enterprise in the area. Information were elicited from Three Hundred (300) Farmers regarding the list of stock and different size categories of pig farms. The questionnaire further elicited information on household characteristics (e.g. the family size, labor endowments, farm size, and total asset value), the demographic information (such as gender, age, education, and marital status) and specifically, questions about whether each pig farmer had off-farm employment and how much time spent on off-farm work. Additionally, the questionnaire elicited information on herd population or total number of pigs that the farmer raised in 2015 and detailed information regarding their methods of handling pig manure. On the basis of this, pig manure management styles were divided into four categories namely: self-use (pig manure is either applied to farmer's land directly or used by neighbouring crop farmers); sale; feed (mainly for fish); and discard.

2.3 Analytical Technique

Estimation Model

Multinomial logit regression model was used to discriminate among factors connected to the size of pig farms as shown in the descriptive analysis and their effects on pig manure management practices. The adoption of the multinomial logit regression is premised on the principle that it permits the analysis of decision across more than two categories, allowing the determination of choice probabilities for different manure management. Estimating single-equation models for instance, using ordinary least squares (OLS) technique for the four categories of manure management namely, 'self-use', 'sale', 'feed', and 'discard', individually, could culminate into seemingly unrelated bias as noted by Zellner (1962). OLS model would lead to estimation of four independent equations in order to predict the proportions of 'self-use', 'sale', 'feed', and 'discard'. However, this assumption of independence among factors is not plausible, since if a factor has a positive impact on the share of self-use of pig manure, it should have a negative impact on the share(s) of other methods of pig manure management, because, the methods adopted in pig manure management are correlated with the size of the farm, it is expected that the equations for predicting these will be interrelated. Thus, we can expect that the single-equation approach will be 'inefficient from a statistical point of view' as surmised by Judge et al., (1988). The multinomial logit is adopted as it shows superior features to any other model in that it was able to give "contemporaneous correlations among the variable categories. Multinomial logit has S possible states or categories that is S=1, 2, 3……,S that are exclusive and exhaustive (Nkamleu and Coulibaly, 2000). In

this analysis, the probability of a pig farmer manure management is characterised as a polychotomous choice between four mutually exclusive alternatives. Let U_{ij} denotes the utility that the farmer derive by choosing one of the four outcomes and $U_{ij} = {}_{\gamma j} X_{ij}$ + eij Where: γj varies and X_{ij} remains constant across alternatives; and eij is a random error term reflecting intrinsically random choice behaviour, measurement or specification error and unobserved attributes of the alternative outcomes. Let also P_{ij} (j = 0, 1, 2, 3) denotes the probability associated with the four categories, where j=0 is the probability of self-use, j=1 is the probability of sale and j=2 feed, and j=3, discard as form of manure management. Because the multinomial logit model does not treat these categories in any continuous order, it is different from ordered or sequential logit/probit models" (Ameniya, 1981).

The multinomial logit model (Babcock et al., 1995), is given by

$$P_{ij} = \frac{\exp(\gamma jXi)}{1 + \sum_{j=1} \exp(\gamma jXi),} \quad \text{for j=1,2,3,4} \quad (1)$$

P_{ij} is the probability of being in each of the groups 1, 2 and 3.

$$P_{i0} = \frac{1}{1 + \sum_{j=1} \exp(\gamma jXi),} \quad \text{for j=0} \quad (2)$$

P_{io} is the probability of being in the reference group or group 0.

In practice, when estimating the model, "the coefficients of the reference group are normalized to zero" (Maddala, 1990; Greene, 1993; Kimhi, 1994). This was because "the probabilities for all the choices must sum up to unity" (Greene, 1993). Hence, for 4 choices only (4-1) distinct sets of parameters can be identified and estimated.

