SAFE UTILIZATION OF HERBICIDE AMONG SMALLHOLDER FARMERS IN BEBEJI LOCAL GOVERNMENT AREA, KANO STATE

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DECLARATION

I, Umar Ado Gwarmai with registrstion number SPS/11/MGE/00070 in the Department of Geography, Bayero University, Kano, do sincerely declare that this research work has been conducted and written by me as part of the requirements for the award of MSc Land Resources Development.

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CERTIFICATION

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DEDICATION

This research work is dedicated to my sons; Fauwaz Umar and Sharfudeen Umar, and our entire family.

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ABSTRACT

This study was undertaken to assess the safe utilization of herbicide among smallholder farmers in Bebeji Local Government Area of Kano State with view to examine the different problems of herbicide utilization, to examine compliance with safety measures of herbicide utilization among the smallholder farmers, to examine the different sources of herbicide and examine farmers' understanding of the herbicides in the study area. The study has also attempted to find out to which extent herbicide is used, how safe is the use of the herbicide by the farmers in the study area and what knowledge of the safe utilization of herbicide do the farmers have in the study area. One hundred (100) questionnaires were administered to one hundred (100) respondents selected using non-probability sampling technique (purposive sampling technique). The information collected were analysed using descriptive statistical techniques. Spear man's correlation coefficient and t-test as statistical tools were employed to answer some research questions. The result of the study shows that farmers within the range of 31-40 years have the highest number (35). Based on educational level of the respondents, 33 have acquired Qur'anic/Islamiya education while 67 have primary, secondary or tertiary education. Majority of the respondents have farming experience of over 10 years. Herbicide usage in the study area is very high with 100% of the farmers involved in the utilization. The result reveals that majority of the respondents (95) buy the herbicides from open market and 88 express satisfaction with the availability of the herbicide in the markets. Almost all the respondents maintained that inadequate fund is the major constraint in acquiring the herbicide. Majority of the respondents (92) reported that lack of skills and necessary equipments, odour, inefficiency of the sprayers and spread of herbicide to unintended areas are major problems in application of the herbicide. Generally, awareness of the effects or hazards of the herbicide is absent, with 71 of the farmers not aware of its negative effects to life, ecosystem and environment. Precautions and safety measures when handling herbicides prove to be absent in the study area, with 77 farmers who do not take any safety measure when mixing and 66 before application of the herbicide. While only 52 of the respondents take safety measures after application of the herbicides, these attitudes endanger life and the entire environment. Appropriate skills and technical knowledge are essential in the management of chemicals, the results of the study shows that 77 of the respondents have wrongly acquired their skills and knowledge of herbicide usage from colleagues while the remaining 23 acquired through either training or at school. Majority of the respondents (63) believed to have enjoyed more than 50% of labour cost reduction as a result of adopting herbicide utilization. Generally, 56 of the farmers reported improvement in terms of yield with adoption of herbicide utilization. Herbicide use among smallholder farmers in the study area is not safe for health and environment. It is therefore, recommended that programmes on health and safe use of herbicide should be put in place.

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

Agriculture in the Third World is coming under increasing influence of modern technological development which mostly originated in the western world. This technology coincides with the needs for maximum production of agricultural products. Western technology is committed to reduce labour, and labour is replaced with capital, machineries and energy. It also increases good supply of skilled labour and industry oriented market (Kellog et al, 1992). Unfortunately the Third World imports such technology without thinking of the problems it may bring. Crop production is one of the sectors that the technology of herbicides utilization without required knowledge of its impacts is well adopted. Agriculture is in the chemical age of development in which the intensive use of chemicals is practiced. The increasing population of developing countries and the attendant need to increase food production is a pointer that herbicides must be used in an increasing proportion in order to increase the much needed food, and to provide it sufficiently (Kolo, 2004). The growing mechanization of farm operations and ever increasing labour wages have stimulated interest in the use of chemical weed control. Non judicious use of herbicide, however, can do more harm rather than good in productivity (Hussaini and Lado, 2012). Herbicides are important and essential component of weeds management in the world of agriculture. Rao, (2006) stated that over 400 herbicides have been discovered and developed in the 55 years. There is almost no weed problem that cannot be solved by herbicides. Today, high yield agriculture heavily depends on herbicides, as they constitute a vital and integral component of weed management practices. Although herbicides lead to increased food production, there is a very reason to

use them properly to safeguard the people and environment. Farmers' knowledge concerning safety handling techniques of herbicides use is very important.

The use of herbicides in Nigeria was introduced through the agricultural reforms of 1970's, while subsequent establishment of River Basin Development Authority (RBDA) and Agricultural Development Projects (ADPS) strengthened the process. According to the survey of Kolo (2004) and Ikoenobi (2005) cited in Kolo and Amusa (2008), they found that the use of herbicides, especially non-selective ones by farmers in Nigeria is gaining acceptability and is on the increase. The current situation concerning herbicides utilization in Nigeria can be said to be unsatisfactory, because farmers do not adhere to safety measures when using herbicides. Therefore, efforts need to be made to create awareness of the risks involved in the improper use of herbicide. Problems with the use of herbicides are usually worse in developing countries because they lack registration systems and proper information concerning the hazardous properties of imported products or restriction on their uses. Herbicides lead to increased food production; however, there is need to use them properly to safeguard the people and environment. Farmers' knowledge regarding safety application technique, timing and dosage of herbicides use is often adequate. Exposure to herbicides has become very common especially for those that use the herbicides at daily basis. It is on this view that certain precautions should be taken during and after herbicide application. FAO,(1997) asserted that the use of chemical in agriculture, if carried out properly can be regarded as wholly beneficial with no attendant adverse environmental effects or increased risk to the health of the farmers. According to Olowogbon et al, (2013), lack of safety precautions causes contamination and poisoning in the field. Unfortunately, investment in protective clothing masks or gloves only pay

back in terms of health and wellbeing, not in financial terms. While Meijden (1998) in (Olowogbon et al, 2013) stated that generally farmers in Nigeria do not wear any protective materials at all, no matter what herbicides. The herbicides are widely associated with so many risks that can be hazardous if not properly managed and handled. The common risks associated with human beings includes: acute toxicity, chronic toxicity carcinogenicity, tetratogenicity and biological concentration (Gushit et al, 2013). Okopido (2002) cited in Gushit et al,(2013) observed that misuse and abuse of this class of chemical farm inputs are likely to be rampant in Nigeria due to in adequate education on the guidelines and control on the safe use and disposal of used herbicides' containers and limited awareness about the toxicity of the chemicals. Different policy intervention has to be put in place to create an enabling environment for the utilization of herbicides by farmers in the rural area. Regulating policy play an important role in restricting access to most toxic and damaging chemicals and regulating its use. Farmers' access to information about sustainable agricultural technologies and practices need to be improved, on other hand, agricultural extension services need to be strengthened. Economic incentives can play a major role in stimulating environmentally friendly technologies (Jamala et al, 2013)

Rural farmers account for the greater part of the population of any developing country including Nigeria. It is the responsibility of government to ensure easy access to all agricultural inputs that will lead to effective and efficient agricultural system that will not only boast agricultural production but also enhance the utilization of natural resources in a sustainable manner. When the rural farmers have access to knowledge and farm agricultural inputs, it will be of important in achieving maximum agricultural yield. Blait (1996) in Obidike (2011) pointed out that the least expensive input for improved

rural agricultural development is adequate access to knowledge and farm inputs. It is on this light that the need to study the safe utilization of herbicides among the smallholder farmers of Bebeji Local Government needs to be given attention.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Over the years, rural farmers depend on indigenous knowledge and traditional methods (manual weeding, crop rotation, ploughing, inter cropping etc.) to suppress or eradicate weeds and improve crops cultivation. Such indigenous or local knowledge refers to the skills and experience gained through oral tradition and practice over many generations. Acquisition of such primitive skills by our rural farmers has not helped to improve agricultural yield. All that is witnessed in our rural agricultural system range from poor farm yield, emergence of new crop and animal diseases, resistant plant weeds and pest that attack crops, old farm implement etc.

In recent past and present, the improvement in technology brought a massive change in weed control. However, introduction of chemical herbicides is gradually phasing out the traditional system of weed control that boasts agricultural outputs by allowing a single person to cultivate many hectres of land. Iyagba (2013) observed that herbicides uses among the farmers are not safety conscious of their lives and that of the environment. Rural farmers in their effort to access these agricultural knowledge and implements from available sources for better farming system and improved agricultural yield are confronted with certain constraints (Obidiki, 2011). Different challenges facing farmers in the past decades were identified or highlighted by several authors; these include inadequate access to productive resources, price of inputs such as herbicides and fertilizers, market access and cost of transport (Mpandeli and Maponya, 2014). They further pointed out that in

order to attain high levels of production and quality it is necessary for farmers to access all the required inputs. As observed over the years farmers are faced with problems due to poor handling technique and random utilization of herbicides. Hence, it is important to safe utilization of the herbicides among the smallholder farmers of Bebeji Local Government Area.

1.3 RESEARCH QUESTIONS

The research will answer the following questions:

I. To what extent is the herbicide use in the study area?

II. How safe is the use of the herbicide by the farmers in the study area?

III. What is the relationship between use and its sources?

IV. What are the problems with herbicide use in crop production?

V. Do the farmers have any knowledge of the safe utilization of herbicides?

1.4 AIM AND OBJECTIVES OF THE RESEARCH

The aim of the research is to assess the safe utilization of herbicides among the smallholder farmers of Bebeji Local Government Area with view to generating information that will guide planners and policy makers.

The objectives of the research are:

i. To examine the different problems of herbicide utilization in the study area.

ii. To examine the level of compliance with safety measures of herbicide utilization among the smallholder farmers in the study area.

iii. To examine the different sources of herbicide in the study area.

iv. To examine farmers' understanding of the herbicides.

1.5 SCOPE AND LIMITATION OF THE STUDY

The research has assessed safe utilization of herbicides among the smallholder farmers in the fourteen (14) wards of Bebeji Local Government Area and data will be generated through questionnaire administration to the sample farmers and field observation by the researcher. Recommendation will be done base on the data generated.

1.6 THE STUDY AREA

1.6.1 Background

Generally Kano region is one of the most important agricultural areas in Nigeria. It currently produces food and cash crops such as rice, millet, sorghum, wheat, maize cowpea and several vegetable crops under both rain fed and irrigation farming. The farming system is extensive use of agricultural land in both lands. It is the system that produces more food on land with a density of 205 - 500 people per square killometre as reported by Ahmed (1995) cited in (Tanko, 2001). Bebeji Local Government Area is one of the Kano State's Local Government Areas that plays a vital role in producing such crops.

A smallholder farmer in Bebeji Local Government Area is the farmer who uses small area of land (usually less than 1ha) and uses less sophisticated agricultural equipments for his agricultural production. This may be due to non access to large area of land and sophisticated equipments. About 95% of the total population of 199,004 people of Bebeji Local Government Area is smallholder farmers (NPC, 2006).

1.6.2 Location and Extent

Bebeji Local Government Area is located within longitude $11^{0}30^{1}$ E- $11^{0}75^{1}$ E and latitude $8^{0}19^{1}$ N- $8^{0}40^{1}$N of the equator, in the southern part of Kano. It is bordered by Garun Malam

Local Government in the North, Tudun Wada Local Government in the East, Kiru Local Government in the South and bordered by Madobi Local Government in the West.

1.6.3 Relief

Bebeji Local Government Area forms part of the semi-arid region of Nigeria known as Kano region, this area has an elevation that ranges from about 400m to 1200m above mean sea level (Olofin and Tanko, 2000).

1.6.4 Climate

The climate of the study area is characterized by the prevailing climate of the northern Nigeria which has been distinguished in to three main seasons : (1) cool dry season from October to February (2) a hot dry season from March to May and (3) a warm moist season (season) from June to September. The warm rainy season is more suitable for crops grown in the area. Weather requirement of crop plants in the area is mainly characterized by two seasons which are wet and dry.

1.6.5 Rainfall

Rainfall is the most important factor for crop production in the area due to the fact that majority of the agricultural practices depend on rainfall. It beginsS mostly in early May and reaches its peak in August or September. The rainfall value ranges between 800mm to 1000mm (Olofin and Tanko, 2000).

1.6.6 Temperature

The temperature of the area is warm to hot throughout the year even though there is slightly cool period between November to February. The mean annual temperature is between 26^0 c and 31^0 c and the average temperature is 24.6^0 c (Olofin, 1987).

1.6.7 Relative Humidity

Humidity follows pattern of rainfall. In the wet season, the moisture content of the air increases which makes the daily average humidity to be up to 61% during wet season and 30% during cool dry season. The cool dry season is influenced by the tropical continental air mass that brings dust and dryness (Olofin and Tanko, 2000). Consequently, there is reduction in humidity in the following hot dry season which continues to be low until May when it rises towards the approach of rainy season.

