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PESTICIDES' USE AND THEIR MANAGEMENT PRACTICES AMONG FARMERS IN MUTARAKWA DIVISION OF BOMET COUNTY, KENYA

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ABSTRACT

The demand for food has increased tremendously over the years as the population grows. To meet this high demand for food, intensified agriculture has been prioritised. However, the resulting high crops yields are threatened by incidences of pests and diseases either at growing stage or at storage. To counter the loss associated with pests and diseases, the development and intensified use of pesticides has become imperative. This paper examines pesticides management practices in Mutatarakwa division in Bomet County, Kenya.

Keywords: Pest, Pesticide, Pesticide residue, Weed, Vector, Integrated Pest Management, Hazard, Toxicity

1.0 BACKGROUND OF THE STUDY

One of the greatest development challenges facing the world in the 21st century is meeting the rising demand for food while maintaining the sustainability of natural resource base. Increase in per capita income, population growth and urbanization are expected to double global food demand in the next 40-50 years. Therefore demand for cereals is estimated to increase from 1.9 billion tonnes in 1997 to 2.5 billion tonnes, by 2020 and for meat from 209 million tonnes to 327 million tonnes (Rosegrant *et al* 2001).These trends in food demand have important implications for natural resources that provide essential support to life and economic processes (Shiferaw *et al* 2005). Agriculture continues to change in response to the needs of society. These needs have contributed to the gradual intensification of agriculture over time. This intensification has been possible and has evolved from the contribution of all branches of agricultural sciences, including crop protection (Dent, 1995).

It is estimated that more than a third of the world's potential crop production is lost each year to pests, diseases, and the effects of weather. Experts fear that losses would double if the existing

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pesticide uses were discontinued. Notably, crop yields of resource poor farmers are much lower than those recorded in the developed world. Yields are more in North America and Europe than in Africa and South America. A major reason for these poor yields is pest and diseases, estimated to cause 20-30 percent of crop losses in the developing world (Wolf & Snnyder, 2003). Since the introduction of DDT for the control of insects in the 1940s, man's use of inorganic chemicals to control a wide range of pests in agriculture and public health, has increased (Lampkin, 1994). Chemical pesticides are in general popular with farmers because of their quick, effective action. Increased use of pesticides increases health risks to the user and the environment (Bull 1982; Njeru, 2016). Indiscriminate use of pesticides for agricultural, public health and veterinary purposes is often associated with chemical residues found in food (Lampkin, 1994). In use of the agrochemicals control of the pests has been emphasised while the safety of the user and the environment often become of secondary importance. In particular, misuse of pesticide due to lack of training, lack of awareness and inadequate facilities and equipment may present a serious potential hazard (FAO & WHO, 1986).

Most developed countries, Kenya included have also set up national laboratories to monitor the residue levels in crop and animal products. In Kenya, there is a Pest Control Products Board which regulates the importation, exportation, manufacture, distribution and use of pesticides in all sectors of agriculture and health. These regulations have reduced the amount of chemicals in the environment and have enhanced farmer awareness in the safe use of agrochemicals in Kenya. However, in Mutarakwa Division of Bomet County, Kenya most farmers lack awareness in the safe use of pesticides to control pest and diseases and this could lead to poisoning, health hazard and environmental degradation.

1.1 Statement of the Problem

Incidences of pests and plant diseases on farms reduce crop yields thereby exacerbating food insecurity. Therefore, control of pests and diseases in crops and livestock through the use of pesticides has been crucial and prioritised. However, proper knowledge and safe practices on the use of these chemicals is important because their misuse has been associated with health hazards and environmental degradation. Unfortunately, incidences of reused containers of chemicals have been noted in Mutarakwa division of Bomet County, Kenya. Although there exists literature on pesticides residues in food stuffs, examination of the factors leading to mishandling of the agrochemicals is wanting. For any meaningful mitigation measures to be instituted there is a need for farm level assessment of how these agrochemicals are handled.

1.2 Research Questions

The following research question have been formulated to guide the research

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i. What pesticides are used by farmers in Mutarakwa division of Bomet County Kenya?
ii. What is the level of farmers' awareness in the use of the management of pesticides Mutarakwa division of Bomet County Kenya?
iii. What are the pesticides management practices among farmers Mutarakwa division of Bomet County Kenya?