"The natural logarithms of the odd ratio of equations (1) and (2) give the estimating equation" (Greene, 1993) as

$$\text{In} \frac{[P_{ij}]}{[P_{i0}]} = \gamma jX_i \quad (3)$$

"This denotes the relative probability of each of group 1, 2 and 3 to the probability of the reference group. The estimated coefficients for each choice therefore reflect the effects of Xi`s on the likelihood of the pig farmer adopting sale, feed, and discard manure management relative to the reference group". However, following Hill (1983), "the coefficients of the reference group may be recovered by using the formula γ3 = - (γ1 + γ2). For each explanatory variable, the negative of the sum of its parameters for groups 1, 2 and 3 is the parameter for the reference group". This analysis was however not calculated in this study.

Dependent Variable:

Y_1= probability of sale as manure management
Y_2= probability of using manure as feed,
Y_3= probability of discard as manure management
Y_4= probability of Self-use of manure

In this analysis, the fourth category (self-use), is the "reference state"

Independent Variables:

The "independent variables comprise the economic and demographic variables that affect the choice of manure management" following Huang, Qiao, Liu, Jia, Lohmar, (2016) include:

X_i= Wealth
X_j = Household Characteristics variables, and
X_k =Pig farmer characteristics
X_L = Geographical variables

Wealth

X_1 = per capita asset value

Household characteristics

X_2= Household size
X_3 = Farm size (Ha)
X_4= No. of labourer
X_5= off-farm work (1= yes, o otherwise)

Pig farmer characteristics

X_6 = Age of Pig farmer
X_7 = Age^2
X_8= Gender (male=1, 0 otherwise)
X_9= Education (years)

Geographical Variable

X_{10} = Distance of Pig farm to the main road
X_{11} = Nearness to fish pond (1= Near, O otherwise)

Dummy Variable

X_{12}= Medium Scale dummy
X_{13}= Large Scale dummy

3. Results and Discussion

3.1 Descriptive Analysis

Table 1 shows the summary of the main variables used in this study. As the Table shows, more than 70 percent of the pig farmers handled pig manure as discard while two methods, namely, sale and feed shares similar values (about 10 percent each) and self-use is indicated as the least method (8.98 percent). The mean family size was about 5 while 'average farm size' was 0.65 hectares. On average, about 23 percent of pig farmers 'engaged in off-farm work'. Majority of the pig farmers are male (mean=0.96) with mean age of about 48 years. Their mean income per capita was ₦4,477.4.

Table 1: Summary of Main Variables

	Mean	SD
Characteristics of households		
Number of pigs produced (100 heads)	3.61	10.99
Household size	5.27	1.53
Farm size (Ha)	0.65	0.47
Percentage of labors with off-farm work	23.16	23.88
Asset value per capita (₦10,000)	8.74	25.27
Percentage of manure methods		
Self-use	8.98	26.24
Sale	9.76	27.31
Feed	10.91	30.00
Discard	70.35	42.05
Characteristics of Pig Farmer		
Gender	0.96	0.19
Age (years)	48.08	9.73
Education (years)	7.98	2.95
Geographical Variables		
Fish Pond	0.36	0.16
Distance from main road (km)	1.55	3.02
Average income per capita	4477.34	1939.45

Sources: Authors' 2017 survey. Total sample size is 300

Following from Table 1, different factors were linked individually with pig manure management, ("Self-use, Sale, Feed and Discard") as shown in Table 2. First, we chart the relationship between pig production size and pig manure handling. There are various definitions of small, medium-scale, and large-scale pig producers. We first define pig producers as follows: small-scale pig farmers have inventories of up to 45 herd, medium-scale pig farmers have pig inventories greater than 45, but less than 200; and large-scale pig producers have inventories of 200 or greater. As shown in Table 2, there are significant differences in manure management practices between different sizes of pig farms.