1.6.8 Vegetation

According to Olofin, (1987), the natural vegetation of Kano region is Sudan Savanna type except in the Northern most part where Sahel Savanna is found and Guinea Savanna in the Southern part of the Kano region.

The study area consist of trees which are hardly taller. The tree species are mostly adaptive to drought condition through long tap roots, leathery leaves and tiny leaves. The trees have canopies and of not more than 20 metres (Olofin and Tanko, 2000).

1.6.9 Evaporation

Bebeji Local Government Area experiences a very high evaporation which estimated to be about 60% to 75% of the total annual rainfall (Olofin and Tanko, 2000).

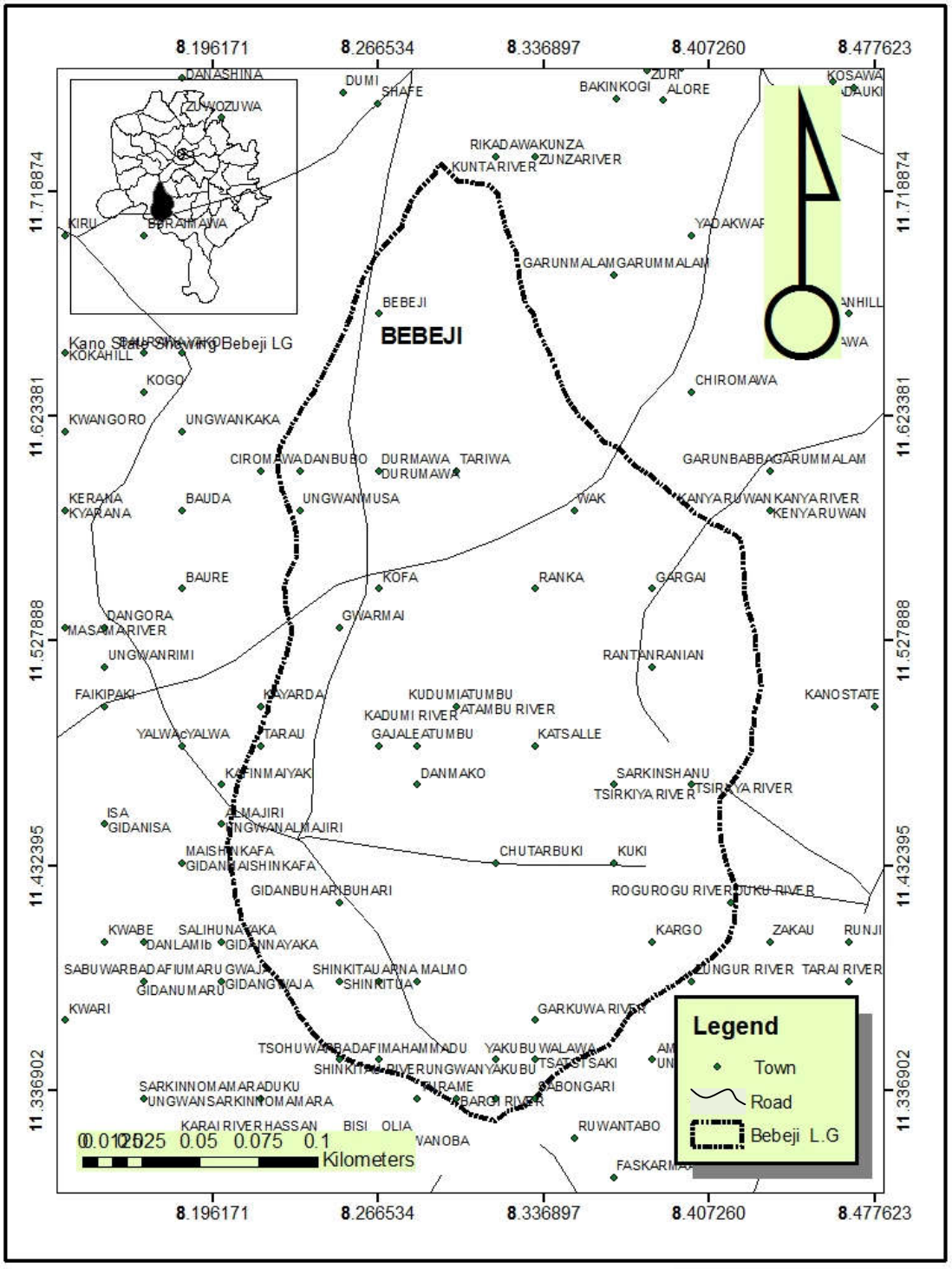
1.6.10 Population and Land Use

The estimated population in the study area according to N.P.C. (2006) is about 199,048 people and a population density of 200 to 227 persons per square killometre. Crop cultivation which is mainly operated during the rainy season is the major land use in the study area; however, irrigation activity is also practiced during the dry season where people engage in growing mainly

vegetable crops. Other land use activities include livestock rearing and poultry farming. The economy of the people is a combination of subsistence and market activities where farmers produce for consumption and sales in the local markets. Modern machines such as tractor and its implements and other agro-allied technology such as improved seeds and chemicals have intensified the farming activities in the area.

1.6.11 Soil

The soils of Bebeji Local Government Area is mature which occur in the basement complex section of the Kano region and are derived from wind drift material which covers the regolith of the ancient rocks. According to Olofin and Tanko (2000), these mature soils are latasols of the ferruginous type; they are not strictly zonal soils because they are highly influenced by parent material and topography of the area. The soils are highly acidic to alkaline and high silt clay particles and very low in organic matter and they are mainly loam and sandy loam (Olofin and Tanko, 20000. The colour of the soil is variable with fairly filtration and draining capacity. With good nature of the soil of the study area, one of the factors contributing to the increased rate of soil fertility decrease is the increasing land use intensity and of course excessive use of organic fertility by the farmers which result in low yield per unit area (Olofin and Tanko, 2000).



Sources: Geography Department BUK

FIGURE : THE STUDY AREA

CHAPTER TWO

2.0 CONCEPTUAL AND THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Concept of Safe Utilization of Herbicides

The word herbicide is derived from the Latin word herb, meaning “plant” and caedere meaning “to kill”. Herbicide had been defined by EPA (2007) as chemical substances or mixture of substances intended for killing pest plants that may be applied to the target area as spray or by hand using various techniques. It is also defined by Qasem, (2011) as a chemical negatively affects weeds’ normal growth, it quickly act and may be applied to a specific area or where other methods of weeds control are not possible or may be integrated with other weeds control methods.

The use of herbicides for weeds control and management took root with introduction of chemical called Bordeaux (mixture consisting copper, sulphate, lime and water) in 1896 which had developed interest in chemical weed control. The period between 1896 and 1910 was important for chemical use in weed control, as many chemicals such as sulpheric acid, ammonium sulphate, Iron sulphate, copper nitrate, sodium nitrate were discovered for weed control. There was little development on chemical weed control due to lack of spraying equipment until after 30 years, when 2,4-D (2,4- Dichlorophenoxyacetic acid) was discovered in U.K and U.S.A in their effort to create biological weapons in 1944. It was introduced as herbicide by Marth and Mitchell of U.S.A where it was successfully used in field weed control (Rao, 2006). Most herbicides are organic chemicals that are primarily made up of carbon (C) and hydrogen (H) atoms.

Herbicides discovery and development is a continuing process because there is always a need for newer herbicide to meet the changing situations in agricultural and non agricultural systems, to achieve greater efficacy and economy in chemical weed control and to minimize risk to the environment through toxicity and residues. This requires massive and expensive technical support by chemical industries, research institutions, universities and public agencies (Rao, 2006). Conceptually, safe utilization of herbicides is the use of herbicide with excellent control of weeds and relatively absence of damage or stress to the crop and applicator. Herbicides or chemical weed killers have largely replaced mechanical methods of weed control in countries where intensive and highly mechanized agriculture is practiced. Herbicides provide a more effective and economical means of weed control than traditional methods of weeds control. Besides being used in farms, herbicides are also used extensively in areas such as industrial sites, road sites, irrigation canals, recreational areas etc. to remove undesirable plants that might cause damage or present fire hazards (Ware and Whitacre, 2007).

Weeds have always been one of the main limiting factors that limit the ability to produce as much food as needed for the ever increasing population of the world with view of eradicating hunger and starvation. Since weeds are responsible for a loss of over 14% of global harvests, herbicides have been rapidly adopted worldwide. The popularity of these chemicals derives from the fact that they are the most reliable and least expensive method of weed control available today. The use of herbicides has simplified crop management attempting to kill weed population at acceptable levels. Herbicides and other agrochemicals have provided year after year tools to grow the most profitable crops on the same fields. Thus, reliance upon herbicides as the primary method of weeds control in crop management systems is understandable. Unfortunately, they are not free from posing serious environmental risks and substantial health dangers to the population.

Residues on food, groundwater contamination as well as occupational exposure to farm workers are not to be disregarded (Soloneski and Larramendy, 2011). It has also been stated by Ware and Whitacre (2007) that, weeds are objectionable to humans, primarily because they reduce the quality and quantity of agricultural production and produce allergens or contact dermatitis that affect public health. Approximately 10% of cell plant species are weeds, or a total of some 30,000 weed species, of this, 1,800 cause serious economic losses in crop production, and about 300 species plague cultivated crops throughout the world. The US has become home to 70% of the world's worst weeds.

In our society today, the common perception about herbicides is often different. This is because, in several surveys conducted, it was found that less than 10% of the interviewed considered herbicides dangerous for human and environment. Although the control and management of weeds in farms is a challenge faced by most farmers across the world (Ibrahim, et al, 2012). However, the concept of safe utilization of herbicides must be taken into consideration if is the only alternative option for the control and management of the weeds. All herbicides are potentially toxic for human beings and environment. They can however, be used safely if the user has full knowledge of the hazards involved and of the procedures to be followed to avoid these hazards. In handling herbicides, exposure to the chemicals must be avoided to the extent possible. Inhalation of herbicides spray, skin contact with herbicides or their residues, injection by mouth, smoking while working, spilling to the nearby water bodies and other avoidable exposure must be avoided. An ideal safe utilization of herbicides according to Rupalli et al, (2004) is minimizing the use of herbicide and its related risks in crop productions. Herbicides should be used as efficiently as possible. The efficient use of herbicides means appropriate application of herbicide in the correct formulation and in the proper amount,

applying them only where it is necessary, at the proper time, under the proper condition. An ideal herbicide should control target weeds, not to be toxic for the current nor for the next crop, not to be poisonous to man, be selective, be stable to protect the crop for a long time, break down fat into harmless substance in order not to contaminate food or environment, not to accumulate in food chains, keep its toxic effects to the target organisms when applied repeatedly, not to be mobile in the environment (Gleason et al, 2006)

2.2 Theoretical Frameworks for the Study of Herbicides

2.2.1 Weeds Control in Crop Fields

Weed control in crop fields constitutes a major factor in determining Agricultural yields. This fact explains the importance of synthetic herbicides in agriculture since their introduction in years following World War II. The principle of chemical weed control is to apply a product that selectively eliminates weeds without affecting the crop itself. Over the past fifteen years, in parallel with research into new selective herbicide molecules, a complementary approach has been developed: the selection of crop plant varieties tolerant to existing herbicidal substances. This herbicide tolerance permits the coupled utilization of a plant variety and its associated herbicide(or family of herbicides), which is thus applied “post emergence”, that is to say, to already developed crop and weed plants (Beckert , et al, 2011).

2.2.2 Herbicide in the Soil Environment

The environmental fate of herbicide is a matter of recent concern given that, only a small fraction of the chemicals reach the target organisms (Pimental, 1995) cited in (Zabaloy, 2011), leading to potential impacts of residual herbicides in soil and water have in human, animal and crop health. It is important to note that, while herbicides are important to Agriculture, under certain

circumstances, they may act as pollutants that can deteriorate soils, ground waters and surface waters (Zabaloy, 2011). While most herbicides are not intentionally applied on to soil, they can enter the soil environment through different ways. According to Zabaloy, (2011), the distribution of herbicides in the soil depends on partitioning between the soil solution and the solid phase. The chemical is partitioning between the soil solution and the solid phase. The proper term for this process is adsorption equilibrium which can be written to describe the interaction between any herbicide and any soil component is follows:-

C + H (aq) =SH

Where S represents a surface site of soil, H (aq) the herbicide is soil solution and SH the herbicide attached to the surface site. These sites are provided by soil minerals (clay, Fe, and Mn Oxides etc) as well as by organic matters

2.3 Different Methodologies Used for Different Studies of Herbicides

This section concerns the procedures that researchers adopt in designing sampling procedure and size, collecting data, analyzing and interpreting data which are the tools for achieving the aim and objectives of their research. A single research might have different methodological techniques for achieving the aim and objectives, however, simple and precise methodological technique that will enhance successful and well accepted research should always be considered. Therefore, the researcher is intended to overlook various methodological techniques adopted by researchers in carrying out their study similar to the one intended by the researcher.

