*International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs)*
*Available online on: http://ijasrt.iau-shoushtar.ac.ir*
*ISSN: 2251-7588 Print*
*ISSN: 2251-7596 Online*
*2016: 6(1):21-27*

*Received: 6 May 2016*
*Reviewed: 10 November 2016*
*Revised: 21 November 2016*
*Accepted: 25 December 2016*

# Analysis of Livestock Waste Management Practices among Rural Farmers in Abia State

**Iheke, Onwuchekwa Raphael**
*Department of Agricultural Economics Michael Okpara University of Agriculture, Umudike PMB 7267, Umuahia, Abia State, Nigeria, Email: ralphiheke@gmail.com*

**Abstract**

The purpose of his study was the analysis of livestock waste management practices among rural farmers in Abia State, Nigeria. A multi-stage sampling procedure was employed to select the 60 respondents for the study. Primary data used the study were collected using well-structured questionnaire. Descriptive statistical tools such as frequency, percentages, means and multinomial logit regression were used in data analysis. Result showed that the mean age of the livestock farmers was 34.3 years and the average household size was 6 persons per household. The average years of educational attainment was 9 years. The average distance to livestock farm from residential dwelling was 0.4km. The average number of livestock reared was 111, while the average monthly expenditure on water was ₦1470.80. The average cost of waste management per month was ₦2195.80 and the average monthly net return from the livestock business was ₦27400. The significant determinants of use of waste management systems were distance from livestock farms to residential quarters, number of livestock reared, frequency of visitation of livestock sanitation officers, number of farm labour, and the quantity of faecal material generated. The major benefits from livestock waste management were environmental sustainability, reduced cost of fertilizer, increased in income, reduced cost of agrochemicals, reduced incidence of pests, increased productivity, and biogas production. Strict enforcement by supervisory agencies of the existing sanitation/health policies aimed at environmental preservation and protection was recommended so as to ensure environmental sustainability.

**Keywords**: Livestock, Waste, Management, Practices

## 1. Introduction

Livestock - as part of global ecological and food production systems - are a key commodity for human well-being. Their importance in the provisioning of food, incomes, employment, nutrients and risk insurance to mankind is widely recognized (Herrero *et al.*, 2009). In contrast, the interactions of livestock with its environment are complex and depend on location and management practices. A serious concern facing many livestock producers is the selection of a waste handling system that best fits their specific situation. The goal of animal waste management is to make best use of the nutrients in manure while protecting natural resources.When managed properly, manure can be a valuable resource on a farm. It can be a source of nutrients for crop production and can improve soil quality. However, if there is insufficient land to use the amount of manure that is produced or if manure is mismanaged, then risks to water supplies and the environment could result.

Most traditional livestock production systems are resource driven, making use of locally available resources with limited alternative uses.All over the world, Nigeria inclusive have different ways of managing livestock waste. Some use the waste as manures for soil, for energy or for some other purposes (Hegg*et al.,* 1987). Livestock waste

management helps maintain a healthy environment for farm animals and can reduce the need for commercial fertilizers while providing other nutrients needed for crop production. Livestock wastes include manure, bedding and litter, waste water, feedlot runoff and even wasted feed (Ajayi, 2008). Livestock wastes abound when too much waste is produced by farm animals in a particular environment with no safe or cost-effective means to either use the wastes productively or dispose of overtime. These wastes can affect the air or water quality if proper practices are not followed. Waste from livestock concentrations which are not protected can wash into nearby streams (David, 1993).

Environmental pollution and conflicts with neighbours result from improper waste management and disposal. Yang *et al.*(2011) noted that improper waste disposal directly or indirectly impact on water, air, soil, environmental sanitation and human health. Pang *et al.*(2010); Shi (2012); and Lin and Duan(2013) observed that lack of consideration of the siting of farms and environmental pollution make livestock waste to become one of the important pollution source to people, living areas, water source, protection areas, rivers, lakes and air.

Livestock wastes can be used to enhance food security mainly through their use as bio-fertilizer and soil amendment, use as animal feed, and energy production. They contain large amounts of organic matter, and many of them can be directly added to the soil without any risk. Turning these livestock wastes (animal manures) into organic fertilizers (through composting) is one of the waste treatment technologies that make it possible to use organic waste as a fertilizer even in populated areas. Technology plays a key role in soil fertility improvement, and hence crop productivity (Hargreaves *et al.,* 2008). As noted by Brouwer and Powell (1988), the use of organic fertilizers is particularly important in most parts of Africa, where low availability of nutrients is a serious constraint for crop production.

