

Manure Management Risks and Ownership of Peri-Urban Poultry Enterprises in Western Kenya

Nyende Kefa Osolo¹, Wakhungu Jacob Wanambacha², John Obiri³

¹Department of Agriculture and Veterinary Sciences, Kibabii University, P.O. Box 1699- 50200 Bungoma, Kenya

²Centre for Disaster Management and Humanitarian Assistance, Masinde Muliro University for Science and Technology
P. O. Box 190- 50100 Kakamega, Kenya

³Department of Disaster Management and Sustainable Development, Masinde Muliro University for Science and Technology
P. O. Box 190- 50100 Kakamega, Kenya

Abstract: *Ownership profile and management practices of peri-urban poultry units in four urban centres in Kenya; namely Bungoma, Eldoret, Kakamega and Kisumu were evaluated. Questionnaire surveys and interviews were used among 475 farmers selected through snowball sampling. More women were reported to own peri-urban poultry than were men although most decisions were made through consultation at family level. Poultry and manure handling practices were found to be poor and varying across municipalities. There was no significant difference across the municipalities with respect to the way farmers kept poultry feeds ($\chi^2_{9, 0.616} = 7.2$). Farmers kept poultry feeds either in residential houses, poultry houses, dedicated stores or given to the birds directly regardless of the municipality. Garden crops varied but most of the peri-urban poultry keepers grew leafy vegetables ($\chi^2_{18, 0.001} = 33.58$). The study recommends that poultry farmers should use designated feed stores to avoid feed contamination and environmental pollution by feeds; Poultry manure should be stored under shade for at least three months; Transport of poultry manure should be in closed containers to avoid contamination of transit routes; Crops applied with poultry manure should be harvested after sufficient waiting time or properly cooked to control spread of diseases.*

Keywords: Manure, management, poultry, ownership, pollution

1. Introduction

Besides the desired plant nutrients in manure, undesired pollutants, including pathogenic organisms, antibiotic resistant bacteria and organic pollutants such as pharmaceutical residues and hormones may be present in manure in varied proportions [16]. Most intensive poultry keepers in Kenya were located in urban and sub-urban areas with inadequate space to utilize all the manures for soil amendment; necessitating its long storage and/or transportation to distant farmlands for use as fertilizer, cattle feed and bio-fuel[7].

High concentrations of intensive poultry farms worldwide tend to be located near urban centres where access to market was guaranteed[7]. Western Kenya hosts 15 out of 69 most rapidly growing urban centres with more than 10,000 inhabitants (KNBS, 2010). Hazards associated with manure from peri-urban poultry farming in Western Kenya have not been assessed and documented, leaving room for lack of dependable basis of formulating any measures to prevent disasters which could arise from any hazards in the manures.

This study was intended to assess and document the extent of peri-urban poultry farming and management practices that contribute to environmental and health hazards. The study was conducted in four municipalities in Western Kenya namely, Kisumu, Kakamega, Eldoret and Bungoma.

The study had two specific objectives with regard to intensive poultry farming in peri-urban areas in Western Kenya, namely:

- 1) To assess the socio-demographic profile of the intensive poultry farmers and
- 2) To examine handling practices of poultry and manure that have implication on environmental pollution;

2. Literature Review

Globally, human population is growing rapidly and is expected to increase from more than 6.5 billion to nearly 9.2 billion by 2050 [21]. Farmers will continue to specialize and apply concentrated animal feeding operations (CAFO) in order to produce food for the multitudes [5]. Since the 1960s, the global production of poultry meat has been growing faster than that of any other meat in both developed and developing countries [3].

In Kenya, urban demand for all animal products grows, and it should be possible for the sub-sector to expand poultry numbers sufficiently to keep pace with this demand [22]. According to Poultry Sector Updates of September 2010 it was estimated that Kenya had about 32 million poultry of which 23% were hybrid chickens reared under intensive systems [9]. The more intensive, commercial egg and broiler production systems were better suited to, or indeed restricted to, peri-urban locations [22].

Profile of enterprise ownership with regard to gender and education levels informs variation in decision making and management trends. A report by FAO [6] suggested that when production becomes more profitable and the poultry enterprise is scaled up, the main and frequent consequence of this is that the control over decisions and income, and sometimes of the entire poultry enterprise, often shifts to

men. Other studies showed that an increase in the educational level (that is, more formal education acquired), will decrease the probability of the farmers defaulting in loan repayment[14]. In Nigeria, studies showed that an increase in educational status increased the likelihood of being technically and allocatively efficient amongst poultry egg farmers in Ogun State[1].