In a research conducted by Jamala et al, (2013), where they assessed agrochemical utilization among smallholder farmers in Guyuk, Adamawa State, they formed their sample according to purposive and random sampling technique, where they divided the population into ten (10) wards

within the study area from which they selected the sampling size randomly. Data was collected using structured questionnaire. Data obtained were analysed and interpreted using descriptive statistics that included the use of frequency distribution and percentages. They used chi-square (x^2) to test for the presence of association among the variables obtained. Iyagba (2013) also assessed the safe use of herbicides by horticultural farmers in Rivers State, Nigeria. He used the same methods adopted by Jamala et al, (2013), but included field observation apart from questionnaire administration in accessing data. Another research conducted by Kolo (2004) where he surveyed farmers during the 2001 rainy season. His survey was aimed at evaluating the rate of chemical weed control technology adopted in Niger State. He also adopted the same methodology adopted by Jamala et al, and Iyagba in his sampling procedure, data collection, analysis and interpretation of the result. Olowgbon et al, (2013) in a study that aimed at assessing Nigeria's small scale farmers' agrochemical use, the health and safety implications in Ibadan metropolis. It is observed that, the data used in the research were obtained with the aid of questionnaire administered to farmers randomly selected from the farming population in the area. And simple statistics such as mean, mode, percentages and frequency were used for the data analysis.

The effect of herbicides on crop production and environment in Makurdi Local Government Area of Benue State was studied by Kughur (2012). He collected the data by using simple random sampling technique using structured questionnaire administered to sample farmers. He divided his sampling frame into four (4) council wards. Data were analysed through descriptive statistics. Huwang, et al (2013) in (Lado and Hussaini, 2014), have assessed the sources and utilization of inputs (herbicides included) for cowpea production in Abuja in 2013. They took Gwagwalada and Kwali area council to represent the sample population (Abuja). They used

questionnaire and field observations as the main tools for data collection. The questionnaires were administered randomly with the aid of interpretation. The information obtained was subjected to simple statistical method of percentages and the data analysed was presented as bar charts. Another research was conducted by Gushit et al, (2013) in Plateau State, Nigeria, in 2013 where they assessed the practice and risk involved in the usage of herbicides by farmers, marketers and agricultural extension workers. They used field survey and semi-structured questionnaire administration in collecting data. They adopted descriptive statistics in analyzing the data collected.

It is in view of these therefore, that this work used the same methodology adopted by Jamala et al (2013) and Iyagba (2013) in conducting this research.

2.4 LITERATURE REVIEW

2.4.1 Global Herbicides Use in Agriculture

Herbicides have been known for its ability to control weeds for decades and they have played and will continue to play vital roles in the field of agricultural production. The increasing population of developing countries and the attendant need to increase food production is a pointer that herbicides must be used in an increasing proportion in order to increase the much needed food and produce it sufficiently (Iyagba, 2013). About 80% of the world herbicide production is consumed in advanced countries, only 20% is left for developing countries in which Nigeria belong (Ado, 2007 cited in Iyagba, 2013). According to Jamala et al, (2013), most African countries' economy is dependent on agriculture and the agriculture sectors use enormous quantities of chemicals including herbicides, although, most often the users neither follow instructions nor understand the potential hazards of careless handling of these chemicals. It is

observed by Okopido (2002) cited in Gushit et al, (2013) that misuse and abuse of this class of chemical farm inputs are likely to be rampant in Nigeria due to inadequate education on the guidelines and control on safe use and disposal of used herbicides containers and limited awareness about the lethal toxicity of the chemicals. The use of herbicides in agriculture is the most common way of controlling weeds worldwide. It is difficult to completely imagine the levels of today's yield without the use of chemical weeds control worldwide. There is growing concern about the known and unknown consequences of herbicides in the environment and human health, while there is already a strong public pressure to reduce their use in some countries. Problems with the use of herbicides are usually worse in developing countries where many products of the WHO category 1 are still used. These products are highly toxic leading to considerable amount of poisoning (WHO, 1999 cited in Oladipo et al, 2006).

2.4.2 Significance of Herbicide in Crop Production

Herbicides are compounds that are artificially produced in large scale to improve the efficiency of crop production by eliminating competition from crops, protecting them from diseases and enhancing or controlling their growth. The majority of the crop protection chemicals are herbicides, the objectives of which are to reduce or eliminate an unwanted plant that disturb our desired or valuable crops by either consuming part of the biomass or even causes inconveniences (Mannion, 2001). Herbicides are chemical toxic to plants which inhibit some vital processes in plants to the extent that the plants die up or can no longer grow (Mcwen et al, 2002). For chemicals that are to be used to control weeds within agricultural crops or planting of other desirable plants, there must be some methods of achieving selective phytotoxicity are prepared when no vegetation is wanted in the area. For effective control of weed flora of an area, rationale use of various herbicides should be encouraged so as to minimize

residual accumulation in the soil. According to Akubundi (1987) cited in Dadari et al, (1999), the chemical weeds control combined with cultural practices (integrated) may be practiced in reducing weeds competition and labour cost. The use of herbicides is reported to have reduced the cost of weed control, cost of production and increase the profitability in field/vegetable crop production (Lagoke and Shebayan, 1988 cited in Dadari et al, 1999).

2.4.3 Basic Principles and Methods of Herbicides Application

Herbicides are chemicals negatively affecting weeds' normal growth, they quickly act and may be applied to specific area where other methods of weed control are not possible. Although the use of herbicides for weeds control create public concern and receives much critics nowadays due to lack of technical extension and experience in herbicides application. In addition, lack of correct diagnosis of the weed problem, selection of incorrect herbicide and prevalence of unsuitable weather conditions, improper application techniques are all reason behind failure of herbicide in controlling existing weeds. Proper handling, precautions and some considerations in herbicides application in the field are factors that need to be considered as they contribute in the success of chemical weed control. Diagnosis of the weed species found in the field is the first step towards any successful weed control program (Qasem, 2011). Application of herbicides is related to the form of the herbicides formulation and the equipments to apply the herbicide. According to Foy and Pritchard (1996) cited in (Qasem, 2011) Herbicides formulations are many including water soluble liquids (require wetting agents), water soluble powders (need stirring or agitation in preparation), water emulsion (require some agitation and held together by an emulsifier), wettable powder (need continuous agitation and most used in soil), water dispersed liquids, water dispersed granules, granules (need water to leach them down in to the soil) and pellets (usually used in spot treatments). However the most used formulations are aqueous and

granules and are all applied by either sprayers or spreaders. Qasem (2011) further stated that, the main and serious problem with herbicides application or uses is the people using these chemicals. Wrong application commonly resulted from failure in sprayer calibration. Sprayer calibration aims at uniform herbicide spray distribution and coverage of treated surface/weeds that means the receipt of the same amount of spray solution per each unit area of treated surface. Sprayer calibration is the first step to be carried out before herbicide application. While Badowski et al, (2008) cited in (Qasem, 2011) suggested that, herbicides application in the field should be carried out since failure of uniform distribution of any herbicide may result in ineffective weed control or crop injures and thus herbicide residue.

According to Lado (2009) cited in (Lado, et al, 2012), herbicides are applied in various ways to plants or soils, the most common method is by broadcasting and it can also be applied as band treatment and injection. The choice of method for herbicides application is influenced by herbicide formulation, target to be treated and the type of weed problem to be solved. Rao, (2006) stated that herbicide application is determined by; time, weed species, time of germination, weed and crop plants, and plants growth stage. Most herbicides are water based sprays using ground equipments that vary in design according to the area to be sprayed. Tu et al, (2009) suggested that, herbicides can be applied in variety of ways; the most appropriate is determined by the weed being treated, the herbicide being applied, the skills of the applicator and the application site. The ways are:

Foliar application: this is method where by herbicides are applied to the leaves and stems of a plant.

Basal bark application: this method applies a 6-12 inch band of herbicide around the circumference of the trunk of the target plant, approximately one foot above ground.

Frill method: this method can also be called "hack and squirt", in this method, the plant is cut using a sharp object. Herbicide is then immediately applied to the cut with syringe or similar equipment.

Injection: according to Hawver et al, (2000) cited in (Tu et al, 2001) herbicide can be injected in to the trunk of a tree using a specialized tool such as metal tube that has teeth on one end that grip the trunk of the tree. A sharp push on the other end of the tube sends a brass capsule of herbicide in to the trunk tree. It is convenient way of applying herbicide and requires minimal preparation or clean up. It is also an easy and safe way to supply herbicide with minimal exposure.

Cut-stump: this method of herbicide application is often used on woody species that normally re-grow after being cut. The herbicide is applied to the entire exposed cambium of the stump within minutes after the trunk is cut using sprayer or point brushes. The outer bark is need to be sprayed.

2.4.4 Classifications and Properties of Herbicides

Hundreds of different herbicides are now commercially available and in order to better understand how they work, and hence more easily to select, on a particular purpose, it is useful to group together those with similar properties. Herbicides properties have to be duly considered when deciding to use herbicides and these properties include: (a) safety (b) herbicides effectiveness against the target species (c) behavior of the herbicide in soils, water and vegetation (d) mechanisms of spread to non target organisms and (e) toxicity to birds, soil

organisms, aquatic organisms, wild lives and human. No classification can be absolutely rigid and there are some herbicides that may fall into more than one group. Kasasian (1971) built useful classification on the basis of: (a) Time of application (b) Type of weed to be controlled, and (c) Whether the effect is primarily through the shoot or root. Ferell et al, (2006) reported that herbicides may be classified in several ways depending on where or how they are applied and their action in or on the plant. Herbicides may be either foliage applied or soil applied. They consist of contact or system i.e. materials that translocated throughout the plant. Herbicides may also be selective or non selective. Some herbicides may be effective either foliage or soil applied. Whether herbicide is selective or non selective may depend on several factors such as the crop or weed present, time of application and rate of application. However, genetic engineering has resulted to transgenic crop varieties that are sensitive to some herbicides. Retzinger and Mallory-smith (2003) suggested their classification based on site action. The classification system was developed with the idea that if the site of action of a herbicide was easily and readily available, recommendations for herbicides resistance management would be easier. However, this publication was revised in 2013 by the authors where they stated that herbicides with the same site action were assigned a group number. The International Herbicide Resistance Action (HRAC) published a similar classification system; however, that system used letters instead of numbers for group designation. According to Rao (2006) herbicides are classified based on method of application, chemical affinity and structural similarity and mode of action. While Qasem, (2011) based his classification on different factors which are; selectivity (kill or inhibit weeds and don't harm crop plants beyond point of economic recovery), action (kill plant parts that become in contact with) and method of application. Therefore, herbicides are grouped into three (3) main types based on mechanism of action. Action of herbicides is related to the effects

of the chemical on growth and development of crop or weeds. Active herbicide inhibits or prevents the germination and growth processes of the weeds. Herbicide is said to be contact when it destroy only the plant tissue in contact with chemical and it is called systematic herbicide when its activity starts from foliar down to the roots or from soil up to the leaves. Selectivity of herbicides is its ability to kill target plant species in a mixed plant population without affecting the other plant in the mixed. The classes are:

Pre-planting herbicides: These herbicides are applied on the soil surface before the crop is planted, in most cases at present time these herbicides are incorporated in to the soil as pre-plant treatment. The great advantage of these incorporated treatment is that the herbicides is placed in the zone where weed seeds germinated and is not dependent on rainfall to move the herbicides into this zone. Herbicides which have greater toxicity on the emerging crop seedlings are applied before the crop is planted.

Pre-emergence: These herbicides are applied to soil surface when the seeds are planted prior to the emergence of both weeds and the plant. It prevents the germination or early growth of weeds by inhibiting key enzymes. This pre-emergence application is usually applied to soil surface and requires rainfall or irrigation to move the herbicides into the soil, if the herbicide is not moved into the soil where the weed is located it will not be effective and if left on the soil surface these herbicides are often lost due to photodecomposition and vapourization. In some areas of the world, pre-emergence herbicides are used to prevent crab grass (annual grass) from appearing in summer lawns (Robert, 2010).

Post-emergence herbicides: These herbicides are applied after crop weeds have emerged. It is applied to weed foliage within two weeks after crops or weeds have emerged.

They can be selective or non selective herbicides; selective herbicides are designed to act on only one type of pest plant and are much more useful when the focus may be on controlling a particular weed species (EPA, 2007).

According to Lado, et al, (2012), pre-emergence application of herbicide provides early weed control. The use of post-emergences will assist in controlling weed that escape pre-emergence herbicides. The advantage of using post-emergence herbicide alone is that it gives the farmer a chance to decide if the weed pressure warrants herbicide application when additional planting competes for limited farm labour.