Onibokun (1999) noted that waste utilization for agriculture including poultry waste is not a new phenomenon in Africa but a traditional method of providing nutrients for crops, enhancing soil quality and creating livelihood for farmers. The utilization of waste for rural agriculture has recently become an important phenomenon in developmental research due to its role in curbing rural food and unemployment problems for the growing urban population. According to Cofie*et al.* (2006), integrated waste management (IWM) relies on a number of approaches to manage waste, including all aspects of waste management, from generation to disposal and all stages in between with proper consideration of technical, cultural, social, economic and environmental factors, has evolved over time and is slowly becoming accepted by decision makers.

Although there are many benefits from livestock waste use in crop production, the diffusion of livestock waste into the environment can cause severe natural resource degradation (Walter *et al.,* 1992). According to USDA (1992), the components of manure which have the most adverse impact upon the environment are organic matter, nutrients, and feacal bacteria. Oxygen is required for the microbial degradation of organic matter in surface waters receiving runoff containing animal waste. Numerous studies have been conducted which document the adverse effects of animal waste contributions to non-point source pollution from various agricultural activities (Younos*et al.,* 1998; Khaleel*et al.*, 1980; Edwards *et al.,* 1997a; Edwards *et al.,* 1997b; Patni *et al.,* 1985).

Improperly managed animal waste can have severe consequences for the environment such as odor problems, attraction of rodents, insects and other pests, release of animal pathogens, groundwater contamination, surface water runoff, deterioration of biological structure of the earth and catastrophic spills (Sakar *et al.*, 2009).Grant and Marshalleck (2008) noted that water pollution resulting from waste contamination often leads to protests from the local people, especially due to the skin disease as itchy skin after using the polluted river water, as well as the unpleasant smell

Proper waste management is pivotal to ensuring environmental and health quality, avoiding societal conflicts, and boosting agricultural production. This study therefore analyzed the livestock waste management practices among rural farmers in Abia State, Nigeria. Specifically, the study examined the types and quantities of livestock wastes being generated per month by the farmers, analyzed determinant of use of livestock waste management system by the farmers, and examined the benefits of the different methods of livestock waste management system adopted by the farmers.

## 2. Materials and Methods

The study was conducted in Abia State of Nigeria. Abia State, with Umuahia as Capital, was created on 27$^{th}$August, 1991 out of the old Imo State. It is one of the five states in the Southeast geo-political zone of Nigeria. It has a land mass of 700 square km. Abia State is bounded on the east by the Cross River and AkwaIbom States, on the north by Ebonyi and Enugu States, on the West by Imo State and on the South by Rivers State. The state lies between longitudes 7$^{o}$ 23$^{'}$ and 8$^{0}$ 02$^{'}$ East of

Greenwich meridian and latitudes 5° 49′ and 6° 12′ North of the equator.

The population of Abia State 1,913,917 persons made up of 933,030 males and 971,878 females (NPC, 2006). With estimated annual population growth rate of 2.0 per cent, the present population is about 2,368574 consisting of 1,160,141 males and 1,208,433 females. This population consists of people in all walks of life with about 65 percent of their engagement in agriculture (ASPC, 2008). The annual rainfall ranges from 200-250mm while the temperature ranges from $22^0$C to $35^0$C.

Abia State has 17 Local Government Areas (LGA), grouped into three Agricultural Zones namely, Aba, Umuahia, and OhafiaZones. Agriculture occupies the prime position, not only because of the industry of the people but also because of the widespread existence of rich soil in most parts of the state, that supports the growth of the crops: yam, cassava, cocoyam, melon, maize, oil palm, garden egg, cocoa, to mention but a few. Poultry, goat, pigs and sheep are the major livestock kept.

The population of this study consists of all rural framers involves in livestock rearing in Abia State. A multi-stage sampling procedure was employed to select the respondents for the study. In the first stage, all the three (3) agricultural zones in the state were purposively selected namely Aba, Umuahia, and Ohafia zone. In the second stage 2 local government areas were purposively selected from each Zone based on the preponderance of livestock. In the third stage, assistance of extension officers were employed to help identify the livestock farmers in each LGA and select ten (10) livestock farmers randomlyselected from the list derived. This gives a total of 60 respondents for the study.