1.4 Research Objectives

i. To identify the types of pesticides used in Mutarakwa Division.
ii. To determine the level of farmer's awareness on pesticide use and determine the source of information they use in application of pesticides.
iii. To examine the pesticides management practices Mutarakwa division of Bomet County Kenya

2.0 RESEARCH METHODOLOGY

2.1 Location of Study

Mutarakwa is one of the three divisions of Sotik Sub-county of Bomet County, Kenya. It covers an area of 224.1km ^{2} and has a population of 50,514. There are 15,326 households in the division with an average farm size of 1.2 ha (3 acres). The average rainfall is 1500mm per year. Arable land covers 159,000 Ha, while cultivated land covers an area of 13,500 Ha. The division has got two agro-ecological zones namely Lower Highland (LH_2), this is the zone that is suitable for wheat maize and pyrethrum and Upper Midland ($UM_{2,\&3}$) which is suitable for coffee and maize (DAO Sotik, 2010). The major crops grown include maize, beans, tea, and coffee, pyrethrum, sorghum, finger millet and horticultural crops. The main horticultural crops grown are cabbages and kales which use chemicals obtained from the agro veterinary shops spread throughout the division. Dairy farming is practiced by the majority of farmers and it plays a significant contribution to the income of the local farmers. There are 43,000 heads of cattle, 20,000 sheep and 12,000 goats. Many farmers spray their animals at home, but other farmers take their animals to the local dips.

2.2 Research Design

The study adopted a descriptive research design. This design described the current situation of pesticide use in Mutarakwa division, Bomet County. This involved surveys and fact-finding of different kinds (Kothari, 1999).The study adopted both qualitative and quantitative research approaches.

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2.3 Sampling Procedures and Sample Size

The study adopted multistage stratified random sampling method for selecting the household respondents (Reza, 1988). The sub-populations were based on the four administrative locations of the division. From each of the four locations, households were selected using simple random sampling. All the Agro-veterinary shops and the functioning dips in the division were visited. Stratified random sampling ensured that the whole division was covered.

Most of the farmers in Mutarakwa division are mixed farmers; they grow crops and also keep livestock. They use agrochemicals in one way or another and even those who do not spray their animals at home take their animals to a local dip, hence coming in contact with agrochemicals. In this case, the sample size was determined using the following formula (Fisher *et al,* 1991):

$$n = \frac{z^2pq}{d^2}$$

Where,

n is the desired sample size, z is the standard normal deviate, usually set at 1.96 which corresponds to 95% confidence interval;

p is the proportion of the population estimated to have a particular characteristic e.g. proportion of households with contact with pesticides (0.9)

q = 1-p, proportion of households without contact with pesticides (0.1)

d = the degree of accuracy usually set at 0.05

This formula has been used in similar studies by (Osman, 1992) and (Kimanthi, 1994).

$$n = \frac{(1.96)^2(0.9)\ (0.1)}{0.05^2}$$

n=138.3 which is approximately 140. Hence this study used a sample of 140 Households.

The study was qualitative and quantitative in nature to establish the types of pesticides used and whether farmers were using the pesticides safely. A pilot study was carried out in neighbouring Bureti division in Bomet County. The questionnaires were pre-tested to see if some questions were not understood or were ambiguous. This allowed for modification where necessary before the actual study was carried out. Three households, one dip attendant and one agro veterinary shop attendant were surveyed in each location for the pilot study. Mutarakwa division has four locations; hence thirty five households were selected from each location using the systematic

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multistage random sampling procedure. In all 140 households were sampled. Mutarakwa division was chosen for the study because of availability of farmers practicing mixed farming where pesticide use was most likely to be encountered.

2.4 Data Collection Methods and Instruments

The study used primary data collected using questionnaires, observations and field measurements. Four research assistants were identified and trained for two days on the administration of the questionnaire and sampling techniques. The process of briefing interviewers was to ensure standardized performance within the frame work of apparently natural behaviour (Sapsford, 1999). Data collection was done using a combination of questionnaires and interviews in an effort to elicit uniform response due to the varied level of education and understanding of the respondents.