2.4.5 Principles for Handling and Safe Utilization of Herbicides

Although herbicide is believed to be beneficial to farmers in weed control, however, it could be harmful to the users and environment if not properly utilized. Wopereis et al, (2009) cited in (Iyagba, 2013) stated that, although herbicides lead to increased food production, there is every reason to use them properly to safeguard the people and the environment. Farmers' knowledge regarding safety application techniques, timing and dosage of herbicides use is often adequate. Iyagba (2013) suggested some precautions that, it is important that before application, the user wears the recommended protective clothing, note the direction of the wind, minimize herbicide ingestion by avoiding eating, drinking, smoking and talking during application and after application, proper disposal of containers and unused herbicide mixture, washing of equipment, cloth and proper bathing. According to EPA (2007), as a responsible user of herbicides you will need to consider all aspects of safety, including safety transport, storage and mixing of chemicals. You will need to understand how to operate spray equipment and the principle of calibration. First you should know how to read the labels on herbicides containers.

They further stated that, when purchasing herbicide ensures that the container is in good condition and not leaking. Preparation is the best defense against emergencies. You should develop an appropriate emergency plan allowing you to deal with such a situation. Make sure you have access to appropriate emergency equipment including protective clothing, spill containment and clean up equipment. If chemical is splashed in the eye, wash it immediately. Hilmer (2000) cited in (Tu et al, 2001) stated that for safety handling of herbicides, protection measures have to be considered. Herbicides labels indicate the maximum protective equipment required by the users. This may vary, depending on the application technique adapted. Users should note that cotton, leather, canvas and other absorbent materials are not chemical resistant, even to dry formulations. He further provided personal protection measures before and after herbicide use as: (i) Always wear at least a long-sleeved shirt, long pants, sturdy shoes or boots and socks. The more layers of fabric between the herbicide, the better the protection. (ii) Hands and forearms usually receive the most herbicide exposure. Wear chemical resistant gloves and tuck sleeves shirt that reach up to forearms. (iii) Canvas, cloth and leather shoes or boots are almost impossible to clean adequately. Wear chemical resistant rubber boots that come up to at least half way to the knee if the lower legs and feet will be exposed to herbicides or residues. (iv) Wash hands thoroughly before eating, drinking or going to the bathroom. (v) Herbicide user requires goggle, face shields or safety glasses with shields (some handling activities pose more risks to eyes than others. Dust concentrates and fine sprays have the highest risk of causing herbicide exposure). (vi) Change clothing and put clothes used during herbicide application in plastic bag, and keep it away from children. (vii) Use detergent and warm water to wash your clothes, hands, forearms, face and any other body parts that may have been exposed to herbicides. (viii) Take birth with warm water and wash your hair and body at the end of the

herbicide application. (ix) wash all protective equipment with hot water and detergent, rinse with clean water and hang to dry in a plenty air away from living areas. (x) When contact with eyes or skin, wash the eyes or skin with normal saline or plenty water for about 15 minutes and refer to doctor. (xi) In case of poisons or ingestion, take milk and call doctor immediately. Meijden, (1998) cited in (Olowogbon et al, 2013) believed that, a major cause of poisoning when using knapsack sprayer is the spilling of herbicides over the back of the operator because of a faulty locking cap of the container and in over aged rubber hoses and not renewing or loosing washers are a great cause for leakages that often poison the users, wastes herbicides causes environmental pollution and may become phytotoxic where herbicides fall on crops at high doses. Lack of safety precautions causes contaminations and poisoning in the field. Unfortunately, investment in protective clothing, masks or gloves only pay a back in terms of health and wellbeing, not in financial terms. In Nigeria generally, farmers do not wear any protective materials at all, no matter what pesticide is being applied. Other precautionary measures are scarcely observed by these farmers as they are found eating, drinking or smoking in between spraying activities. The leftover herbicides and empty containers are not properly disposed as the containers are sometimes washed and used for domestic purposes. Herbicide is never completely empty from the container, it can therefore pose serious hazard to people, animals and environment if not carefully disposed. However, the hazards can be minimized by rinsing the empty container with plenty of water before disposal. The disposal is done by crushing and burying the emptied container in a safe location in the farm premises. The burial pits should be at least 200m away from livestock grazing areas, wells, steams and where water supply will not be contaminated. According to Libich et al, (1984) cited in (Tu et al, 2001) herbicides should only be mixed in pre-designated area preferably in an area near the treatment

site in which damage from small spills or other herbicide contamination will be minimal. Carefully measure the herbicide concentrate and add to the tank water as small measuring error can lead to large errors in the amount of herbicide applied. Keep containers below eye level when opening and pouring. Be aware of weed direction before pouring to minimize exposure down wind. Herbicide user should ensure that, the herbicide is transported in tightly sealed container so that leaks to the environment or on to the user are prevented.

In most countries herbicides must be approved for sale and use by government agency. For example, in the United State, the Environmental Protection Agency (EPA) does so. Study must be conducted to indicate whether the material is safe to use and effective against the intended herb. During the registration process, a label is created. The label contains directions for use of material based on acute toxicity, herbicides are assigned to toxicity class. Some agrochemicals are considered too hazardous for sale to the general public and are designated restricted use chemicals. Only certified applicators which have passed an examination may purchase or supervise the application of restricted use chemical. Ensuring safe and effective use of herbicides will be achieved by increasing awareness, training and the dissemination of relevant information, and by enacting legislation of control sales, distribution, use, production, formulation and disposal. There is further need for research in to alternative herbicides and the deployment of herb-management strategies (Khugur, 2012). The residual tolerance and safety period of herbicides according to Schoebroeck et al, (1992) is of great importance for the safety of both people and animals to know what happens after herbicides have used. There is currently a mandate on every pesticide to be decomposed within certain time limit into parts dangerous to neither people nor animals. This applies to not only that portion sprayed on the plants but also to that on the soil. On food crops, a compound must be decomposed to such an extent that any

residue would not be dangerous for the consumers. The level of these residues is known as residue tolerance. Separate residue tolerance level has been established for the various chemicals and for the different agricultural and horticultural produce. The residue tolerance is expressed in milligram per kilogram (mg/kg in ppm) an example of which is that of paraquat (Dimethyl-4-bipyridinium dichloride) which is one of the most widely used herbicides. Its residual tolerance in potatoes and grains is 0.1 and 0.05. He further stated that safety measures are structural measures such as adopting the law, forbidden dangerous chemicals, introducing cultural practices that prevent weed infestation, and training concerning integrated weed management and supplying medical facilities in the event of accident with herbicides.

2.4.6 Impacts of Herbicide Utilization

2.4.6.1 Environmental Impacts of Herbicide Use

Modern agriculture relies heavily on herbicides for control of weeds in crops and pasture to maximize yields and economic benefits to sustain an increasing world population. However, the environmental fate of herbicides is a matter of recent concern as small portion of the herbicide reaches the target organisms. While herbicides are very important to agriculture, under certain circumstances they may act as pollutants that can deteriorate soils, ground and surface water, while most herbicides are not intentionally applied on soil, they can enter the soil from direct interception of spray, runoff of herbicides from vegetation and leaching and from dead materials. Herbicides in soil causes toxicity to soil micro organisms which may alter community structure including potential increase in plant or animal pathogens, herbicides may also cause changes in microbial community function and concomitant impacts on soil health and ecosystem processes (Zabaloy et al, 2011). It is stated by Ananata (2002) that, herbicide plays an important

role in the disturbance of soil ecosystem when soil micro flora and fauna lies in the breaking down of organic matter; incorporating it into the soil and releasing nutrients for plant growth. The herbicides can have direct effect upon decomposing micro-organisms, root pathogens and disease antagonists such as parasites and predators as well as organisms pathogenic to invertebrates. As herbicides are designed specifically to minimize plant diversity by controlling weeds thus promoting monoculture, so, they can also indirectly decrease populations and diversity of related soil organisms and lessens the natural input of organic matter into the soil as well as have direct effect on soil organisms. According to Miller (2004), over 95% of the sprayed herbicides reach destinations other than the initial target species including air, water, bottom sediments and food. When herbicide is sprayed, it unintentionally diffuse and suspends in the air, as particles are carried by wind and many blown into nearby areas potentially posing threats to human and wild lives. Havens et al, (1995) stated that, in some conditions, herbicides can be transported through leaching or surface runoff that leads to ground water or distant water sources contamination which are all intensified by persistence degradation and high water solubility. The amount of herbicides that migrate from the intended application area is influenced by the particular chemical's properties such as its tendency for binding the soil, its vapour pressure, its solubility and resistance to being broken down. Factors in soil such as its texture, its ability to retain water, its organic matter content also affect the amount of herbicide that will leave the area (Kellog et al, 2000). The benefit of grass cover or weeds such as reduction of runoff and erosion, maintenance of fertility in the soil etc. must be weighed against the demerit when using herbicides. Herbicides can contaminate on intended land and water when they are sprayed aerially or allowed to runoff fields, or when they escaped from production sites and storage tanks or inappropriately discarded. Miller (2012) asserted that, some herbicides contribute to the global

warming and the depletion of the ozone layer. The use of herbicides is replacing other practices of land use management which are rather complex, because weeds exist in a wide variety of environment and this must be considered when alternative management strategies are proposed. Other factors need to be considered in chemical weed management systems are factors concerning cycle of nutrients and maintenance of soil fertility (Ayoade, 2005). Herbicides residues in soil can be directly toxic to soil micro organisms or can exert substable effects by influencing their activities, behavior, reproduction and metabolism. Soil organisms such as earth movers suffer strong toxic reaction due to the use of herbicides (Tudun Wada, 2004). Agricultural chemicals have significantly increase crop yield in the short term by limiting damage by pest, competition for water and nutrients from weeds and by providing large amounts of nutrients in a form that is easily available to plants. In the long term, these processes can lead to serious depletion of soils because the natural processes of converting organic matter and the balance of micro organisms in the soils have been disrupted. Herbicides used against control of grasses can kill beneficial insects like lady bugs, aphids, among others. When the beneficial insects are gone, there is no natural control over the pest, so their populations can increase much more quickly after the initial application, requiring further application of pesticides to control the original pest. Herbicides can kill butter flies, moths, spiders and bees which play other roles in the environment such as pollinating plants. Herbicides can also be used in animal production as antibiotics administered either by injection or combined with feed to control infectious diseases and parasites that often arise when animals are raised under extreme crowed conditions (Khugur, 2012).

Beckie (2009) stated that since the 1980's, declines in amphibians population including crashes and mass localized extinctions has been noted from locations all over the world. These

declines are perceived as one of the most critical threats to global diversity, and several causes are believed to be involved among which is the use of herbicides. Amphibians generally have a two staged life cycle consisting of both aquatic larvae and terrestrial adult phase, they are sensitive to both terrestrial and aquatic environmental effects because their skins are highly permeable, and they may be more susceptible to toxins in the environment than other organisms such as birds or mammals.

2.4.6.2 Health Impacts of Herbicide Utilization

The intense controversies surrounding the health risks of herbicides utilization and in particular the environmental implications of the contaminants o some herbicides have resulted in heated debates over decades of year (Malik and Vanden Born, 1986). According to Howard et al, (1992) cited in (Tu, et al, 2009), herbicides have variable wide toxicity in addition to acute toxicity from high exposure levels; there is concern of possible carcinogicity. Some herbicides cause a range of health effects ranges from skin rashes to death. The pathway attack can arise from intentional direct consumption, improper application resulting in the herbicide coming into direct contact with human or wildlife, inhalation of aerial sprays or food consumption prior to the labeled pre-harvest interval. Under stream conditions herbicides can also transported through surface runoff to contaminate distant water sources. Brandi and Reinachers (2012) stated that most herbicides used in agriculture contain an active substance called glyphosate (Roundup). The compound was to radically affect the metabolism of plants by preventing them from forming essential amino acids. Environmentalist, veterinarians, medical doctors and scientist, however, have raised increasing alarm about the danger of glyphosate in the animal and human food chain and the environment due to the fact that glyphosate have been found in animal's urine, faeces, milk and feed of the animals and even more alarming,

glyphosate was detected in the urine of the farmers. Study conducted in early 2009 prove that even small amount of glyphosate presence in desiccated crops, as found in animal and human foods causes cell damage. Increased use of herbicides in recent years causes more concerns about their effect on farmers' health. While herbicide technology has made remarkable progress in terms of developing sage herbicides that are less toxic to human beings, many farmers still suffer from chemical poisoning after applying herbicide. The extensive use of pesticides poses a more direct problem on farm workers. Epistemologies data shows that workers who handle pesticides more than 20 days a year have an increased risk of developing certain type of cancer (Dahama, 1997 cited in Ghimire, 2002). While Weiss et al, (2004) cited in (Rao, 2008) posited that, the most common health effect of herbicides is irritation to the skin and respiratory track, however, acute exposure to certain highly corrosive herbicides can cause multi- system injury and pulmonary failure. It is also observed by Gushit et al, (2013) that herbicides are widely associated with so many risks that can be hazardous if not properly managed and handled. The common risk associated with human beings include; acute toxicity, chronic toxicity, carcinogenicity, tetragenicity and biological concentration. It is certain that human exposure to herbicides and other pesticides is an important health and social issue as it usually result in serious health challenges such as respiratory disorder, strokes, epilepsy, cancer, leukemia, brain and liver tumours and convulsion. Other herbicides effects on humans stated by Jurewicz and Hanke (2008) cited in (Khugur, 2012) include damage to the reproductive and nervous systems and other organs, behavioral and developmental abnormalities, interference with hormone function as well as affecting the immunity system. Herbicides gather fat deposits in the body where they stay and cause a lot of damage. Most of the infants and young children drinking breast milk ingest herbicides as women who eat fruits and vegetables that have been sprayed

with pesticides may pass the chemicals through their breast while pregnant women can pass the chemicals unto their fetus.