Primary data used for the study were collected using well-structured questionnaire designed to elicit the information on the socio-economic characteristics of the livestock farmers, types and quantities of livestock wastes generated per month by the farmers, the waste management practices adopted by the farmers, the benefits of livestock waste management adopted by the farmers, and other farm production data such as quantities and prices of inputs and output.

Descriptive and inferential statistical tools were used in the analysis of data such as use of frequency distribution tables, percentages, means, and regression analysis. Analysis of the determinants of use of livestock waste management system was done using multinomial logit model. The model is expressed explicitly as;

$$\text{Logit}\ (Y_{ijk}) = \alpha + \beta_1 X_1 + \ldots\ldots\ldots + \beta_{12} X_{12} + e_i \quad (1)$$

Where: Y = the probability that a selected farmer uses a particular wastes management system derived as the ratio of number of waste management syytems used by the ith farmer to the total number of waste management systems identified in the study area, $\alpha$ = the constant, $\beta i$ =the predictor variable coefficient, $X_1$-$X_{10}$ = the observed predictor variable values, that is, the independent (explanatory) variables, $X_1$ = Distance from livestock farm to residential households (km), $X_2$ = Number of livestock animal reared (Units), $X_3$ = Frequency of visit of livestock sanitation officials per month (number of visits per month), $X_4$ = Age of livestock farm manager (Years), $X_5$ = Quantities of water used (litres), $X_6$ = labour (Family and Hired) (Man-day), $X_7$ = Farming experience of the farm manager (years), $X_8$ = Quantity of faecal materials generated (Kg), $X_9$ = Number of dead animals (numbers), $X_{10}$ = Frequency of waste clearance per month(number of visits per month), $e_i$ = Random (stochastic) factors external to the model.

## 3. Results and Discussion

### 3.1 Summary statistic of major socio-economic and waste related variables

Major socio-economic characteristics of the respondents and waste related variables is presented in Table 1.

Table 1 showed that the youngest and oldest livestock farmers were aged 16 and 62 years respectively. The mean age of the livestock farmers was 34.3 years. The result implies that there were wide variations in the ages of the farmers. The average household size according to Table 1 was 6 persons per households. This is desirable and of great importance in farm production as rural household may rely more on their members than hired workers for labour on their farms. This corroborate with the findings ofNwaru (2004), Iheke (2010) and Iheke *et al.* (2013) that larger household size implies more farm hands and this is so if members are not made up of the aged and very young people, otherwise scare capital resources that should have been employed for farm production would be channeled for upkeep of these dependent members.

The educational distribution ranges from those who did not acquire formal education to those who attended tertiary education. The average years of educational attainment was 9 years. This hold positive implications for improved farm productivity and waste management. It has been noted that the level of education of a farmer not only increases his farm productivity but also enhances his ability to understand and evaluate new production and management techniques (Obasi, 1991; Iheke, 2006; Iheke *et al.,* 2013; and Nwaru and Iheke, 2015).

Similarly, Imburr *et al.* (2008), noted that higher level of educational attainment implies that the farmers are better positioned to take advantage of new techniques and innovations that could improve agricultural productivity and boost food production. Higher education level brings about positive changes in the knowledge, attitude and skills through research and extension.

Experience of the respondents in farming ranged from 1 to 24 years, with the mean farming experience being about 8 years. this result implies that the farmers were reasonably experienced and this should impact positively on their performance. According to Nwaru (2004), the number of years a farmer has spent in farming business may give an indication of the practical knowledge he has acquired on how he can overcome certain inherent farm production problems, including waste management.

The average distance to livestock farm from residential dwelling was 0.4km. The farther away the farm is from residential dwelling the less the conflict with neighbours. Proper waste management is ensured when livestock farms are close to people's houses to reduce conflicts resulting from environmental pollutions especially offensive odour.

The average number of livestock reared was 111, with the minimum and maximum being 24 and 950 respectively.The average monthly expenditure on water was ₦1470.80 while the average waste generated per month was 393.3 kg. The average number of death of livestock recorded was 4. The average frequency of waste clearance per month was 5 times, while the average cost of labour per month was ₦7353.30. The average cost of waste management per month was ₦2195.80 and the average monthly returns from the livestock business was ₦27400.It is expected that the greater the number of livestock kept, the greater would be the amount of waste generated and hence the need for efficient management of the waste. This would equally increase the cost of labour and waste management.