Table 2: Production Scale, Manure Management and Selected Household Characteristics Linkages

Category variable	Observation	Mean	Pig manure use 'Self-use	Sale	Feed	Discard'
Scale of pig production (Inventory)		(head)			(%)	
Small (1-45)	174	30	88.65	1.06	2.76	5.53
Medium (45-199)	76	135	64.98	10.89	12.72	11.41
Large (200~)	50	712	15.25	29.50	27.54	27.71
Asset value per capita			(₦10,000)		(%)	
Low (bottom one-third)	136	0.76	79.93	2.57	9.49	8.01
Middle	137	3.28	77.01	5.43	8.39	9.16
High (top one-third)	135	22.32	53.95	21.38	14.89	9.78
Farm size (Ha) (%)						
More than 1 Ha	264	4.77	67.30	8.78	13.83	10.09
0.5~0.99 Ha	112	17.34	75.16	13.05	5.00	6.79
0.1~ 0.49Ha	32	57.18	78.75	6.25	7.50	7.50

A is plausible. Over all, 'the positive sign' implies that the probability of the pig farmers to adopt sale, feed or discard as pig manure management relative to the 'reference group' increases as these explanatory variables increase.

Table 3: Estimates of Multinomial Regression Analysis

Sale	Feed	Discard
Medium-scale dummy(herd size: 45-199)	10.95 (4.00)***	3.21 (1.24)	5.71 (1.94)*
Large-scale dummy(herd size:>200)	26.86 (6.56)***	2.96 (0.76)	-2.48(5.30***)
Asset value per capita	0.16 (3.20)***	-0.10 (-2.09)**	-0.02 (-0.30)
Household size	0.98(1.15)	-1.77 (-2.18)**	0.61 (0.66)
Off farm Work	-0.06 (-1.17)	-0.04 (-0.76)	0.08 (1.42)
Farm size	-0.02 (-0.28)	-0.11(-2.12)**	-0.12(-2.01)**
Gender	4.25 (0.70)	-3.33 (-0.58)	7.11 (1.08)
Age	0.63 (0.74)	-0.55 (-0.69)	-1.00 (-1.09)
Age square	-0.01 (-0.89)	0.00 (0.63)	0.01 (1.16)
Education	-0.30 (-0.67)	-0.35 (-0.82)	0.71 (1.06)
No. of Labourer	2.36 (0.63)	3.49 (0.98)	-7.56 (-1.87)*
Distance from main road	-0.93 (-2.36) **	0.70 (1.87)*	0.69 (1.17)
Nearness to Fish pond area	-2.32 (-2.10) **	3.30 (3.16)***	2.46 (2.07)**
Constant	60.31 (1.76)*	26.37 (1.22)	26.68 (1.08)
Observations	300	300	300
Pseudo R^2	0.300		
Log likelihood	-2375.654		
Restricted log likelihood	-5014.412		
Chi-squared	504.31		
Significance level	0.0000		

Notes: z-statistics in parentheses. *po=0.1; **po=0.05; ***po=0.01

Distance from main road and nearness to fish pond are negative and significantly associated with sales of pig manure. Likewise Asset value per capita, Household size and farm size are negative and significantly associated with using pig manure as feed. Similarly, Large-scale dummy, farm size and number of labour are negative and significantly associated with discard as pig manure management. The negatively significant parameters mean that the probability of being classified in the three groups is lower relative to the probability of being placed in the reference group.