The research assistants were conversant with the study area and were able to communicate in the local language which came in handy especially some respondents were illiterate. The data was collected by visiting the respondents in their homes or place of work to administer the questionnaires. Four sets of questionnaires were administered, each for the agro-veterinary shops attendants, extension officers, farmers and the dip attendants in the division.

2.5 Data Analysis

Analysis of data from the questionnaires was done using Statistical Package for Social Sciences (SPSS) software. Both frequencies and descriptive statistics were applied in the analysis of different variables. Related data were also cross tabulated to establish how they changed with time.

The presentation of the results in the form of tables and graphs were reinforced by using non-parametric techniques, a measure based on chi-square. Excel spread sheets and Simple runs test was also used to analyze the trend of livestock dipping in the study area, while Pearson and spearman rank correlation coefficient analysis was used to measure the strength of relationship between variables (Reza, 1988)..

3.0 DATA PRESENTATION AND DISCUSSION

3.1 Demographic Information of the Respondents

Majority of the respondents were male who accounted for 66% while female respondents accounted for 34%. About half (40%) of the respondents were in the age category of 25-35 years, followed by age category above 45 years which accounted for 29%, then age category 36-45

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years which accounted for 28 % and the last was that of age category 15-24 years accounting for 3% of the respondents. This means the majority of the respondents were in the category of active citizens who could work with pesticides

The study established that majority of respondents owned between 1-3 acres of land which accounted for 52.1%, followed by those with land between 4-7 acres which accounted for 22.9%. Those with land over 7 acres accounted for 13.6% and those with less than one acre accounted for 11.4% of the respondents as shown in table 5.5 and figure 5.4 above. This implies that most of the people in the study area have small pieces of land which required low volumes of chemicals which needed to be packaged appropriately in order to avoid the need to keep the excess chemicals which was a challenge to the farmers.

3.2 Pesticides Handled by Farmers

The study sought to identify the type of pesticides used in the study area. It was found out that the pesticides mainly used by farmers were insecticides as indicated by 34% of the respondents, followed by fungicides (28%) acaricides (24%) and the least used were herbicides as indicated by 14% of the respondents. The specific names mentioned as selling most in the study area were *dimethoate* and *Tata Alpha* (insecticides) *Oshothane* and *Milraz* (fungicides), *Ectomine* (acaricide). The study established that farmers used pesticides on their households, on stored food, on crops and on livestock as shown in Tables 1 and 2.

Table 1. Pesticide use in Houses and Stored Food

Responses	Households treated with pesticides Percentage	Pesticide use in stored food Percentage
Yes	81	83
No	19	17
Total	100	100

Information in Table 1 shows that 81% of households had applied pesticides in their houses and 19% had not used pesticides in their houses. Those who used pesticides on their houses either sprayed or sprinkled pesticide. A paltry 1% applied these chemicals daily while a great majority (88%) applied once a year. More than four fifths (83%) of the respondents reported that they used pesticides on stored food while 17% did not use pesticide on stored food. The main stored food preserved with pesticides was maize (92%) and beans 8%.

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Table 2. Pesticide Use on Crops and Livestock

Responses	Crops %	Livestock %
Yes	84	96
No	16	4
Total	100	100

The results on Table 2 indicate that 84% and 96% of the respondents used pesticide on crops and livestock respectively. However 20% of the respondents neither used pesticide on livestock nor on crops. For those who applied chemicals on their livestock 3% used hand pump, 8% used stir up pump, 32% used foot pump, and 42% used knapsack sprayer. However 15% took their animals to local dips

3.3 Health Hazards

Table 3. Pesticide Storage Practices

Pesticide storage	Percentage
In house	19
In store (maize)	59
Special store for pesticide	22
Total	100

Results in Table 3 shows that more than three quarters (78%) of the respondents did not have special stores for pesticides. They kept them either in the house where they were living or they kept them in the maize store. Less than a quarter of the respondents had a special store for pesticide. This implies that the majority of the respondents, 78% did not store the pesticides appropriately, with only 22% storing the pesticide in an appropriate manner.