Good manure management starts with recognizing and understanding the value of manure as a resource that contains nutrients for crop production as well as the potential negative impacts manure can have on air, water, and soil[13]. Manure can be beneficial as a rich source of soil nutrients (Nitrogen and Phosphorous); it can be used in fuel (biogas, char, oils, dry burning) as well as animal and fish feed production. In the future, livestock production will increasingly be affected by competition for natural resources, particularly land and water, competition between food and feed and by the need to operate in a carbon-constrained economy[19].

Good practices in small scale Poultry production embraces bio-security measures including all activities related to disease management such as housing, feeding, marketing and breeding[7]. Biosecurity is essentially, the application of 'informed common sense'; it is the application of management practices that reduce the opportunities for infectious agents to gain access to, or spread within, a food animal production unit[20]. Improper handling and storage of poultry manure has been reported to result in loss of fertilizer nutrients; contamination of surface and /or ground water; potential for spread of poultry diseases; and odour and aesthetic problems [17].

3. Materials and Methods

3.1 Study Site

This study was conducted among poultry farms in four purposively selected urban centres of Bungoma, Eldoret, Kakamega, and Kisumu all in western Kenya (Figure 3.1). Western Kenya is the region bordering Uganda to the West and Tanzania to the South, comprising of former Nyanza and Western provinces as well as the Western highlands extending to Kericho, Nandi hills, Eldoret and Kitale in the North Rift [23].

The region lies between latitude 10 8' N and 10 24' S and between longitude 340 and 350 E. The altitude ranges between 1000 to 1600 metres. The region hosts 9.7 million persons, which is about 25% of Kenya's population as per the Population Census Survey of 2009[10]. The area is estimated to house about 933 broiler and 809 layer chicken farms accounting for about 5% of Kenya Commercial hybrid chicken farms [7].

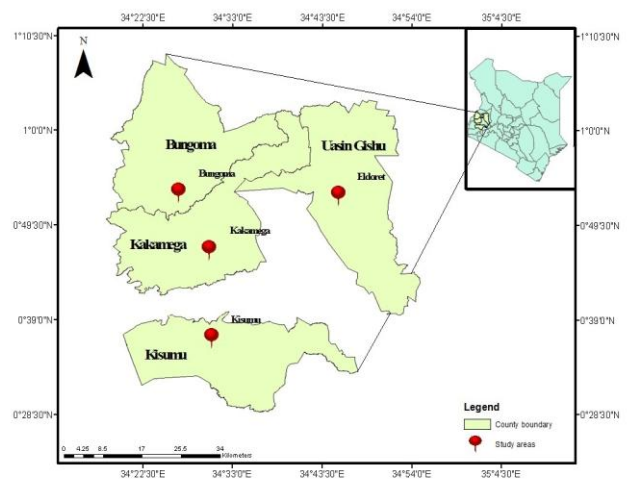


Figure 3.1: Map of Kenya showing the Study areas in Western Kenya.

Source: Researcher (2014)

3.2 Research Design

Cross-sectional Survey Design using questionnaires was used to gather data on farmers' profile, poultry manure and management practices amongst farmers. Questionnaire and interview were used to gather information on parameters such as gender of the farmer, level of education, feed storage, feed type, floor manure management, manure storage and disposal, interval between manure application and harvesting of crops.

3.3 Sampling Strategy

Purposive and snowball sampling were used to select key informants who were used to help identify poultry farmers were Agro-vet stockists, traders dealing with eggs and chickens, hoteliers and extension workers in the Ministry of Livestock Development. The identified poultry keepers were then interviewed using structured questionnaires to answer on variable listed in section 3.2 above. Snowball sampling was applied by identifying more farmers through those already interviewed. The minimum sample size was calculated by the formula shown in equation 1 below[11].

$$n = z^2 pq/d^2 \dots\dots\dots \text{Equation (1)}$$

Where:

n = the desired sample size (if the target population is greater than 10,000).

z = the standard normal deviate at the required confidence interval.

p = the proportion in the target population estimated to have characteristics being measured.

q = 1 – p.

d = the level of statistical significance set.

In our case we required accuracy at the level (**d**), of 0.05. In a large population the proportion of target population assumed to have the characteristics of interest is 50%. This means **p=q=0.5**. **z** value obtained from tables at 95% confidence level was 1.96.

Therefore, the minimum required sample size was,

$$n = \frac{(1.96)^2(0.05)(0.05)}{(0.05)^2} = 384.$$

During the study a total of 475 farmers were interviewed from the four municipalities. This was higher than the minimum number required and therefore exceeds the threshold required for representative sample size.