Programmes that aimed at weeds eradication organized by Agricultural Protection Board (APB) in the Kimberley region of Western Australia were undertaken during 1970s and 1980s, the programmes involved people in the spraying of 2,4-D and 2,4,5-T have reported suffering from ill health as a result of exposure to herbicides . An interview conducted indicated that personal protective clothing was rarely worn amongst sprayers and the majority of workers believed the spray to be middy toxic, harmless or hard to understand of its toxicity. A range of past and current symptoms and health problems were reported, which include the nervous system, skin, constitutional, gastrointestinal, musculoskeletal, reproductive, respiratory, psychology, urogenital, cardiovascular, endocrine, cancer and immunological (Hamper, 2002 in Khugur, 2012).

2.4.7 Resistance of Weeds to Herbicide

Resistance of weeds to herbicides is the inherited ability of weeds to survive and reproduce following application or exposure to a dose of herbicide. This is a serious problem that could totally cause shift in weed population from susceptible to resistant. The main cause of this is the high selection pressure imposed by use of only single herbicides having the same mode or mechanism of action for a relatively long period (Qasem, 2011). Development of certain biotypes of weed species that are resistant to herbicides is a great problem facing agricultural producers currently. The occurrence of herbicide resistant weeds has increased during the past decade, but the first reports of herbicide-resistant weeds were documented as early as 1950s, when dandelion and wild carrot biotypes were reported to be resistant to 2,4-D and to date

resistant to triazine herbicides has been documented most frequently (Hager and Sprague, 2000). They further stated that, appearance of herbicides resistant weeds is the consequence of using herbicide with a single site action year after year or of repeating applications of herbicide during the growing season to kill a specific weed species not controlled by any other herbicides or in any other manner. This can be as a result of genetic mutation occurs within a plant following the application of herbicide or natural selection. However, according to Lado et al, (2012), the choice of best herbicide, herbicide combinations and proper time of application and its proper dose is an important consideration for better output. According to Beckie (2009), a survey conducted has revealed that, minimum till or no-till cropping systems alter the soil micro climate, resulting in cooler soil temperatures at or below the surface due to greater soil moisture levels at greater crop residue on the surface reflecting sunlight relative to that in conventional tillage systems. Thus, some degree of soil disturbance in the cropping system may reduce the risk of herbicide resistance either by facilitating a reduction in herbicide use or by slowing the rate of weed seed bank turnover. It is therefore suggested that cropping diversity is the basis of proactive weed resistance management (Beckie, 2009).

2.4.8 Alternatives to Herbicide Utilization

Application of herbicides is the main method by which unwanted vegetation is controlled at present. However, it is important to see its use reduced over time, and that alternative management approaches are promoted instead. This is due to its environmental effects, and that it only provides temporary reduction in pest plants rather than a long term solution. Alternatives to the use of herbicides are available and it include methods of cultivation, use of biological pest controls (such as pheromones and microbial pesticides), genetic engineering, and methods of interfering with insect breeding (Miller,2004 cited in Khugur, 2012). He further stated that,

methods of alternative weed control are becoming increasingly popular and are often safer than traditional herbicides. Cultivation practices include polycultures (growing multiple types of plants), crop rotation, planting crops in areas where the pests that damage them do not live, timing planting according to when pests will be least problematic and use of crops that attract pest away from the real crop. According to Barker and Prostak (2008), several alternative herbicides are marketed as products to manage growth of vegetation. These materials have an active ingredient that is often of plant origin and include various by products of food and feed processing and materials that are prepared particularly for their herbicidal activities. Corn gluten meal (CGM) has been publicized widely in recent years and is another example of a plant by-product with herbicidal effects. Its common use is as feed supplement for livestock and poultry. Christians (2001) cited in (Barker and Prostaks, 2008) stated that, about 20 years ago , during studies of fungal pathogens of turf grass, corn gluten meal (CGM) was noted to inhibit root formation of germinating seeds. And thus its herbicidal effectiveness is limited to pre-emergence applications. It is commonly applied as a powder or in a pelletized form to the surface of the soil. Other alternatives for weed control are the mechanical treatment which involves physical removal or alteration of vegetation to kill plants or suppress their growth. These methods include mowing, manually removing weeds from plants, heat treatment (flaming and steaming), covering weeds with plastic, maintaining healthy soils which breed healthy plants that are resistant to pests, introducing cultivation practices which prevent weeds infestation.

Based on the literature reviewed, it is found that, there has never been any research on the safe utilization of herbicides among the smallholder farmers in the study area. It is on this base therefore, that this study attempts to assess how farmers handle and utilize herbicides and the problems in the study area.

CHAPTER THREE:

3.0 RESEARCH METHODOLOGY AND PROCEDURE

3.1 INTRODUCTION

This chapter is concerned with the processes this work follows in order to achieve the aim and objectives of the research.

3.2 RESEARCH DESIGN

This research is mainly social and field survey investigation in which the work collected information about smallholder farmers and herbicides use in Bebeji Local Government Area. Information was collected using structured questionnaire tool, primarily designed to address issues raised by objectives I, ii, iii and iv of the research, which state:

I. To examine the different problems of herbicide utilization in the study area.
II. To examine the level of compliance with safety measures of herbicides utilization among the smallholder farmers in the area.
III. To examine the different sources of herbicides in the study area.
IV. To examine farmers' understanding of the herbicides.

The field survey is meant to visit farmers in their various farms to observe how the smallholder farmers in the study area handle and utilize herbicides.

3.3 DESCRIPTION OF THE RESEARCH SUBJECT

This research is concerned with smallholder farmers' safe utilization of herbicides in Bebeji Local Government Area.

Use of chemical (herbicides) is a method adopted to reduce cost of eradicating or limiting the spread of weeds in the farm. The method is adopted to replace the traditional method that was used before the introduction of chemicals in recent years, and this method is well adopted among the smallholder farmers of Bebeji Local Government Area.

3.4 PROCEDURE OF SAMPLING THE FARMERS

The sampling procedure adopted in this work is non-probability sampling technique (purposive sampling technique}. This is because herbicide use is well adopted in the study area. About 95% of the population of Bebeji Local Government Area are smallholder farmers (NPC,

2006), that have adopted herbicide use in their crop production. The area has fourteen (14) wards which include; Anadariya, Baguda, Bebeji Cikin gari, Damau, Durmawa, Gargai, Gwarmai, Kofa, Kuki, Rahama, Ranka, Rantan, Tariwa and Wak. The wards differ in terms of population size recorded during 2006 census, therefore, these differences in population size formed the bases for selection of sample size, such that the number of samples selected from the wards are representative of the population of the study area. However, because of the types of the information require from a single farmer, a total of one hundred (100) farmers were selected as sample size. Therefore, one hundred questionnaire were administered, eight (8) for each of the ten (10) most populated wards which include Bebeji C/gari, Durmawa, Gargai, Gwarmai, Kofa, Kuki, Rahama, Ranka, Ranta and Wak. And five (5) for each of the remaining four (4) less populated wards of the local government area which include Anadariya, Damau, Baguda and Tariwa.

TABLE 3.4 : SHOWING THE ESTIMATED POPULATION OF EACH OF THE 14 WARDS OF THE STUDY AREA AND THE NUMBER OF THE SAMPLE SELECTED FROM EACH

Wards	**Estimated Population**	**No. of Samples Selected**	
		Male	**Female**
Anadariya	9515	4	1
Baguda	12615	5	
Bebeji C/gari	15206	8	
Damau	12011	5	
Durmawa	14507	8	
Gargai	14217	8	
Gwarmai	18859	8	
Kofa	14013	8	
Kuki	16423	6	2
Rahama	13982	6	2
Ranka	15819	8	
Rantan	14235	8	
Tariwa	13228	5	
Wak	14221	8	

Source: Field work 2014\

3.5 PROCEDURE FOR DATA COLLECTION

A structured questionnaire administration was the primary source for data (information about herbicide use and its problems) collection in this work, which will be interpreted to the respondent. Snowballing method was employed as a basis for selection of respondent, where by the farmer will be interviewed at convenient time after which the respondent direct the interviewer to another individual who also meet the criteria of the research work. Another procedure for data collection in this work is field survey which involves visiting the farmers in their farms to observe how they handle and use the chemicals on their farms and also the photographs of the farmer in action will be included. Information will also be collected through interviewing herbicides sellers.

3.6 PROCEDURE FOR DATA HANDLING AND ANALYSIS

All information generated using questionnaire were handled and analysed using statistical technique. The statistical methods used include percentages, mean and standard deviation. Spearman's correlation co-efficient was employed to identify the relationship between education of the farmers and their ability to adopt the use of herbicides in crop production, and the relationship between herbicide use and its availability in the area will also be identified. A t-test was employed to test for significance level of compliance with safety measures for herbicides use among the smallholder farmers of the study area. Data collected through field observation will be used directly into the research work.

3.7 PROCEDURE FOR DATA PRESENTATION

All information generated and analysed in this research work will be presented using descriptive statistics and tables while observed data will be presented using photographs.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 INTRODUCTION

This chapter presents and discusses all the information gathered in the field. The chapter also discusses the access to and utilization of herbicides by smallholder farmers including the problems associated with herbicide utilization and safety measures in handling herbicides adopted by smallholder farmers.

4.1 Classification of Farmers According to Experience in Farming

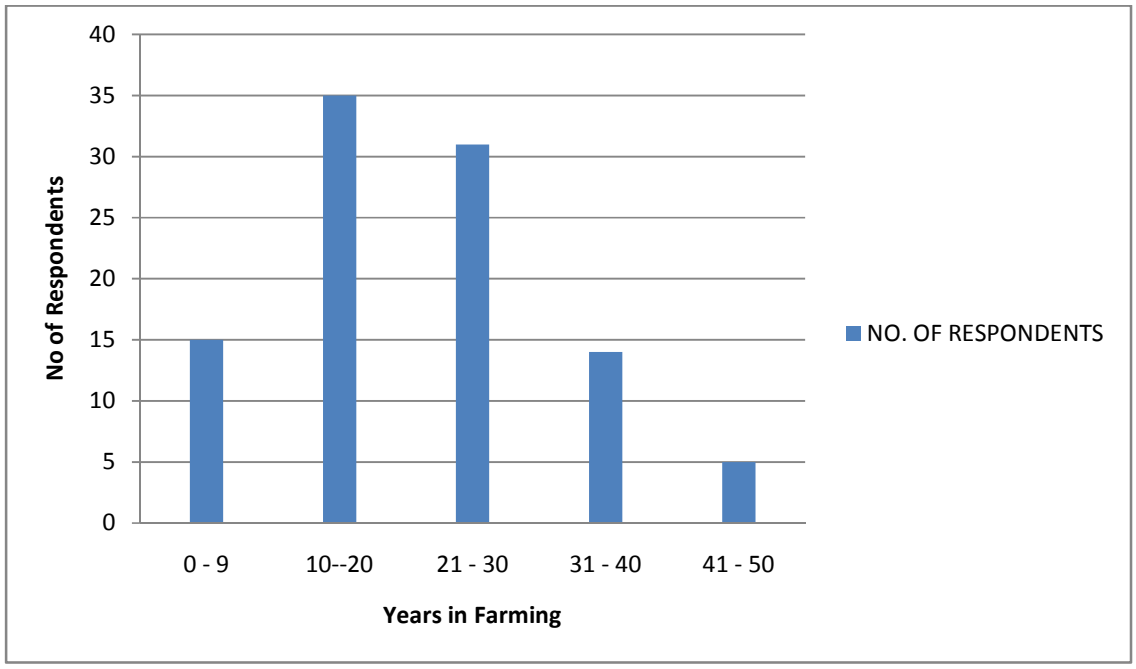


Fig. : Farming Experience of Farmers

It can be observed from fig. 4.1 that, farmers with farming experience between 10-20 years are the majority of the respondents that is 35 of the respondents have about 20 years of experience in farming. From 21-30 years are 31 farmers, while respondents with 0-9 years, 31-40 years and 41-50 years experience are 15, 14 and 5 farmers. This indicates that the respondents

have no long term orientation in agriculture and this can play vital role in adopting safe herbicides use for crop production.

4.2 Usage of Herbicide in the Study Area

Usage and adoption of new innovation and techniques especially concerning chemicals need someone who has experience of chemicals. Herbicides usage has become popular in the study area and farmers have individual's reason for accepting it. According to Lado and Hussaini (2014), the use of herbicides has recently increased among farmers in the savannah region of Africa especially on high value crops. It is faster and less laborious though may lead to crop injury if not properly used.