While spraying their crops and livestock, it was observed that none of the respondents used the full recommended personal protective equipment. The respondents only used a few of the recommended protective devices with a quarter (26%) using gumboots, overall and gloves. They missed out on eye shield, which is important to safeguard the eyes of the applicator. Gumboots were used by 2% of the respondents while the remainder used various combinations of two or three protective devices. This implies that for every pesticide application, the farmers exposed themselves to health hazards due to use of incomplete personal protective equipment. In addition, those exposed to pesticides exhibited symptoms ranging from allergy (itching, sneezing

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and coughing) 53%, allergy and headache 1%, headache, 23%, dizziness 10%, with allergy and dizziness accounting for 3%.

Table 4. Disposal of Pesticide Container

Fate of Pesticide Container	Percentage
Clean and reuse	1
Throw into the bush	9
Throw into the toilet	61
Dig a pit and bury	21
Others	8
Total	100

According to the information on Table 4, the main method of disposal was throwing the used containers in the toilet as indicated by 61% of the respondents, 21% dig a pit and bury while 9% throw the containers in the bush. Sadly, 1% of the respondents cleaned and reused the containers. This improper disposal of pesticide containers including throwing in the toilet will negatively affect the users and underground water resources.

3.4 Farmers' Level of Education and Health Hazards

The study established that respondents with primary and those with secondary level of education each accounted for 42%. Less than a fifth of the respondents have postsecondary level of education. Pearson chi-square test was used to test the significance of farmers' level of education and the possible health hazards posed by pesticides in Mutarakwa division of Bomet County. The test was carried out on the null hypothesis that there is no significant relationship between the farmers' level of education and their method of storage of pesticides. Table 5 shows the resultant cross tabulation of pesticide storage and the farmer's level of education.

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Table 5. Cross Tabulation of Pesticide Storage and the Farmers' Level of Education

Pesticide storage	Education level											
	None		primary		Secondary		College		University		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
In house	3	2.1	13	9.3	6	4.3	3	2.1	1	0.7	26	18.6
In store	5	3.6	38	27.1	34	24.3	2	2.9	2	1.4	83	59.3
Special store	0	0	8	5.7	19	13.6	4	2.9	0	0	31	22.1
Total	8	5.7	59	42.1	59	42.1	11	7.9	3	2.1	140	100

The calculated chi-square value was found to be 14.373 at 8 degrees of freedom and 0.05 significance level, against the chi- square value from table of 15.51 (that is 14.373<15.15). This leads to failure to reject the null hypothesis. This implies that the choice of the place to keep the pesticide is independent of the level of education in Mutarakwa Division of Bomet County. Therefore, there is need for specific trainings on pesticide handling targeting all farmers regardless of their level of education.

3.5 Environmental Hazards

The study sought to determine the possible environmental effects of the pesticides. This was done by estimation of both the distance from spraying crushes and vegetable gardens to the nearest water source. The findings are shown in the Table 6.

Table 6. Location of Spraying Crushes and Vegetable Gardens

Distance from water source in meters	Spraying crushes (%)	Vegetable gardens (%)
0-50	52	42
51-100	19	20
101-200	10	19
201-300	6	6
301-400	0	1
>400	13	12
Total	100	100

The study found out that 52% of the respondents located their spraying crush at between 0-50 meters and about a fifth of the respondents located their crush more than 200 metres from water sources.

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In addition, 42% of the respondents located their vegetable gardens at between 0-50 meters from water source, and 38% of the respondents had sited their crushes at over 100 meters from water source. The close proximity of these crushes and gardens to water sources means that pesticides found their way into the water sources as a result of drift or with run-off from the fields with a very high potential of environmental consequences to the aquatic flora and fauna. This was further supported by chi-square test which was used to test the significance of water sources on the choice of location of the crushes and vegetable gardens. The test was carried out on the null hypothesis that there is no significant relationship between the site of livestock spraying crush/vegetable garden and the source of water. The alternative hypothesis was that there is a significant relationship between the site of Livestock spraying crush/vegetable garden and the water sources.