3.4 Primary Data Collection

Poultry farmers were identified through key informants such as the District livestock production officers, day-old chick sales outlets and chicken products traders. The farmers were interviewed using structured questionnaires and interviews to establish their manure handling practices. In addition to identifying the poultry farms, the livestock production officers were engaged in focused group discussions (FGD) to provide corroborating information on poultry and manure handling practices, awareness on laws and by-laws, and incidences of disease. The FGDs consisted of between 8 and 12 persons and held discussion for about two hours in strategic places (hotels) within the respective municipalities. Observation checklists were used to assess and record nature of poultry structures, manure condition for wetness and categorized as moist, dry and wet during questionnaire interviews.

3.5 Data Analysis and Presentation

Data was analyzed using Statistical Package for Social Sciences (SPSS) computer package. Descriptive statistical analysis was used to give the non-numerical and numerical summary of the data on the study population [2]. Descriptive statistical analyses were used to show frequency of distribution, percentile ranks, measures of central tendency and measures of dispersal of different poultry manure handling practices in the study area. These were summarized in tables, graphs and charts.

4. Results and discussions

4.1 Socio – Demographic Characteristics of Poultry farmers

The socio demographic characteristics of the peri-urban poultry farmers were considered to affect management practices in different ways. Gender of the farmer for example would affect poultry practices such as decision making on enterprise, access to credit, land and disposal sites. Level of education may influence the level of awareness/practices on pollution risks as well as regulations relating to peri-urban farming. Results of the survey are discussed in this section.

4.2 Gender of the Respondents

The respondents were asked to indicate their sex and the results were summarized in Figure 4.1. Majority of the respondents were female as compared to males in all the three municipalities except in Kisumu. However, this was significantly different ($\chi^2_{3, 0.05} = 12.183$) across

municipalities. The least number of female respondents was recorded in Kisumu, with Eldoret scoring the highest percentage of female farmers (Figure 4.1).

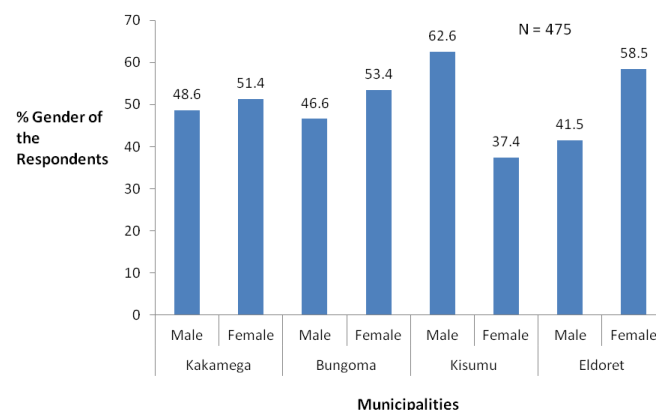


Figure 4.1: Gender of Peri-urban Poultry Farmers in Western Kenya

Focus Group Discussions (FGDs) revealed that decisions regarding peri-urban poultry farming in western Kenya were taken by men and women in equal measure. This was encouraging because it presented a scenario where women had been empowered. According to FAO, poultry enterprise provided rural women with a source of income for responding to immediate household needs and supplementing and/or complementing the family's protein intake and diet [6]. Peri-urban poultry farming therefore provided a catalyst for women empowerment in Western Kenya. Peri-urban poultry keeping is therefore likely to continue in western Kenya and therefore it's accompanying offloading of manure to the crowded neighborhoods.



Plate 4.1 A Focus Group Discussion session in Kakamega Town, Kenya.

Source: Author (2013)

It may be worth noting that the high percentage of men poultry keepers in the peri-urban western Kenya may have been motivated by the commercial aspect of these enterprises. As had been reported that when production becomes more profitable and the poultry enterprise is scaled up, the main and frequent consequence of this is that the control over decisions and income, and sometimes of the entire poultry enterprise, often shifts to men[6]. One therefore hopes that this shift will not displace women from peri-urban poultry farming altogether. A look at the level of education in the next section gives a reasonable guarantee that women farmers will not be displaced.

4.2.1 Education level of Peri-urban Poultry farmers in Western Kenya

The highest education level of respondents was investigated. Figure 4.2 shows that Bungoma recorded the highest percentage of respondents with secondary level of education ($\chi^2_{9, 0.05} = 17.59$). A greater percentage of respondents with university education were recorded in Kisumu (17.9%) among the four municipalities followed by Kakamega (14.6%) municipality. Majority of respondents were found to have secondary education in the four municipalities; ranging between 34.1% in Eldoret and 46.6% in Kisumu.

Although the majority had secondary school education, poultry keepers were heterogeneous in terms of their level of education.