More interestingly, the estimation results seems a sort of response to the main question of this study: pig farm size has been shown to have a significant influence on pig manure handling. As shown in the first column ('sale') of the regression results describing the share of manure sold by the farmer, the estimated coefficients of medium-and large-scale pig producer dummies are both positive and statistically significant. The regression results shows that, compared to small-scale producers, medium-scale pig farmers increase the share of sale by about 11 percent, while large-scale pig farmers share increase by 27 percent in reference to self-use. Thus, unlike 'small-scale pig producer, larger-scale pig producers are more likely to sell pig manure. In fact, the former usually did not sell pig manure (Table 3). This result is as expected, since these big pig producers usually raise hundreds of pigs and their land endowment may not be sufficient for the large amounts of manure generated by their farms. Thus necessitating evolvement of other ways to manage the excess dung/manure generated by their farm. Since pig manure is valuable and has been known replace chemical fertilizer and improve soil structure in ways chemical fertilizer cannot – one method is selling the pig manure to other farmers or factories (to produce organic fertilizer). Another method adopted by these commercial producers is dumping pig manure. As shown in the last column of Table 3, the estimated coefficients of medium-and large-scale pig producer dummies are positive and negative respectively and are both statistically significant (rows 1 and 2). The estimation results show that compared to small-scale pig producers, the share of pig manure dumped by medium-scale pig producers increased by nearly 6 percent, while it reduced by about 2 percent for large-scale pig producers. However, as with the descriptive statistics, the largest producers were more likely to sell the manure than to dump it.

4. Conclusions

This study shows that pig production size significantly affects pig manure handling by pig farmers and hence, the rural environment. Compared to more traditional, small-holders, large-scale farmers, owing to land constraints, are less likely to use generated dung/manure on their fields and more likely to either sell the manure or discard it without treatment. Mechanisms to deal with the pollution caused by pig manure are presently non-existent in Nigeria, more demoralising is the fact that current efforts by government to boost production does not include waste management. Investment in technologies capable of neutralizing environmental hazards is typically way beyond the means of a rural/small-scale pig farmers. Therefore, one cost-saving way for commercial pig producers to deal with pig manure is to simply discard it, if they cannot find a willing buyer. Nigeria's pig industry will certainly continue to grow because of the different agricultural credit programmes by the present regime. Average per capita pork consumption is still below levels in other more developed climes; and not only is urban per-capita consumption well above rural per-capita consumption in Nigeria, but urban per capita consumption by wealthier households is well above consumption at lower levels of income. Thus, as incomes continue to grow and Nigeria's economy continues to transform, we can expect demand for lean pork to continue to grow. Moreover, due to scale efficiency, large farms would be far more efficient than smaller farms in terms of feed conversion, sow productivity, and overall mortality and disease control, with consequential drift towards increasing large-scale farm establishment. While this study gave an insight into how small holder pig farmers manage their manure and shows a clear correlation between size and use on fields, the implications for the environment are not entirely clear. For example, smaller holders' likelihood to use manure on their own farms or land is not synonymous to the fact that they are using it in a way that prevents any runoff. Researchers' fieldwork experience shows that none of the participants (pig farmers) actually tested the nutrient content of their manure nor estimated the nutrient demand of the crops they planned to grow. Hence, the field applications of pig manure was haphazard and without concern for potential soil nutrient build up or nutrient runoff. Tied to this, is that most manure was allowed to dry before being applied (or sold) and this likely means a high proportion of the liquid manure was allowed to runoff. This liquid itself can contain high levels of nitrogen and a significant amount of phosphorous as well, and if this liquid manure found its way into nearby waterways it can contribute significantly to environmental degradation. Apparently, cost of treating the manure could be an issue, as farmers may not be willing to carry additional costs. Experience has shown that the cost of treating the manure could be high, sometimes as much as 15 percent of total production costs, and these costs reduce the overall competitiveness of this farming sector. Thus, while environmental policies that encourage greater manure treatment and focus on the very large operations may be reducing the untreated manure effluent from these operations, they might also be discouraging further expansion of this segment of the swine industry and thus encouraging more small-scale production where manure management is less regulated.

References

[1]Ameniya, T. (1981). Qualitative response models: a survey. *Journal of Economics Literature* XIX (Dec.):1483-1536

[2]Babcock, B.A., Chaherli, N.M. and Lakshminariayam, P.G. (1995). Programme participation and farm-level adoption of conservation tillage: estimates from a multinomial logit model. *Working paper 95-WP 136*, Centre for Agricultural and Rural Development, Iowa State University, Ames, Iowa.