Tables 7 and 8 show the computed value of chi-square. For the crushes, it was found to be 144.17 while that of vegetable gardens was 88.56, against the chi-square value from table of 11.070 (that is 144.17 > 11.07 and 88.56 > 11.070). This implies to failure to reject the null hypothesis that there is no relationship between the site of livestock spraying crushes/vegetable gardens and the source of water. Therefore we accept the alternative hypothesis that there is a significant relationship between the site of livestock crushes/vegetable gardens and the water sources. This means that the choice of location of livestock spraying crushes and vegetable gardens in Mutarakwa division of Sotik district depends on the proximity of water sources to the exclusion of the other technical considerations.

Table 7: Chi-square Computation for Spraying Crushes

Distance from Water sources (meters)	Observed (O)	Expected (E)	O-E	$(O-E)^2$	$(O-E)^2/E$
0-50	73	23.3	49.7	2470.1	106.01
51-100	26	23.3	2.7	7.29	0.31
101-200	14	23.3	-9.3	86.49	3.71
201-300	8	23.3	-15.3	234.09	10.05
301-400	0	23.3	-23.3	542.89	23.30
>400	19	23.3	-4.3	18.49	0.79
Computed Chi-statistic	$X^2 = \sum \frac{(O-E)2}{E}$				144.17
Table X^2 Value					11.070

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Table 8: Chi-Square Computation for Vegetable gardens

Distance from Water sources (meters)	Observed (O)	Expected (E)	O-E	$(O-E)^2$	$(O-E)^2/E$
0-50	59	23.3	35.7	1274.49	54.7
51-100	28	23.3	4.7	22.09	0.95
101-200	26	23.3	2.7	7.29	0.31
201-300	8	23.3	-15.3	234.09	10.05
301-400	1	23.3	-22.3	497.3	21.34
>400	18	23.3	-5.3	28.09	1.21
Computed Chi-statistic	$X^2 = \sum \frac{(O-E)2}{E}$				88.56
Table X^2 Value					11.070

3.5 Farmers' Level of Education and Environmental Hazards

Pearson chi-square test was used to test the significance of farmers' level of education and the environmental effects of pesticides. The test was performed on the null hypothesis that there is no significant relationship between the farmers' level of education and the sitting of spraying crushes. Table 9 shows the cross tabulation of distance of spraying crush to nearby water source and the farmers' level of Education.

Table 9: Cross tabulation of Distance of Spraying Crush to nearby Water Source and the Farmers' Level of Education

Distance from spraying crush to water source	Education level										Total	
	None		primary		secondary		college		university			
	F	%	F	%	F	%	F	%	F	%	F	%
0 50	7	5	32	22.9	26	18.6	6	4.3	2	1.4	73	52.1
51 100	1	0.7	13	9.3	10	7.1	2	1.4.	0	0	26	18.6
101 200	0	0	7	5.0	6	4.3	1	0.7	0	0	14	10.0
201 300	0	0	5	3.6	2	1.4	0	0	1	0.7	8	5.7
>400	0	0	2	1.4	15	10.7	2	1.4	0	0	19	13.6
Total	8	5.7	59	42.1	59	42.1	11	7.9	3	2.1	140	100

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The calculated chi- square value was found to be 24.050 at 16 degrees of freedom and 0.05 level of significance against the chi-square value from table of 26.30 (that is 24.050<26.30). This leads to failure to reject the null hypothesis. This implies that the sitting of livestock spraying crushes is independent of the level of education of the farmers in the study area. It implies that the educated and the uneducated site their crushes inappropriately, hence a need for trainings targeting all farmers regardless of their level of education on the safe handling of pesticides.

Table 10: Rank Correlation of Preference of Site of Spraying Crush and Vegetable Gardens

Distance from water source (Metres)	Rank (X) Spraying crush	Rank (Y) Vegetablegarden	Difference in Ranks D=(X-Y)	$D=(X-Y)^2$
0-50	6	6	0	0
51-100	5	5	0	0
101-200	3	4	-1	1
201-300	2	2	0	0
301-400	1	1	0	0
>400	4	3	1	1
			0	2

rs= 1- 6x2 /6(35) =1-0.057= 0.943

The result of 0.943 shows a strong correlation between the sitting of the crush and vegetable garden at 0 .05 level of significance.