Results of the study revealed that all the sampled farmers use herbicides. Almost all the respondents reported similar reasons for adopting herbicides which they stated as means of reducing cost on labour and eradication of weeds in their farms. It has been observed that cost effectiveness has been the major reason for adopting herbicides among the smallholder farmers in the study area.

4.2.1 Number of Years in Using Herbicides

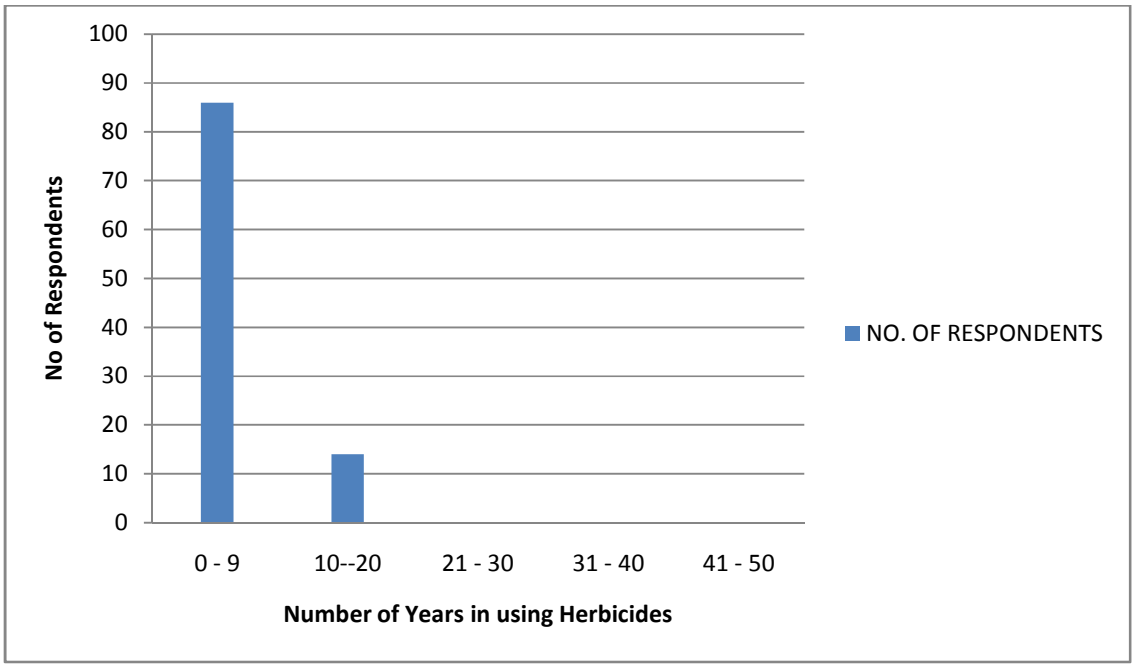


Figure : Farmers' Experience in Using Herbicides

It can be observed from the Fig.2 that majority of the respondents (86) have between 0-9 years of experience in using herbicides, while the remaining 14 have 10-20 years of experience in using herbicides in crop production. This can be related to the view that the farmers in the study area were using traditional system of weed control in their crop production, until in recent years when chemical herbicide is gradually phasing out the traditional systems of weed control.

4.2.2 Types of Herbicides Used in the Study Area

It is observed that farmers in the study area differentiate herbicides based on their understanding of its functions. They mentioned pre-emergent herbicides which are applied before planting the crop or before the crop emerges which prevent germination or early growth of weed seeds. They also mentioned post-emergent herbicides which are applied after the crop has emerged and can be selective or non-selective.

Table 4.2.2 Distribution of Respondents According to Types of Herbicide Used

Types of Herbicides	Frequency
Pre-emergent only	63
Post-emergent only	15
Both pre and post-emergent	22
Total	**100**

Source: Field work 2014

Results in Table 4.2.2 shows that majority (63) of the respondents use pre-emergent herbicides only in their farms. While 22 use both pre-emergent and post-emergent and 15 used post-emergent only. The reason for having those using pre-emergent herbicides only with highest percentage is related to the view that farmers prefer to control weeds right before its emergence and the cost on labour is much less In controlling the weeds before they emerge compared to cost of controlling the weeds after they emerged. The farmers also argued that effects of the herbicides on crop tends to be minimum if pre-emergent herbicide is properly used.

4.3 Source of Herbicides Among Smallholder Farmers in the Study Area

Table 4.3 Distribution of Respondents by Sources of Herbicides

Source	Frequency
Government agencies	5
Open market	95
Total	**100**

Source: Field work 2014

Most of the time farmers prefer to go to open market to purchase their farm inputs no matter the level of cost rather than to go to government or non-governmental agencies despite the subsidies. This is because easy accessibility of the inputs is what matters. The data presented in table 4.3 shows that majority of the respondents (95) buy herbicides from open market while only few (5)

of the respondents buy them through government agencies. Sometimes easy access to a particular input influences the usage of such input.

4.4 Problems Faced in Herbicides Application Among Smallholder Farmers in the Study Area

Application of herbicides requires skills, safety measures and proper equipments. The study has revealed that majority of the respondents (92) reported similar problems which are difficulties in application of the herbicides due to lack of skills and necessary equipments required for safety measures. Other effects are odour, inefficiency of sprayers and spread of herbicide to unintended areas. While the remaining few respondents (8) emphasized on moisture problem which mostly occurs during the early period of rainy season and this also affects the effectiveness of the herbicides.

4.5 Availability of the Herbicides in the Study Area

Table 4.5 Distribution of Respondents According to Satisfaction on Herbicide's Availability in the Study Area

Response	Frequency
Unsatisfactory	12
Satisfactory	33
Very satisfactory	55
Total	**100**

Source: Field work 2014

It can be observed from Table 4.5 that, majority (88) of the respondents express satisfaction, where they said that, the herbicides are always available in the markets where by any time farmer wishes to use the herbicide can go directly to market without any difficulty. However, very few (12) of the respondents express dissatisfaction with the availability of the herbicides in their area

which is related to being located some distance from major places where the herbicides are mostly sold in the study area.

4.6 Awareness of Herbicide Effects on Health, Ecosystem and Environment

Despite the high level of herbicide usage in the study area, majority (71) of the respondents are not aware of the negative effects of herbicides to health, ecosystem and environment. The study reveals that only few (12) of the respondents have some knowledge on the effects of herbicide on health, ecosystem and environment while the remaining 17 respondents have little knowledge of effects of the herbicides to life only which they all attributed the effects to the toxicity of the herbicides. This indicates a low level of awareness of the effects of herbicides among the smallholder farmers in the study area. For sustainable use of herbicides the health of an individual, community and ecosystem should be the focus.

Farmers in the study area have stated cases of vomiting, skin rashes, dizziness, stomach upset and sometimes fever as the common illness encountered as a result of herbicide application. They based their reasons on the fact that the incidences occurred in the process or after the application. Very few of the respondents reported soil fertility decline in their farms which to their own perceptions is attributed to adoption of herbicides utilization.

4.7 Awareness of Herbicides Handling Methods

Awareness about proper methods of handling herbicides is of great importance and beneficial to man and the entire environment.

Table 4.7 Distribution of Respondents According to Awareness of Herbicides Handling Methods

Response	Frequency
Yes	62
No	38
Total	**100**

Source: Field work 2014

However, this study has on table 4.7 shown that majority (62) of the respondents who are aware of handling but don't consider them important and the remaining 38 who are not even aware of any safe handling method it can be said that proper handling methods of herbicides are not in existence in the study area which pose great threats.

4.8 Whether Precautions and Safety Measures are Taken when Handling Chemicals by Smallholder Farmers in the Study Area

Table 4.8 Distribution of Respondents According to Whether they Take Precautions and Safety Measures when Handling Chemicals

Response	Frequency	Mean
When mixing		
Yes	23	50
No	77	
Total	**100**	
Before application		
Yes	34	50
No	66	
Total	**100**	
After application		
Yes	52	50
No	48	
Total	**100**	

Source: Field work 2014

Herbicides should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations and the environment. Farmers through herbicides utilization can enhance efficiency and increase productivity, but this should be done in such a way that ecosystem's health and well being is not endangered. It must be ensured that herbicides utilization is healthy, safe and ecologically sound. It can be seen from Table 4.8 that in all the respondents only few (23) take safety measures and precautions when mixing and 34 before application, higher number (77) do not take any safety measures when mixing and 66 before application of the herbicides. It can also be observed from the Table 4.9 that 52 of the

respondents take safety measures after application while the remaining 48 do not take any safety measure after herbicides application. Observations of the study have shown that majority of the farmers do not take proper precautions and safety measures when mixing and application of the chemicals. It was observed that few (23) of the farmers use gloves/socks, nylon bag, handkerchief and rain boot for protection and most of the body contacts with the chemicals occur during mixing and application. This can be ascertained from the plates below where farmers mix and apply the chemicals with bare hands and foot, and face uncovered and even the rest of the body is poorly covered.