**3.2 Determinants of Use of Livestock Waste Management System**

The estimated determinants of use of livestock waste management system is presented in Table 2. The coefficient of multiple determination was 0.7527 which implies that 72.27% of the variation in the use of waste management system was explained by the variables included in the model. The likelihood ratio chi square was significant at 1% level of significance indicating the goodness-of-fit of the model.

The coefficient of distance of livestock farms to residential household was significant at 5% and negatively related to use of waste management system. This implies that the shorter the distance of livestock farm to residential households, the higher the use of waste management systems. Quick and frequent disposal of waste is crucial to avoid environmental problems and conflict between the farmers and households hence, the increased use of waste management systems. Akanni and Benson (2010) obtained similar result and noted that the proximity of many farms to residential households has often raised a lot of concerns on human and the environment. On many occasions, residents living within 1 km distance of the farms complain of restiveness, malaria, sneezing and/or nausea. Cases of cholera outbreak, reptiles' (mostly snakes) and wild animals' attack are also common. All these have severe implications on the productivity of the victims of the attack and by extension, the national economy. They conclude that distance between the farmer's residential households was significant determinant of waste management use.

The coefficient of number of livestock reared was significant at 1% and positively related to use of waste management systems. This implies that the higher the number of animals reared the higher the waste management system used. Large stock size implies large waste generated and hence the need for waste management systems.

Frequency of visitation of livestock sanitation officers was significant at 1% and positively related to use of waste management systems. This implies that increase in the number of times sanitation officers visit the farm will lead to increase in the use of waste management system and vice versa. Visit by sanitation officer is very vital to improve use of waste management systems.

Number of farm Labour was significant at 5% and positively related to the use of livestock waste management. This implies that unit increase in number of farm labour causes an increase in the use of livestock waste management. This conforms to a priori expectation. The coefficient of the quantity of faecal material generated is significant at 1% and positively related to the use of waste management system. This implies that as the quantity of faecal material generated increases, the use of livestock waste management system also increases. This position was corroborated by Grant and Marshalleck(2008). The coefficient of frequency of waste clearance was significant at 10%. This shows that use of waste management system increase as the frequency of waste clearance increase and vice versa

**3.3 Benefits of Livestock Waste Management**

The frequency distribution of the respondents according to benefits of the different methods of livestock waste management system

adopted by the farmers is presented in Table 3. Majority (73.33%) of the respondent reported environmental sustainability as major benefit of livestock waste management system. Reduce cost of fertilizer (55%) ranked second it was followed by increase in personal income. The least benefit rank was biogas production which accounted for 8.33% of total respondent.

Table 1. Summary statistics of major variables

| Variables | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| Age | 34.3 | 12.8 | 16 | 62 |
| Household size | 6 | 3 | 1 | 12 |
| Education | 9 | 5 | 0 | 16 |
| Experience | 7.8 | 4.5 | 1 | 24 |
| Distance | .4 | 0.1 | 0 | 1.5 |
| Number of animals reared | 110.8 | 58.3 | 24 | 950 |
| Water cost | 1470.8 | 775.7 | 450 | 3450 |
| Feacal quantity | 393.3 | 196.6 | 100 | 980 |
| Number of dead animals | 3.7 | 2.2 | 0 | 12 |
| Frequency of waste clearance | 5.8 | 2.660445 | 1 | 12 |
| Labour cost | 7353.3 | 11190.3 | 1200 | 90000 |
| Waste management cost | 2195.8 | 1078.1 | 800 | 4800 |
| Returns | 27400 | 14562.8 | 10000 | 70000 |