Table 11 Corrélation Coefficients

X(Education level)		Y(Distance of dipping crush to water source)	Y^2	Y^2	XY
None	8	73	64	5329	584
Primary	59	26	3481	676	1534
Secondary	59	14	3481	196	826
College	11	8	121	64	88
University	13	19	169	361	247
Total	140	140	7316	6626	3279

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The correlation between the farmers' level of education and the site of the dipping crush was calculated using the formula below:

$$r = \frac{\sum xy - (\sum x)(\sum y)/n}{\sqrt{\sum x^2 - (\sum x)^2/n \,/\, .\sum y^2 - (\sum y)^2/n}}$$

Substituting the figures from table 11 above, it becomes,

$$r = \frac{3279 - (140)(140/5}{\sqrt{7316 - (140)^2/5.6626 - (140)^2/5}}$$

$r = 0.147$, hence $r^2 = 0.022$

From the calculations, $r = 0.147$ and $r^2 = 0.022$, meaning that(X),the level of education of the respondents, explains 2.2% of the variability in the dependent variable (Y),distance of dipping crush to the nearest water source or the variance in site of dipping crush(Y) is explained by its linear relationship with farmers level of education (X).This implies that the level of education is not the main factor in location of the dipping crush and apparently, other underlying factors are at play. The small absolute value of r suggests a weak linear association between the level of education and the site of dipping crush.

3.6 Source of Information on Pesticide Use

The second research question sought to establish where farmers got advice on the use of pesticides. The findings are shown in Table 12.

Table 12: Source of Information on Pesticide Use

Source of information	Percentage
Government extension officer	11
Private extension officer	4
Agro vet attendant	11
Media	8
Government extension officer and Agro vet	1
Combination including media	65
Total	100

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The study found out that only 1% of the farmers got advice from both government extension officers and agro vet attendants.11% got from only government extension officers, 4% got advice from only private extension officer, and 11 % from only agro vet attendants and 8% got advice exclusively from media. However the majority of the respondents, 65%got advice from a combination of categories mentioned above. It was noted that all these combinations included media. Hence media played a major role in educating farmers as to which chemicals to use and how the chemicals were used. The study also showed that farmers were open to various sources of information which is both positive and negative. This is because some of the sources are unreliable and others are driven by profits, so they may not give unbiased advice to farmers. On the other hand the variety of sources will enrich the farmers' knowledge.

3.7 Pesticide Handling in Local Dips

The third objective of the study sought to determine whether the right procedure of handing pesticides was practiced in the local dips. The study found out that all the ten dip attendants were male of which four were aged between 25-35 years and six of them were of age category 36-45 years. Their level of education showed that 2 were of primary level and 8 were of secondary level. It was also established that 4 dips used *Almatix*, 3 dips used *taktic*, and 2 used *Norotraz* while one dip used *Tixfix*. This multiplicity in use of chemicals may lead to development of resistance to acaricides, leading to a crisis in tick control unless new classes of compounds are developed.

The respondents said that they drew out the dip wash manually (7 dips) or using water pumps (3 dips) into the dip disposal pit which was filled up in 2 of the dips but was properly maintained in 8 of the dips. The water for replenishing the dips was reported by seven dips to be from nearby river or stream while one dip used nearby dam and roof harvesting. Another used both nearby dam and water tank while 1 dip exclusively used water from a dam dug near the dip. It was noted that these sources of water were too close to the dips and was also used for other domestic purposes with possible environment and human health hazards.

The study found out that the pesticide container was much sought-after by the farmers. It was reported that this is mainly used to keep milk or to transport milk to buying centers. In only 3 dips, the dip attendant said they burned the pesticide container. However in the remaining 7 dips, the attendant either took it home or gave it to other farmers who asked for it. This clearly demonstrated that farmers were reusing the pesticide containers with possible serious health hazards.

On the issue of personal protective equipment (PPE), it was found out that 6 attendants used ordinary clothes together with gumboots, one dip attendant used overall, and 2 attendants used

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gumboots and gloves while one attendant used gumboots and hat. Hence none of the dip attendants used the full range of recommended PPE. The foregoing discussion indicated that the right procedure of handling pesticides in the local dips was not being followed. This calls for aggressive training of both the dip attendant and the farmers on the importance of following the right procedure in the use of chemicals in the dips, particularly the reuse of the pesticide container and the importance of using protective equipment.