Plate: A : Farmer mixing chemical before applying

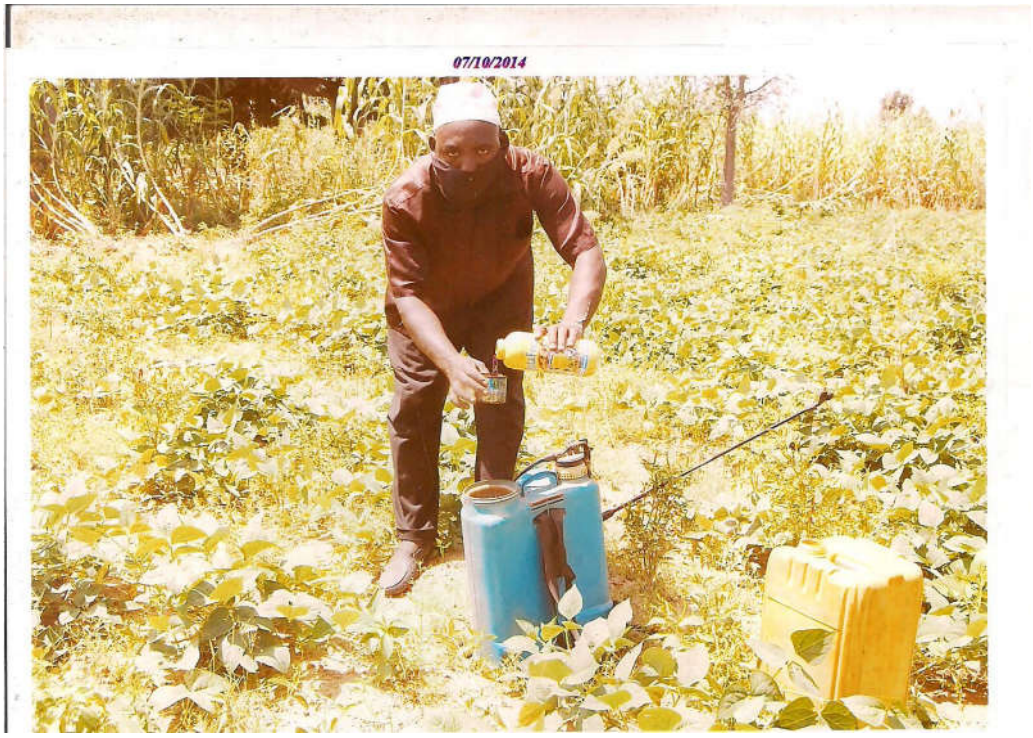


Plate: B: Farmer mixing chemical before applying

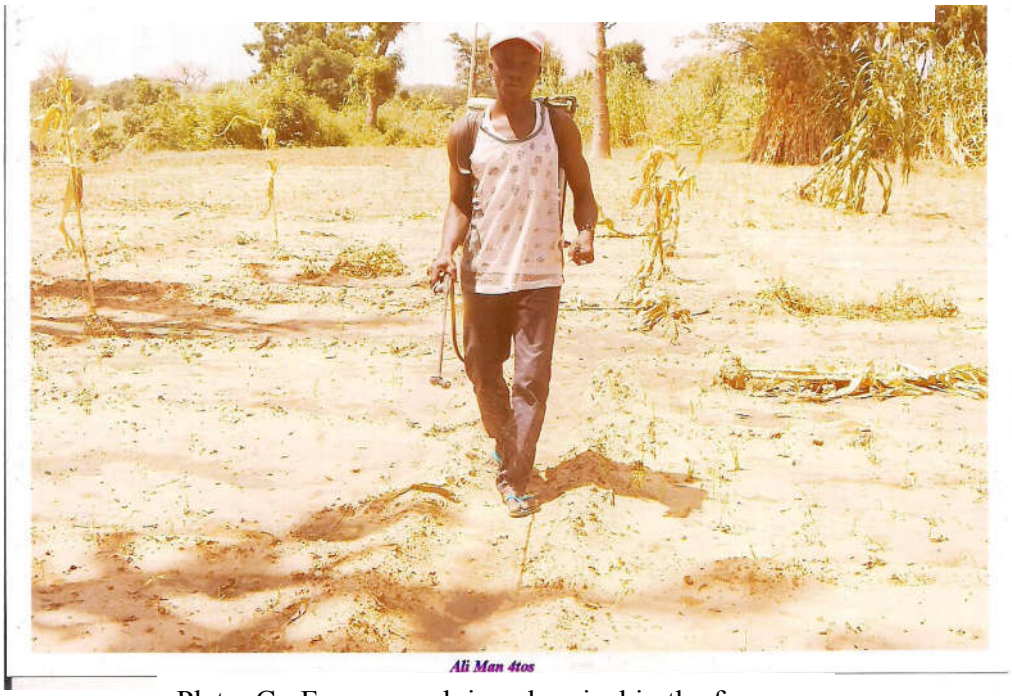


Plate: C : Farmer applying chemical in the farm

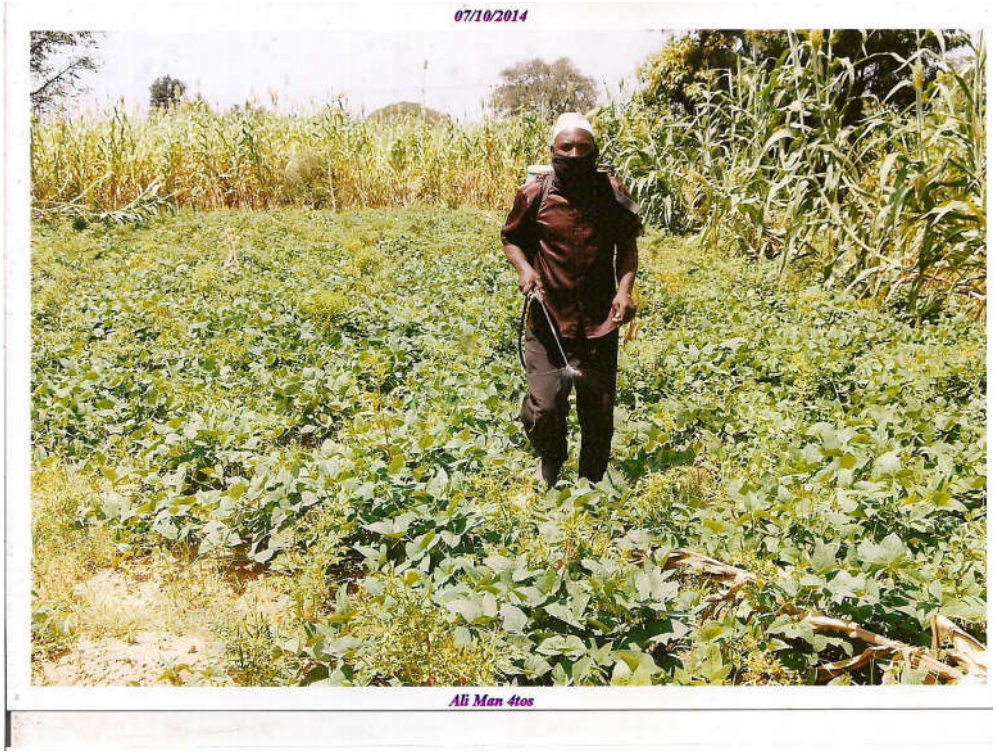


Plate D : Farmer applying chemical in the farm

4.9 Methods of Disposing Herbicide Containers Among Smallholder Farmers in the Study Area

The recommended ways for treating empty herbicides containers are crushing and burying or sometimes recycling for manufacturers re-use (Iyagba, 2013). Proper disposal of emptied herbicides containers is of significant importance to health and general environment as chemical is never totally emptied from the container. The study has shown that higher number (48) of the respondents wash emptied containers and sell or put them into domestic use and 43 abandon the emptied containers where ever the mixture of the chemicals finishes while few (19) throw away the emptied containers any where they wish. The study reveals that none of the respondents adopts the recommended way of disposing empty herbicide containers. These attitudes of the

farmers indicate low level of knowledge about the health and environmental risks in left over chemicals.

4.10 Comprehension of Instructions on the Herbicide Containers Among Smallholder Farmers in the Study Area

Instructions label on herbicide containers are tools that guide user in proper handling of herbicides, however, the instructions are mostly violated or totally ignored by the users (Iyagba, 2013).

Table 4.10 Ability to Read and Comprehend Instruction on Herbicides Containers Among Smallholder Farmers in the Study Area

Response	Frequency
Yes, but not always	8
No	66
Yes, but not give attention	26
Total	**100**

Source: Field work 2014

From table 4.10, it can be observed that higher number (66) are farmers who cannot read instructions label on herbicide container, while only few (8) can give time to read the instruction and sometimes comply, 26 of the them can read the instruction but do not give it attention, this can be due to I don't care attitude and ignorance of the implication.

4.11 Skills and Technical Knowledge for Herbicide Use Among Smallholder Farmers in the Study Area

Skills and technical knowledge are essential tools that can enhance efficacy in management of chemicals. Management techniques of herbicides usage need a comprehensive training and skill

before being adopted. It requires a high level of discipline and experience due to the danger involved in the usage.

Table 4.11 Distribution of Respondents According to Skill and Technical Knowledge in The Study Area

Source	Frequency
At school	6
At training programme	4
extension agents	13
Others (colleagues)	77
Total	**100**

Source: Fieldwork 2014

Base on the interview with the farmers, it can be seen from Table 4.11 that 77 of the respondents acquired their skills and technical knowledge on safe use of herbicides through learning by watching from colleagues who are already in the system. While 13 learnt from extension workers, 6 at school and 4 which are very minimum attained throught training progammes mostly organized by Kano State Agricultural Development Authority (KNADA).

4.12 Awareness of Herbicides Legislation Among Smallholder Farmers in the Study Area

Table 4.12 Distribution of Respondents According to Awareness of Herbicides Legislation

Response	Frequency
Yes	14
No	86
Total	**100**

Source: Field work 2014

The use of herbicides has rules and regulations and such rules and regulations must be obeyed and respected in all aspects concerning herbicides, that is from manufacturers to distributors to

dealers and lastly to the end users which are the farmers. It can be seen from Table 4.12 that majority (86) of the respondents are not aware of any legislation attached to herbicide utilization, they even argued whether herbicides utilization in the area may lead to application of legislation. The remaining 14 respondents said that they only hear about it and they don't take it into consideration because it is never in place or being experienced in the area.

4.13 Perception of Farmers on Yield Improvement from Use of Herbicides

With the advent of herbicide technology, there has been an increase in agricultural productivity. In contrast there might be decrease in the farm yield if the herbicide is wrongly used. Effectiveness of herbicides as well, defends to a great extent on how the herbicide is applied and the equipment used in the spraying. It was observed that ineffective herbicides utilization mostly occurred due to in appropriate application of the herbicide and also the inefficiency of the spraying machines.

Table 4.13 Distributions of Respondents According to Perceived Effects of Herbicides on Yield Improvement

Response	Frequency
Increase	56
Decreased	11
Same	33
Total	**100**

Source: Field work 2014

Result in table 4.13 shows that 56 of the respondents have experienced yield increments with adoption of herbicides utilization, while 33 reported that their crop yield remains the same. However, very few (11) of the respondents reported failure in crop yield as a result of herbicide usage and this may be related to misuse of the chemicals.

4.14 Level of Cost Reduction as a Result of Herbicide Usage

Herbicides are designed to have 100% labour cost reduction i.e. total eradication of weeds or grasses if properly utilized (Yola, 2007). The labour cost is expected to be reduced to minimal level provided the spray is effective.

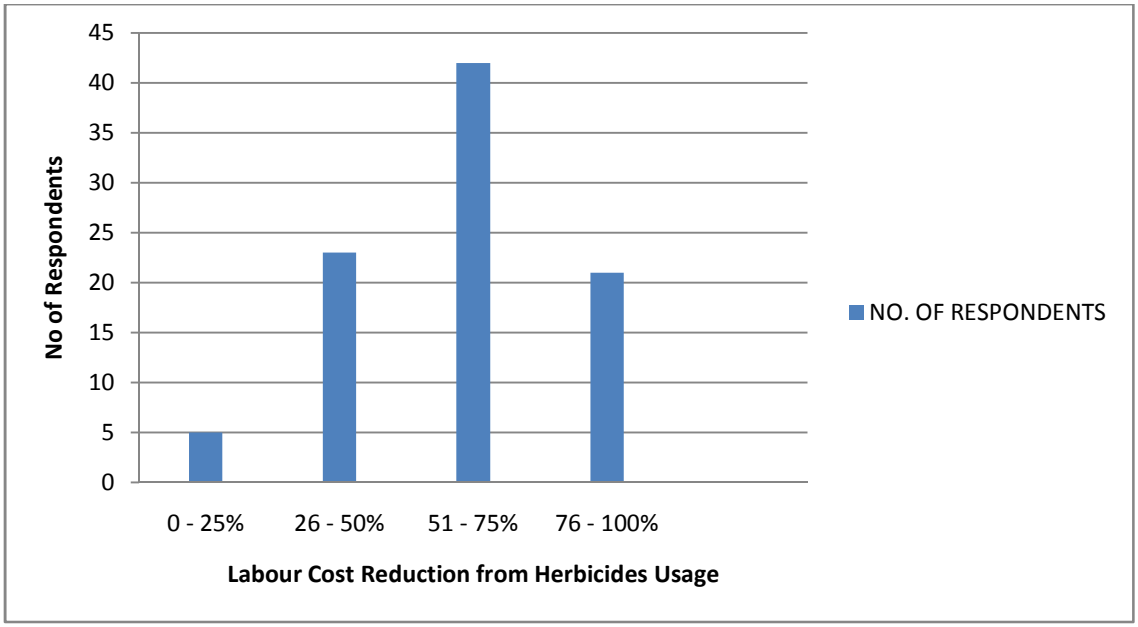


Figure : Farmers' Cost Reduction on Weed Management from Use of Herbicides

Result in the figure shows that 21 of the respondents enjoy 76-100% cost reduction in terms of weeds management, 42 enjoy 51-75% cost reduction in terms of weeds management, 23 enjoy 26-50% cost reduction in terms of weeds management and 5 enjoy 1-25% cost reduction. Only 9 of the respondents were silence in labour cost reduction as a result of adopting herbicide utilization and all these can be attributed to the efficacy of the herbicides application.

4.15 Personal Data

It was found that, 95 of the respondents are male adult farmers while 5 are female farmers and majority are married. This gender distribution of the respondent could be attributed to the fact that men are more actively participated in farming activities in the study area.

4.15.1 Classification of Farmers according to Age Group

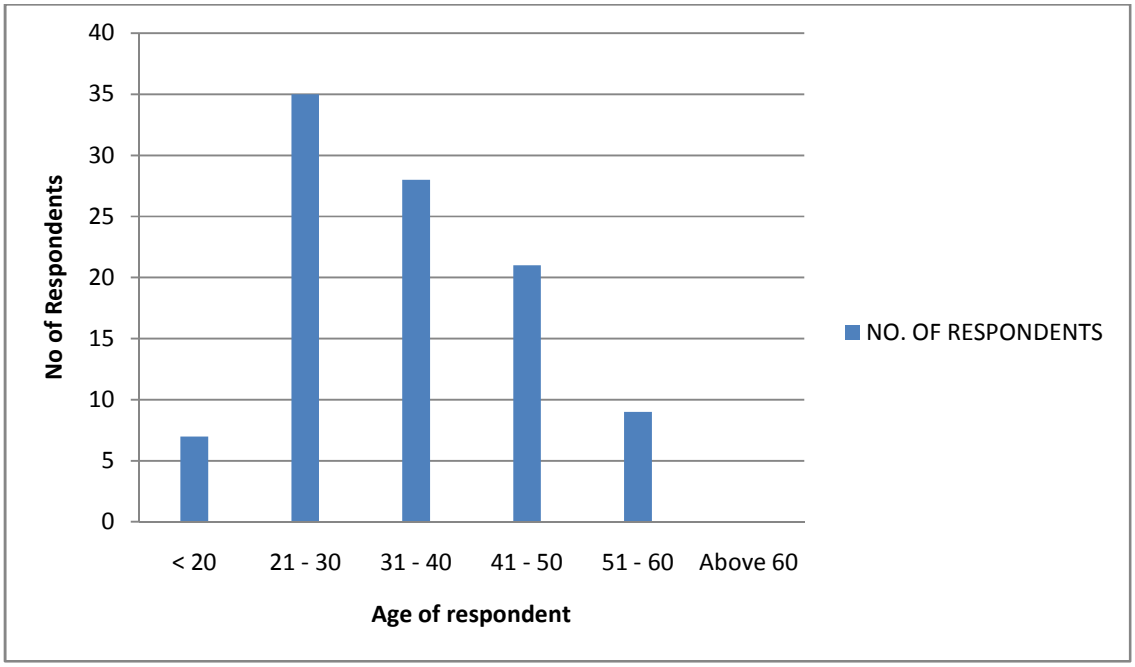


Fig.: Classification of Farmers' by Age Group

It can be seen that 7 of the respondents are in the age group of 0-20 years, 9 in the age group of 51-60 years, 21 in the age group of 41-50 years, and 28 in the age group of 21-30 years while respondents in the age group between 31-40 years old are the highest with 35. It can be observed that farmers under the age between 0-20 and 51-60 years have the lowest percentage, this does not mean that farmers of these ages do not use herbicides but because application of herbicides in the farm requires energy especially in carrying the sprayer containing the herbicide mixture. Therefore age status does not affect herbicides usage in the study area but affects the individual application of the herbicide in the farm.