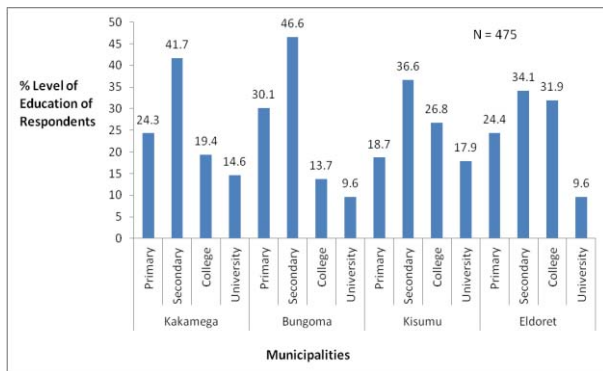


Figure 4.2: Education level of Peri-urban Poultry Farmers in Western Kenya

Urban population often have a high level of education than that of rural population, and hence the farmers found therein. This trend is in agreement with a study conducted in four towns in Tehsil Faisalabad- Pakistan showed that a minority (2%) of poultry farmers had primary level education while the rest had post primary education[18]. It shows that peri-urban urban poultry farmers in Western Kenya were majorly those who had medium to high level of education. Such educated farmers were likely to be stable poultry investors, most probably able to comprehend and apply environmental conservation measures related to poultry.

A study by Adewuyi [1] indicated that an increase in educational status increased the likelihood of being technically and allocatively efficient amongst poultry egg farmers in Ogun State. This means that peri-urban poultry farming in Western Kenya would continue to be dominated by those with higher levels of education.

Both men and women who were empowered through education could easily have access to income of their own and therefore exert control on use of resources and poultry enterprise. From the FGDs, it was observed that the majority of peri-urban poultry farmers were educated beyond primary schooling.

4.3 Practices Applied in Handling Poultry and Manure/Wastes in Peri-Urban Western Kenya

The environmental pollution related poultry manure handling practices were assessed to address the first study objective.

This assisted in making comparisons by grouping questionnaire variables and analyzing across municipalities. The practices include type of chickens kept, feed, water and manure management.

4.3.1 Contamination of poultry feeds during storage in Western Kenya

Results of the survey (Figure 4.3) showed that there was no significant difference across the municipalities with respect to the way farmers kept poultry feeds ($\chi^2_{9, 0.616} = 7.2$). Farmers kept poultry feeds either in residential houses, poultry houses, dedicated stores or given to the birds directly regardless of the municipality.

According to results of FGDs and Interviews, storage of feed in the residential houses was mainly motivated by the need to secure the feed from danger of theft. The key informants were of strong opinion that unless there was active awareness creation against keeping feeds in residential houses, more farmers were likely to do this in future. They however expressed discomfort with keeping feeds in residential houses due to offensive odour emanating from those feeds besides the menace of rats and mice.

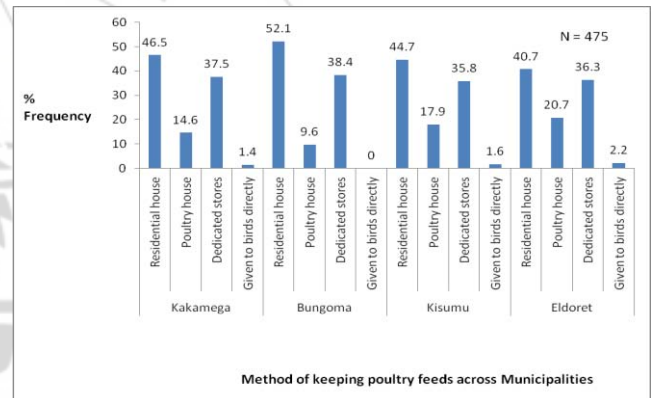


Figure 4.3: Distribution of places of Storage of poultry feeds in Western Kenya

Storage of feeds determines the level of exposure to risks of contamination especially with microorganisms and other air borne and water borne contaminants. Good feed storage should be one that prevents the degrading effects of temperature, moisture and light. Storage temperatures should be cool to avoid fungal and bacterial growth. Feed stores should protect feed from rodent and insect entry to the feed. It is advisable to keep feeds dry during storage to avoid aflatoxins in cereal based feedstuffs. Dust borne microbial contaminants could lead to re-infection of poultry by any disease of previous or current flocks.

4.3.2 Poultry Litter management in Western Kenya

Respondents were asked whether they stirred or raked litter on the floors of their poultry houses. Results presented in Figure 4.4 show that there was a significant difference across the municipalities with respect to stirring or raking poultry manure by farmers ($\chi^2_{6, 0.001} = 40.1$). Manure stirring is a good practice which improves aeration of manure, ensures drying of manure and dispersing wet area as well as avoiding caking. This practice was done by a majority which implies a step towards manure quality control.