3.8 Consistency of Dipping Livestock

The study also sought to establish the consistency of dipping by analyzing the number of animals dipped per week. Dipping records for 44 weeks of year 2009 as shown in Figure 1 was analyzed.

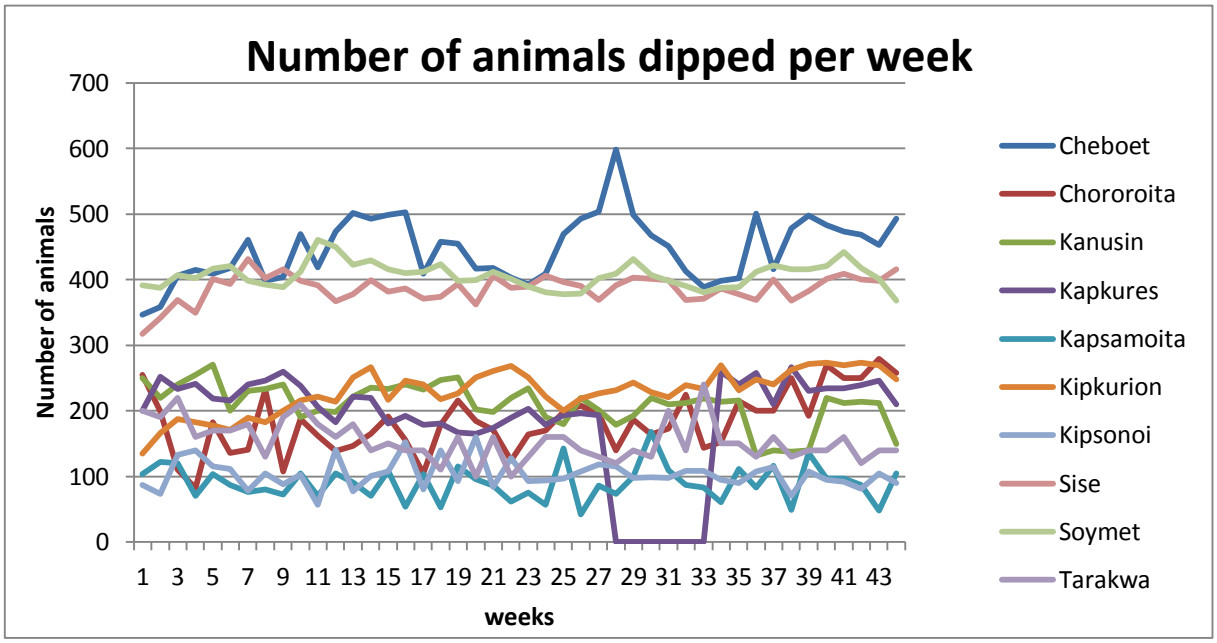

Figure 1: Number of Animals Dipped per Week

The total number of animals dipped per week was obtained for all the ten dips. The average number of animals dipped per week was calculated and found to be 2,396. This average was then compared to weekly totals to establish whether it was above or below average. The resultant runs were counted and used for simple runs test.

Simple runs test was applied to test whether the number of animals dipped per week was more or less evenly distributed or whether the number tended to cluster significantly in certain weeks, indicating perhaps that the number of animals dipped weekly was likely to have happened by

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chance or that something other than chance was at work. The idea was to determine whether there was a cyclical characteristic of the number of animals dipped per week, that is whether there was a sufficiently strong relationship or grouping of weeks with high and low number of animals in order to infer that there might have been some cyclical changes in the number of animals dipped or whether the observed groups might be expected through random variations into the prevailing environmental conditions over the period under study.

Simple runs test was carried out against the null hypothesis (H_0) that each week's number of animals dipped was independent of the other and that apparent runs of weeks in which the number of animals dipped was high or low was as a result of chance. The alternative hypothesis (H_1) was that there was a significant difference in the number of animals dipped per week.
The number of runs (r) =18,n 1= 9 (above mean) while n 2 = 9 (below mean)

The critical value from table is 5/15; hence the failure to reject the null hypothesis. This means that the number of animals dipped weekly is independent of the other weeks, hence it shows there was a very wide variation.