Source: Survey data, 2015

Table 2. Determinants of use of livestock waste management systems

| Variables | Coefficient | Standard error | z-value |
|---|---|---|---|
| Intercept | 3.865 | 1.002 | 3.86*** |
| Distance of Livestock farm to residential household ($X_1$) | -1.943 | 0.0905 | -2.15** |
| Number of Livestock animal Reared($X_2$) | 0.005 | 0.001 | 3.89*** |
| Frequency of visitation of livestock sanitation officers ($X_3$) | 0.161 | 0.049 | 3.28*** |
| Age of livestock farm manger ($X_4$) | -0.012 | 0.048 | 0.26 |
| Quantity of water used ($X_5$) | 0.136 | 0.238 | 0.57 |
| Number of farm labour ($X_6$) | 0.061 | 0.025 | 2.45** |
| Farming experience ($X_7$) | -0.003 | 0.002 | -1.16 |
| Quantity of faecal material ($X_8$) | 0.050 | 0.014 | 3.67*** |
| Number of dead animals ($X_9$) | 0.019 | 0.077 | 0.41 |
| Frequency of waste clearance($X_{10}$) | 0.000 | 0.000 | 1.80* |
| $R^2$ | 0.7527 | | |
| Likelihood ratio $\chi^2$ | 37.71*** | | |

*** Significant at 1%, ** Significant at 5%,* Significant at 10%

Table 3: Benefits of livestock waste management

| Benefit | Frequency*** | Percentage | Ranking |
|---|---|---|---|
| Environmental sustainability | 44 | 73.33 | 1st |
| Reduce cost of fertilizer | 33 | 55.00 | 2nd |
| Increase personal income | 22 | 36.67 | 3rd |
| Reduce cost of agrochemicals | 16 | 26.67 | 4th |
| Reduce incidence of pests | 15 | 25.00 | 5th |
| Increase productivity | 14 | 23.33 | 6th |
| Biogas production | 5 | 8.33 | 7th |

Source: Field survey (2015) *** Multiple Responses recorded

## 4. Conclusion and Recommendations

The major benefit of waste management is ensuring environmental sustainability and that quick and frequent disposal of waste is crucial to avoid environmental sanitation problems and conflict between the farmers and households. Hence, the increased use of waste management systems. Since, the distance of livestock farms from the residential

areas, frequency of visits by sanitation officials and frequency of clearance of livestock wastes were some of the significant determinants of livestock waste management, this study therefore, recommend strict enforcement by supervisory agencies of the existing sanitation/health policies aimed at environmental preservation and protection, especially the location of livestock farms at least 1km away from residential areas.

**References**

1. Ajayi, F. F. (2008). Solid Waste Management Problem and its Implication on Health. Environmental Management, 11: 34 – 38.

2. Akanni, K. A. and Benson, O. B. (2010). Poultry Wastes Management Strategies and Environmental Implications on Human Health in Ogun State of Nigeria. Advances in Economics and Business 2(4): 164-171.

3. Brouwer, J. and Powell, J. M. (1998). Increasing nutrient use efficiency in West African agriculture: The impact of micro-topography on nutrient leaching from cattle and sheep manure. Agriculture, Ecosystems and Environment, 71: 229 - 239.

4. Cofie, O. O., Agbottah, S., Strauss, M., Esseku, H., Montangero, A., Awuah, E. and Kone, D. (2006). Solid liquid separation of faecal sludge using drying beds in Ghana: Implications for nutrient recycling in urban agriculture. Water Research, 40: 75-82.

5. David, D. (1993). Waste Disposal Methods in Agricultural Industries. 3rd Ed. Academic Press Inc., Florida pp. 17 – 21.

6. Edwards, D. R., Coyne, M. S., Daniel, T. C.,Vendrell, P. F., Murdoch, J. F., and Moore, Jr. P. A. (1997a). Indicator bacteria concentrations of two northwest Arkansas streams in relation to flow and season. Transactions of the ASAE, 40(1): 103-109.

7. Edwards, D. R., Coyne, M. S., Daniel, T. C., Vendrell, P. F., Murdoch, J. F., and Moore, Jr. P. A. (1997b). Fecal coli form and streptococcus concentrations in runoff from grazed pastures in northwest Arkansas. Journal of the American Water Resources Association, 33(2):413-422.

8. Grant, S and Marshalleck. A. (2008). Energy Production and Pollution mitigation from broilers houses on poultry farm in Jamaica and Pennsylvania. International Journal for Service Learning in Engineering, 3(1): 41-42.

9. Hargreaves, J. C., Adl, M. S. and Warman. P. R. (2008). A review of the use of composted municipal solid waste in agriculture. Agriculture, Ecosystems and Environment, 123(1-3): 1 – 14.