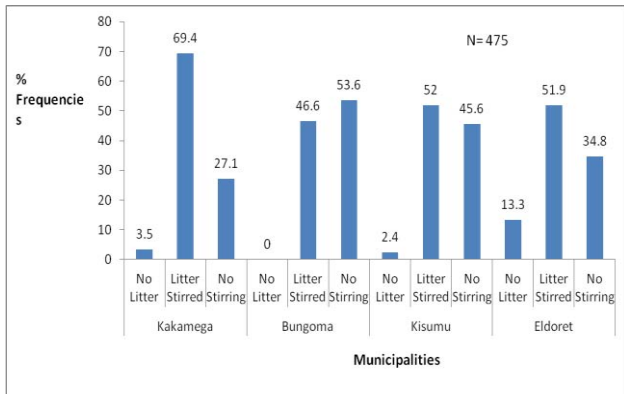


Figure 4.43: Distribution of Percentage of farmers stirring/raking litter on the floors of their poultry houses in western Kenya

4.3.3 Manure storage by peri-urban poultry farmers in Western Kenya

Figure 4.5 examined farmer's choice of storage location for poultry manure across the municipal cities. There was a significant difference across the municipalities with respect storage location of poultry manure ($\chi^2_{15, 0.001} = 72.2$). Majority of the farmers in Kakamega and Kisumu municipalities reported to have stuffed poultry manure in bags and kept them in houses while most farmers in Bungoma use pits for storage and in Eldoret farmers had compost heaps to store poultry manure.

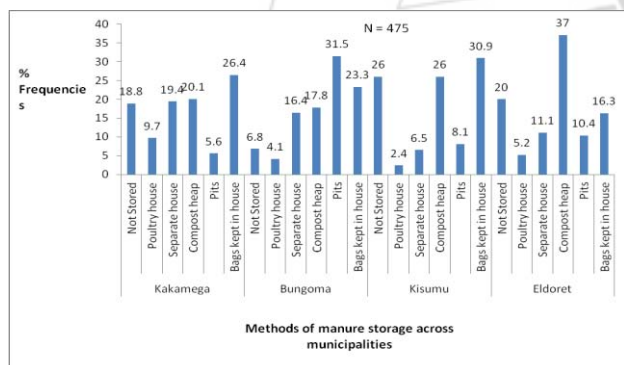


Figure 4.5: Distribution of Where peri-urban poultry farmers store manure in Western Kenya



Plate 4.2: Poultry manure stored adjacent to residential house in sacks in Kisumu City, Kenya.
 Source: Author (2013).

As shown in plate 4.3, farmers were little aware that keeping manure beside the footpath provided for further spread of its particles by users of the path. They were also keeping manure very close to the neighbours' houses. Furthermore, the bags used for storage were not water proof and therefore could easily soak and leach from rain waters leading to contamination of nearby soil and water sources.

4.3.4 Cleaning and disinfection of poultry houses and equipment in Western Kenya

Results of the assessment of whether farmers cleaned and disinfected their poultry houses are presented in Figure 4.6. Chi Square test conducted on the data showed that there was a highly significant ($p < 0.001$) variation on whether the poultry house was cleaned and disinfected ($\chi^2_{2, 0.001} = 348.51$). Kakamega municipality had the highest (54.2%) proportion of respondents who do not clean and disinfect the poultry houses while Kisumu reported the lowest (7.3%) cases.

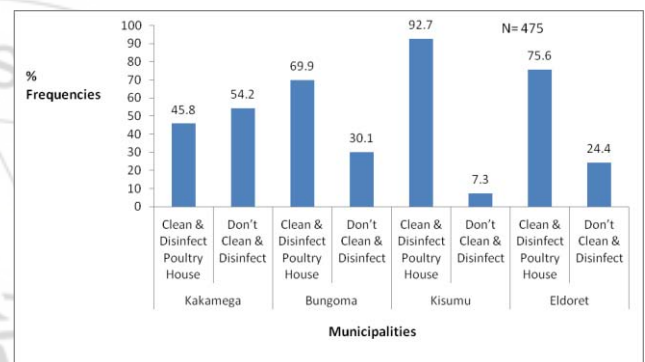


Figure 4.6: Distribution of Peri-Urban Poultry Farmers who clean and disinfect poultry houses in Western Kenya

Cleaning and disinfection of poultry house and equipment after removal of birds is an important step to avoid carry-over of diseases to the new flock. It not only protects the successive flocks from disease but also helps to break disease cycle in the poultry production chain leading to safer foods from the poultry. Chen and Jiang[4] recognized disinfection as effective means of reducing the population of antibiotic-resistant pathogens and the potential infection of subsequent flocks with resistant bacteria. This means that the risks of infection of subsequent flocks would be in the order of being highest in those municipalities where cleaning and disinfection was least practiced and lowest where it was being practiced. Kisumu flock would be safer than those of Kakamega would be most at risk of contracting diseases which were in the previous flocks.