[3]Bakare, M. (2007). Pig farm with a difference. The news: 28 (13): 67-69.

[4]Basant, R. (1997). Technology strategies of large enterprise in Indian industry: some explorations. *World Development* 25.10: 1683-1700.

[5]Bruno, T., Christianson, L. and Zhang, Y. (2008). Pig manure could be fuel of the future. (http://www.redorbit.com/news/science/1429738/pig manure_could_be_fuel_of_the_future/i..)

[6]Gerd', de L. and Tondeur, W. (2001). Crucial role for training in manure management. Pig progress, 17 (16): 20-22.

[7]Greene, W.H. 1993. *Econometric analysis*. London:Macmillan.

[8]Huang, S., Zhang, W., Yu, X. and Huang, Q. (2010), "Effects of long-term fertilization on corn productivity and its sustainability in an Ultisol of southern China", Agriculture, Ecosystems and Environment, Vol. 138 Nos 1-2, pp. 44-50

*[9]*Hill, M.A. (1983). Female labour force participation in developing and developed countries: consideration of the informal sector. *Review of Economics and Statistics* 63.3: 459-468.

[10]Judge, G., Hill, R., Griffiths, W., Lutkepohl, H. and Lee, T. (1988), Introduction to the Theory and Practice of Econometrics, 2nd ed., Wiley, New York, NY.

[11]Kimhi. A (1994). Quasi maximum likelihood estimation of multivariate probit models:

farm couple labour participation. *American Journal of Agricultural Economics* 76.4: 828-835.

[12]Liu, E., Yan, C., Mei, X., He, W., Bing, S., Ding, L., Liu, Q., Liu, S. and Fan, T. (2010), "Long-term effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China", Geoderma, Vol. 158 Nos 3-4, pp. 173-180.

[13]Maddala G.S. 1983. *Limited dependent and qualitative variables in econometrics.*Cambridge University Press, Cambridge.

[14]Nkamleu, G.B. and Coulibaly, O. 2000. Les determinants du choix des methods de luttees contre les pestes dans les plantations de cacao et café du sud- Cameroun. *Revue Economie Rurale No.259* Sept.- Oct. 2000

[15]Okoli, I. C., Alachie, D. A., Okoli, C. G., Akano, E. C.,Ogundu, U. E., Akujobi, C. T., Onyicha, I. D., and Chinweze, C. E. (2006). Aerial pollutant gases concentrations in tropical pig pen environment in Nigeria. Nature and Science. 4(4): 1-5.

[16]Oseghale, C. (2010). Community at war with bank manager, wife, over stench from piggery. Saturday Punch, June 5, 2010. p.12.

[17]Rahji, M.Y., Fakayode, S.B. and Sanni, G.K. 2008. A Multinomial logit analysis of agricultural credit rationing by deposit money banks in Nigeria: a case study of Oyo State, South-west Nigeria. *Economic and Financial Review* 46.2: 55-82

[18]Spence, C., Whitehead, T. and Cotta, M. (2008). Treating hog manure with borax, cuts odour. World Vet. Assoc., USA-ARS.

[19]State News (2007). Spontaneous combustion of manure starts 200-acre blaze.

[20]Weiming Huang, Fangbin Qiao, Huaiju Liu, Xiangping Jia, Bryan Lohmar, (2016) "From backyard to commercial pig production: Does it lead to a better or worse rural environment?", *Nigeria Agricultural Economic Review*, Vol. 8 Issue: 1, pp.22-36, https://doi.org/10.1108/CAER-10-2014-0100

[21]Zellner, A. (1962), "An efficient method of estimating seemingly unrelated regression equations and test for aggregation bias", Journal of American Statistical Association, Vol. 57 No. 298, pp. 348-368.

[22]Zepeda, L. 1990. Adoption of capital versus management intensive technologies. *Canadian Journal of Agricultural Economics* 38: 457-469.

5/23/2021