10. Hegg, D.A., Radke, L. F., Hobbs, P. V., Brock, C. A. and Riggan, P. J. (1987). Nitrogen and Sulphur emissions from the burning of forest products near large urban areas. Journal of Geophysical Research, 92: 14701 - 14709.

11. Herrero, M., Thornton, P. K., Gerber, P. and Reid, R. S. (2009). Livestock, livelihoods and the environment: understanding the trade-offs. Current Opinion in Environmental Sustainability 1(2): 111–120.

12. Iheke, O. R. (2006). Gender and Resource use Efficiency in Rice Production System in Abia State, Nigeria. M.sc Thesis. Department of Agricultural Economics, Michael Okpara University of Agriculture Umudike, Nigeria.

13. Iheke, O. R. (2010). Impact of Migrant Remittances on Efficiency and Welfare of Rural Smallholder Arable Crop Farm Households in South Eastern Nigeria. PhD Dissertation. Michael Okpara University of Agriculture, Umudike, Nigeria.

14. Iheke, O. R., Nwaru, J. C., and Onyenweaku, C. E. (2013). The Impact of Migrant Remittances on the Technical Efficiency of Arable Crop Farm Households in South Eastern Nigeria. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

15. Imbur E. N, Agwu, A. E and Akinnagbe, O. M.(2008). Adoption of Citrus Production Technology Amoung Farmers in Kastina-Ala Local Government Area, Benue State; Nigeria in Journal of Agriculture Extension: A Publication of Agricultural Extension Society of Nigeria (AESON) Vol.11: 2008.

16. Khaleel, R., Reddy, K. R. and Overcash, M. R.(1980). Transport of potential pollutants in runoff water from land areas receiving animal wastes: a review. Water Research. 14(4):421-436.

17. Lin C. and Duan, . (2013). Biogas technology in the large scale application of piggery wastewater treatment. Swine Industry Science. 10: 42-43.

18. Nigerian Population Commission (NPC) (2006). 2006 Nigerian Census Figures. Nigerian Population Commission, Abuja.

19. Nwaru, J. C. (2004). Rural Credit Market and Arable Crop Production in Imo State of Nigeria. PhD Dissertation Michael Okpara University of Agriculture Umudike, Nigeria.

20. Nwaru, J. C. and Iheke, O. R. (2015) Factors influencing the decision to migrate among rural smallholder arable crop farm households in South eastern Nigeria, AMSE JOURNALS -2015 - Series: Modelling D, 36 (1): 62-76

21. Obasi, P. C. (1991). Resource Use Efficiency in Food Crop Production: A Case Study of the Owerri Agricultural Zone of Imo State, Nigeria .M.Sc Thesis, University of Ibadan, Ibadan, Nigeria.

22. Onibokun, A.G. (1999). Managing the Monster: Urban Waste and Governance in Africa.

International Development Research Centre Ottawa, Canada.

23. Pang, Y., Wenyang, Z. and Yan, W. (2010). The effective ways to solve the point source pollution of non-intensive livestock production waste. Animal Husbandry & Veterinary Medicine, 42( 6): 97-99

24. Patni, N. K., Toxopeus, H. R. and Jui, P. Y.(1985). Bacterial quality of runoff from manured and non-manured cropland. Transactions of ASAE 28(6):1871-1877.

25. Sakar, S., Yetilmezsoy, S.andKocak, E. (2009). Anaerobicdigestion technology in poultry and livestock waste treatment— a literature review. Waste Management and Research,27(1): 3-18.

26. Shi, X. (2012). Considerations on Becoming Resources of Agricultural Discard in China.Journal of Jilin Agricultural Sciences, 6: 75-78.

27. United States Department of Agriculture (USDA) (1992). Agricultural Waste Management Field Handbook. USDA

28. Walter, M. F., Payne, V. W. E. and Powers, T. (1992). Agricultural waste characteristics. In Agricultural waste management field handbook. Chapter 4. 23pp. United States Department of Agriculture.

29. Yang, L., Shenfu, Z andXin, P. (2011). The countermeasures of mountain pig scale breeding waste treatment. Heilongjiang Animal Science and Veterinary Medicine. Vol (2): 29-31.

30. Younos, T. M., Mendez, A. Collins, E. R. and Ross, B. B. (1998). The impact of a dairy loafing lot on stream water quality. Journal of the American Water Resources Association 34(5): 1061-1069.