4.3.5 Use of protective clothing among poultry farmers in Western Kenya

The survey results on use of protective clothing by peri-urban poultry farmers in Western Kenya are shown in figure 4.7. Chi Square test conducted on the data showed that there was no significant ($p > 0.05$) variation in responses on whether workers wore protective clothing ($\chi^2_{1, 0.05} = 2.29$). Most of the respondents in the highest incidents of farmers not using protective clothing were reported in Eldoret municipality (56.3%) while the lowest was in Bungoma (31.1%).

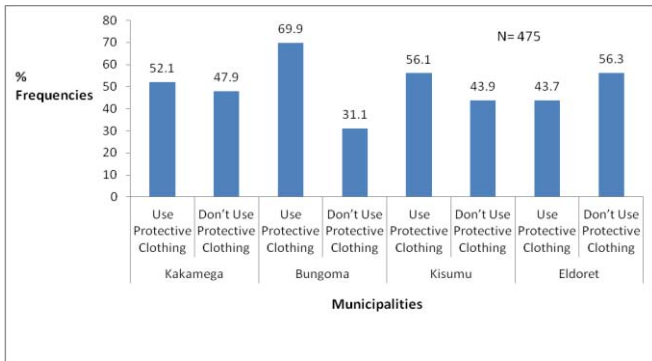


Figure 4.7: Distribution of Use of Protective clothing by handlers of peri-urban Poultry in Western Kenya

Non use of protective clothing exposes the farmer to hazards in the poultry house and also provides for the rapid spread of diseases across poultry farms since clothes from one poultry farm would transfer pathogens to other farms visited after working on an infected flock. Good hygiene is not only to protect the person working directly with poultry, but all persons with whom they have contact.

4.3.6 Application and management of poultry manure on crops in Peri-urban Western Kenya

Most of the per-urban poultry keepers grew leafy vegetables (Figure 4.8). This cuts across all the four municipalities ($\chi^2_{18, 0.05} = 33.58$). Bungoma municipality recorded the highest (100%) proportion of poultry farmers who grew leafy vegetables. Leafy vegetables are often subjected to continuous harvesting of the foliage. If manure was applied on such a crop there are high chances of consuming contaminations from manure, more so if the time interval between manure application and harvesting is short.

Ready market due to demand for food by a large urban population could explain why Kisumu municipality poultry farmers grew cereals and mixed vegetables in addition to the poultry enterprises. An earlier study also showed that groups in Mombasa and Kisumu preferred to have a mix of crops mainly vegetables and tree fruits [15].

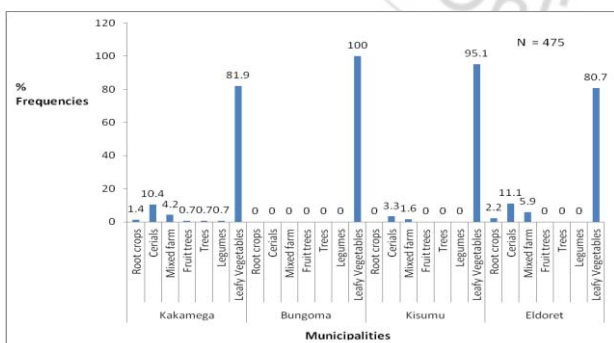


Figure 4.8: Distribution of Type of crops grown by Peri-urban Poultry Farmers in Western Kenya

Chi Square test conducted on the data showed that there was a highly significant ($P < 0.01$) variation in the duration taken between manure application and harvest of crops ($\chi^2_{3,0.01} = 1385.29$). As pathogens most commonly associated with fresh produce outbreaks, including *E. coli*, *Salmonella*, and *Listeria*, are unlikely to survive at detectable population

levels in soil after 270 days, it is proposed that the waiting period (application interval) between the application of untreated biological soil amendments of animal origin (such as untreated chicken litter) and the harvest of covered produce should be 9 months provided the material is used in a manner that does not contact covered produce during application and minimizes the risk of contamination after application [4].

The health impact of manures by transmission via field crops will depend on the extent and method of application. The risk is high if effluents are applied to the foliage of a growing crop where the leaves are consumed; and must be avoided [15]. As noted in Figure 4.8, most peri-urban poultry keepers in Western Kenya grew leafy vegetable crops using their poultry manure.