3.8 Pesticides' handling in the Agro veterinary Shops

There were 10 agro veterinary shops in the Division and it was observed that 3 were manned by male while 7 were operated by female. Their age category ranged from (15-24), Six attendants and 25-35 years, 4 attendants. It was noted that 3 had secondary level of education while 7 had college level of education. All the agro vet attendants responded that farmers asked for advice from them on which pesticides to use and how to use them.

Table 13: Fate of Pesticide Wrappers

Fate of pesticide wrappers	Percentage
Burn	10
Throw away in dust bin	10
Give to farmers who ask for it or use to wrap purchased items for customer	80
Total	100

Generally the operational procedure of chemical handling was up to date and all the chemicals sold were registered with pest control products board of Kenya. All pesticides had registration numbers which were counter checked with the list of registered chemicals and found to be true.

The only area which seemed not to follow the recommended procedure was the disposal of pesticide wrappers like cartons. It was found out that 8 of the shop attendants used them to wrap

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purchased items for the customer or gave to farmers who asked for it. One shop attendant said he threw the pesticide wrappers in dust bin, while one said she burnt them as shown in Table 13. Upon reaching home the farmer might use the cartons to store books, foods, and other items with possible health hazards.

Despite this demographic background most of them used pesticides to treat their houses, on stored food, on field crops and on livestock. The study found out that 81% had treated their houses with pesticides, 83% had used pesticides on stored food, and 84 % had used pesticides on crops while 96% had used pesticides on their livestock. Despite the above wide spread use of pesticides it was observed that the farmers did not use the pesticide safety. The unsafe practices ranged from unsafe disposal of pesticide containers, 79%, unsafe disposal of pesticide wrappers, 80%, using the same spraying equipment for livestock and crops, the unsafe storage of the pesticide in the houses, 19%, or in maize store, 59% instead of using separate stores for pesticides to non-use of the complete recommended personal protective equipment. None of the respondent used eye shield which is very important to safeguard their eyes. As a result of this non-use of protective clothing, 45% of the respondent reported that they had experienced incidence of unusual high personal exposure to pesticides characterized by itching, sneezing, coughing, headache and dizziness.

The study found out that majority of the people sited their livestock spraying crushes and their vegetable gardens close to water sources. This increased the chances of contamination as a result of drift or rainfall run off from the field with the concomitant environmental consequences to aquatic flora and fauna together with human health. In addition, through chi-square test, Test runs spearman Rank and correlation coefficient calculation, the study established that there was a relationship between the site of livestock spraying crushes and vegetable gardens and the water sources. This means that the choice of location of livestock spraying crushes and the vegetable gardens in Mutarakwa Division of Sotik District depends on the proximity of water sources.

In the local dips it was observed that several type of chemicals were used simultaneous and also the dipping was so erratic that resistance to chemicals will be manifested in the not too distant future.

The unsafe handling of pesticide in Mutarakwa division is attributed to the multiplicity of source of information and the limited knowledge on the side of the farmers on pesticide use. Media played a major role in this regard. It is known that those who advertise products in the media targets to sell the product and to increase their profit margins, hence they may not give balanced information to the farmers. This scenario is worsened by the few agricultural extension personnel in the study area.

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4. CONCLUSIONS

The stakeholders in the pesticide industry in Mutarakwa Division of Bomet County do not use the recommended methods of pesticides handling. This is attributed to the lack of awareness on the safe use of pesticides. They are not aware of the need to use personal protective clothes while applying pesticides. The close proximity of livestock spraying crushes and vegetable gardens together with reuse of pesticide wrappers and containers will result in the contamination of the water sources with serious affects to human health, the aquatic flora and fauna

5. RECOMMENDATIONS

The study recommended the following:

i. The county government of Bomet should ensure that the laws governing the pesticide industry are observed through enhanced surveillance.
ii. More practical trainings on the safe use of pesticides should be carried out throughout the county
iii. The government should monitor the content of media programmes and advertisements regarding the use of pesticide.
iv. The government should legislate on the minimum education levels for agro-veterinary shop attendants.
v. Adopting of organic farming should be encouraged.

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