Time interval between manure application on crops and harvesting was investigated. The results are summarized in Figure 4.9. In most other cases, where the application of manure does not come into direct contact with the consumable part of the plant, risks can be minimized by following good agricultural practices.

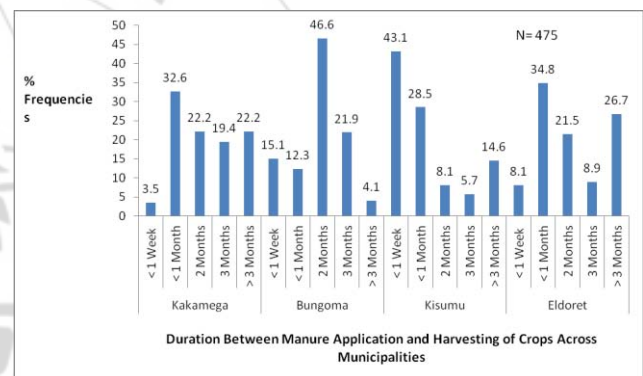


Figure 4.9: Distribution of Interval between Peri-urban poultry manure application and harvest of crops in Western Kenya

There should be adequate time between applying the manure and grazing or forage harvesting (silage and hay making) to allow the manure to decompose and to minimize contamination [8]. The Northern Ireland environmental agency (NIEA) guidelines provide that poultry litter should be deep ploughed into arable ground and that it should not be spread on agricultural land that is to be grazed, or from which silage or hay is to be harvested, in the same year [12].

5. Conclusion and Recommendations

Ownership of Peri-urban poultry in Western Kenya consisted of more women than men. Ownership and decision making was indicative of women empowerment. The level of education was generally high among the peri-urban poultry farmers in western Kenya. Poultry production appeared to be an enterprise that was compatible with the educated working class urban dwellers of either gender in Western Kenya.

This study found many of the poultry management practices appearing to be poor compared to best practices. Most of the

poultry feed was stored in residential houses. This suggests that the accompanying negative consequences of poultry feed such as smell and attraction of rats and mice menace would affect the households. Manure on the floor contaminated both feed and water in the poultry house. The implication of this was that there were high risks of disease re-infection.

Storage of manure was found to be through poor methods and for shorter periods (less than 2 months) than recommended 3 months in open places adjacent to walkways. Most farmers transported the manure in open containers. This suggests that the manure would contaminate the storage sites and route of transport and cause a lot of public health concerns. Exposure to rains could reverse the benefits of dry manure as the rains would not only leach away the nutrients causing pollution of ground water sources, but would also encourage fermentation leading to bad smell in the neighbourhood.

Crops grown by poultry keepers were mainly leafy vegetables. Interval between manure application and crop harvesting was far shorter than the recommended 9 months. One interpretation of this is that vegetable crop from farms where this manure was used would require special cooking regimes to destroy pathogens likely to have come from the manure.

The study made the following recommendations for peri-urban poultry subsector in Western Kenya:

- 1) Poultry farmers should use designated feed stores to avoid feed contamination and environmental pollution by feeds.
- 2) Poultry manure should be stored under shade for at least three months.
- 3) Transport of poultry manure should be in closed containers to avoid contamination of transit routes.
- 4) Crops applied with poultry manure should be harvested after sufficient waiting time or properly cooked to control spread of diseases.

References

- [1] Adewuyi S.A, Folawole O.O, Biola Phillip, E.O Fakoya (2013). Production Efficiency of Credit and Non-Credit Users of Poultry Egg Farmers in Ogun State, Nigeria: A Data Envelopment Analysis (DEA) Approach. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)* e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 3, Issue 4 (May. - Jun. 2013), PP
- [2] Babbie E., & Mouton J. (2010). *The Practice of Social Research*. Oxford University Press Southern Africa (Pty) Ltd.
- [3] Chang Hui-Shung (2008). *Overview of the World Broiler Industry: Implications for the Philippines*. University of New England, U.S.A.
- [4] Chen Z. & Jiang X. (2014). Microbial Safety of Chicken Litter or Chicken Litter-Based Organic Fertilizers: A review. *Agriculture*, 4, 1-29.
- [5] Clive O. D. (2009). Disinfection of animal manures, food safety and policy. *Bioresource Technology*, 100, 5392-5394.
- [6] FAO, Food and Agriculture Organization (2013). *Understanding Gender Issues In Livestock Projects And Programmes in Gender and Livestock; Overview of key gender issues in the livestock sector* Gender, Equity and Rural Employment Division (ESW) Francesca.
- [7] Food and agriculture Organization (2009). *Good Practices In Small Scale Poultry Production: A manual for trainers and producers in East Africa*. Viale delle Terme di Caracalla, 00100. FAO, Rome.
- [8] Food and agriculture Organization (2008). *Poultry sector Country Review, Kenya*. FAO Animal Production and Health Division. Rome.
- [9] Government of Kenya (2010). *Poultry Sector Updates-* (Wednesday 29.9.2010). Ministry of Livestock Development (MLD). Nairobi.
- [10] Government of Kenya (2007). *Kenya Vision 2030*. Ministry of Planning National Development and Vision (MPNDV 2030). Nairobi.
- [11] Mugenda O.M., Mugenda A.G. (2003). *Research Methods: Quantitative and Qualitative Approaches*. Acts Press, Nairobi.
- [12] Northern Ireland Environment Agency (2012). *Updated Guidance for Farmers on Requirements for the Storage and Spreading of Poultry Litter 2012 to 31 December 2014*. NIEA, Department of Agriculture and Rural development (DARD). Lisburn. n
- [13] Ogejo J.O. (2010). *Manure Management and Environmental stewardship*. Virginia Cooperative Extension. Virginia.
- [14] Oni O.A, Oladele, O.I and Oyewole, I. K (2005). Analysis Of Factors Influencing Loan Default Among Poultry Farmers In Ogun State Nigeria. *Journal of Central European Agriculture* Vol 6 (2005) No 4.
- [15] Onyatta J. 2005. *Urban Agriculture Surveys By NCST in Kenya*. Workshop Urban Micro-Farming And HIV-AIDS, Johannesburg/Cape Town, South Africa. 15-26 August 2005
- [16] Petersen S.O., Sommer S.G., Be'line F., Burton C., Dach J., Dourmad J.Y., Leip A., Misselbrook T., Nicholson F., Poulsen H.D., Prvolo G., Sorensen P., Vinneras B., Weiske A., Bernal M.P., Bohm R., Juhasz C., Mihelic R. (2007). Recycling of livestock manure in a whole-farm perspective. *Livestock Science*. 112: 180-191.
- [17] Rasnake M., Pescatore T., Overhults D. (1995). *Poultry Litter Handling and Storage*. University of Maryland.
- [18] Razaq A., Ali T., Saghir A., Arshad S., and Cheema A. (2011). Training Needs Assessment of Poultry Farmers in Tehsil Faisalabad. *The Journal of Animal & Plant Sciences*, 21(3) Page: 629-631
- [19] Thornton P.K. (2010). *Livestock Production: recent trends, future prospects*. Philosophical Transactions of the Royal Society B. 365: 1554.
- [20] Thrusfield M.V. (2008). *Veterinary epidemiology*. Third Edition. Blackwell Science Ltd. Cornwall.
- [21] United Nations (2008). *World Population Prospects: The 2007 Revision and World Urbanization Prospects*. Population Division of the Department of Economics and Social Affairs of the United Nations Secretariat. (UN)

- [22] Upton M. (2000). The Livestock revolution- Implications for Smallholder agriculture: A case study of Milk and Poultry Production in Kenya. FAO. Rome.
- [23] World Agro-forestry Centre(ICRAF). (2003). Improved fallows for Western Kenya: an extension guideline. Retrieved on 20th July 2013 from <http://www.worldagroforestry.org/aca/downloads/>.

Author Profile

Kefa Osolo Nyende Received BSc. Agriculture and MSc Animal Science from the University of Nairobi in 1992 and 2000 respectively. He has had experience as an Extension Officer and Trainer in Agriculture and Livestock Production. He also holds International diploma in Poultry Husbandry from IPC Barneveld, The Netherlands and has since led many Poultry consultancy teams in Kenya. He currently works as a lecturer at Kibabii University and is registered for PhD at Masinde Muliro University for Science and Technology.

Jacob Wanambacha Wakhungu holds BSc, MSc and PhD from the University of Nairobi. He is a professor of agriculture and food Security and current Dean of the Centre for Disaster management and Sustainable Development at the Masinde Muliro University for Science and Technology. He is a member of several professional bodies. He was distinguished as the Man of Achievement 2005 by the American Biographical Institute. Professor Wakhungu has authored more than 60 articles in referred journals.

John Obiri is a holder of BSc in Botany and Zoology (University of Nairobi) and BSc Biotechnology (Durban South Africa). He also holds MSc and PhD from University of Natal. Dr Obiri has successfully supervised students at Masters and PhD levels and is the current chairman of the Department of Disaster Management and Sustainable Development in Masinde Muliro University for Science and Technology. He is a member of several professional bodies and author of book chapters and articles in several referred journals.