4.15.2 Distribution of Respondents According to Educational Level

Education being a major factor in an individual's development economically, socially and politically, this has shown that 100% of the respondents have acquired western and or Qur'anic/ Islamiya education.

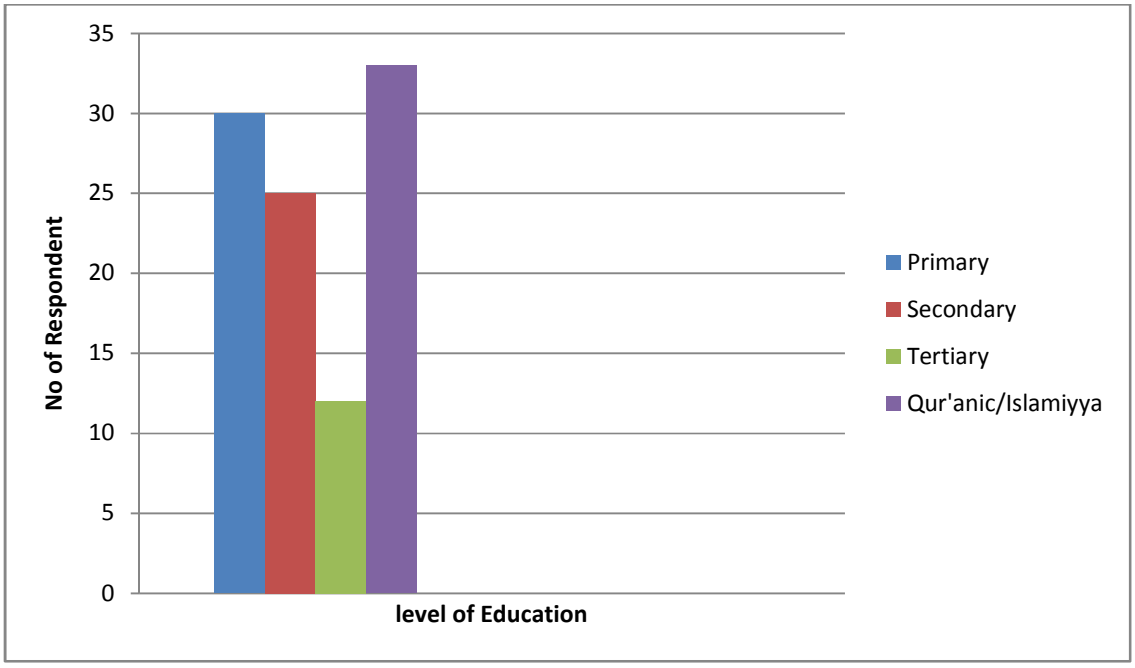


Fig.: Farmers' educational level

Figure 4 clearly shows those farmers who acquired Qur'anic/Islamiya education have the highest percentage which are 33, followed by those who have only primary certificate wich are 30, while secondary certificate are 25 and only 12 farmers obtained tertiary education.

Western education is assumed to have more influence in adopting innovations or technology than other forms of education (Yola, 2007). This is because person who acquired western education assumed to be wiser enough to source herbicide information from a reliable source. Based on this, research question was formulated to testify whether there is a relationship between farmer's educational qualification and safe utilization of herbicides. A spearman's correlation coefficient and student t-test were used as a statistical tool to testify between the two situations.

The spearman's correlation was calculated and further subjected to student t-test. The t-test value was found to be 1.41 and the critical t-table value obtained at(0.05) significance level with (2) as degree of freedom is(2.92).This indicates a negative relationship between farmers' educational qualification and their actualization of safe utilization of herbicides since the critical t-table value (2.92) is greater than the student t-test value (1.41). Despite the low level of western education among the smallholder farmers in the study area which is assumed to have more influence in adopting innovations, however, herbicide technology is well adopted in the study area.

4.16 Farming Status

Farming formed the major occupation of the population of the study area where crops grown at subsistence level. The main crops produce in the area are cereal followed by legumes and vegetables.

Table 4.16 Distribution of Respondents According to Nature of Farming

Response	Frequency
Full time	31
Part time	69
Total	**100**

Source: Field work 2014

It can be observed from Table 4.16 that 69 of the respondents are part time farmers, mostly cultivating their farm lands during rainy season only (rain fed cultivation). While 31 are full time farmers that cultivate their lands during both seasons (i.e rain fed and irrigated cultivation) where they access irrigation water from wells and ponds to produce maize and vegetable crops.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF THE STUDY

This work studies the access to, and safe utilization of herbicides among smallholder farmers in Bebeji Local Government Area Kano State. The findings show that herbicide utilization is 100% adopted by the farmers with a view to controlling weeds and reducing cost of labour in crop production. It was found that the use of herbicide is simultaneously phasing out the traditional methods and becoming popular way of weeds control. It is effective because high yields are being experienced, but attitude of farmers in handling the herbicides is not safe for health and environment. It was also found that despite the poor financial status of the farmers and high costs of the herbicides in the market, majority (95) of the farmers buy their herbicide from market. The study reveals how the cost to health and environmental effects frequently faced by the farmers can undermine the benefits derived from herbicide utilization. The health and environmental implications are mainly caused by the unsafe utilization of the herbicides which consists of misuse of the herbicides, lack of adequate skills and technical know-how, lack of personal protection equipment, low level of extension services in the area, inefficiency of the spraying machines and the hazardous nature of the commonly available chemicals.

5.2 CONCLUSION

From the result of the study, it is evident that herbicide usage among the smallholder farmers in Bebeji Local Government Area is not safe to the lives of the farmers and the environment; hence, there is no relationship between education and safe utilization of herbicide among the smallholder farmers in the study area. Herbicide usage is well adopted in the area. The findings have shown that the use of herbicide is not related to its accessibility; however, the usage is

related to effectiveness of the herbicide in crop cultivation. The problems with herbicide usage in the area were stated by the farmers as its accessibility, application and threats to human health, ecosystem and environment. In conclusion, the usage of the herbicide which is high in the study area should go along with health and safety education for the farmers and the environment.

5.3 RECOMMENDATIONS

From the information gathered in this study, recommendations have been suggested with view to promoting the safe and effective use of herbicides in crop production in Bebeji Local Government Area:

1. Opportunities should be provided for training in the safe and effective use of herbicides in crop production not only by the government but also by the chemical companies and nongovernmental organizations (NGOs) in the study area.
2. There is need for enhanced collaboration among manufacturers, suppliers and users of chemicals to promote the safe and effective utilization of herbicide by farmers.
3. The herbicide manufacturers should develop weed control inputs that are well effective but at affordable prices
4. Government in collaboration with stakeholders should develop massive awareness on the health and environment safety implications of herbicides.
5. There is need for massive sensitization on the use of personal protective equipment. And this can only be achieved through extension services.
6. Sustainable agriculture should be encouraged through the introduction of locally integrated weed management (IWM) practice due to low level technology of the farmers.

7. Small scale loans and credit facilities and more especially the personal protective equipments should be provided to farmers by government and NGOs. However, it is recommended that extension services should be developed so as to encourage farmers to form associations so as to pull resources together, buy herbicides, spraying and personal protective equipments and disburse among themselves in order to avoid been dependent on government alone. Because these can help farmers to acquire enough herbicides and other farm inputs at right time.

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APPENDIX 1

DEPARTMENT OF GEOGRAPHY
BAYERO UNIVERSITY, KANO
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INTRODUCTION

QUESTIONNAIRE FOR AN ASSESSEMENT OF HERBICIDES FOR WEED CONTROL BY SMALLHOLDER FARMERS IN BEBEJI L.G.A KANO STATE

MSc. Land Resource Development Thesis 2014

PART A:

RESPONDENT'S PERSONAL DATA

1. AGE: < 20, 21- 30, 31- 40, 41 – 50, 51 – 60, Above 60
2. GENDER: Male ☐ Female ☐
3. MARITAL STATUS: Single ☐ Married ☐
4. NAME OF WARD _____
5. LEVEL OF EDUCATION: Adult literacy Primary ☐ Secondary ☐ Tertiary ☐ Qur'anic/Islamiyya ☐
6. STATUS OF FARMING: Full time ☐ Part time ☐
7. FARMING EXPERINCE:<10, 10-20, 21-30, 31-40, 41-50, Above 50

PART B:

ACCESS AND UTILIZATION OF HERBICIDES

8. Have you ever used herbicide in your crop production? Yes/No? If yes, why do you use herbicide in your crop production?_____ _____
9. For how long have you been using herbicides? < 10, 10-20, 21-30, 31-40, 41-50, Above 60
10. Which type of herbicide do you frequently use in your farm? _____
    _____

11. Where do you get or purchase the herbicides?
    (a) Government agencies (b) N.G.O (c) Open market
12. Does the availability of the herbicides satisfy your requirement? Yes/No? If yes, at what level?
    (a) Un satisfactory (b) satisfactory (c) well satisfactory
13. What are the major problems faced in accessing the herbicides?
    _____
14. What are the major problems faced in herbicide application?
    (specify)_____

PART C:

PROBLEMS ASSOCIATED WITH HERBICIDE UTILIZATION

15. Are you aware of herbicides effects or hazards? Yes/No, if yes, which one do you know?
    (specify)_____
16. Have you ever experienced any illness as a result of herbicide application? Yes/No. if yes, what type of illness (specify)_____
17. Why do you relate the illness to the herbicide application (Explain)
    _____
18. Is there any soil or environmental degradation noticed in your farm as a result of herbicide utilization? Yes/No. if yes. Why? And if No, why
    _____
    And if No, why (specify)_____
19. Do you know herbicide usage or misusage can affect the following and why?
    (a) Life_____
    (b) Ecosystem_____
    (c) Environment_____

PART D:

SAFETY MEASURES IN HANDLING HERBICIDES

20. Are you aware of any method of handling of herbicide? Yes/No? if yes, explain_____

21. Do you take safety measure when mixing the chemicals? Yes/No. if yes, what measures? (specify)_____
22. Do you take precautions before herbicide application? Yes/No. if yes, what are the precautions?_____
23. Do you take safety measures after herbicide application? Yes/No. if yes, what are the measures? (specify)_____
    (a) Wash work clothing immediately (b) wash working material and dry in plenty air (c) wash personal protective equipments (d) take birth immediately (e) wash hands, forearms and face with detergent (f) others
    (specify)_____
24. How do you treat herbicide containers after use?_____
    (a) Wash for domestic use (b) crush and throw away (c) crush and bury the emptied containers (d) others (specify)
25. Can you read, understand and comply with instruction label on the herbicide container?
    (a) Yes (b) No (d) yes, but not give attention
26. Have you acquired skills and technical knowledge on safe use of herbicides? Yes/No. If yes, how?_____
    (a) At school (b) at training (c) trained by others (specify)_____
27. Are you aware of any legislation on herbicide handling? Yes/No. if yes, mention the legislation_____
28. What do you notice in terms of yield before and after adopting herbicide?
    (a) Increase (b) decrease (c) Same
29. Is the use of herbicides effective? Yes/No. if yes, at what level?
    (a) Partially effective (b) well effective (c) very well effective
30. By what percentage does the use of herbicides reduce your labour cost?
    (a) 100% (b) 75% (c) 50% (d) 25% (e) others (specify)_____

Thanks

_____
Umar Ado Gwarmai
M.Sc. Land Resources Development

APPENDIX 2

SPEARMAN'S CORRELATION TABLE OF EDUCATION AND SAFE

UTILIZATIO OF HERBICIDE

No. of observation	Educational Ranking (1)	Safe utilization Ranking (2)	Difference d	Difference d^2
1	33	50	18	325
2	30	50	20	400
3	25	50	25	625
4	12	0	12	144
				$\sum d = 1493$

$$rs = 1 - \frac{6 \sum d^2}{N(N^2 - 1)}$$

$$t = r \sqrt{\frac{n-2}{1 - r^2}}$$

Where n= is called degree of freedom.

APPENDIX 3

SPEARMAN'S CORRELATION TABLE OF HERBICIDE USAGE AND ITS ACCESSIBILITY

No. of Observation	Herbicide Usage	Herbicide Accessibility	d	d^2
1	100	95	5	25
2	0	5	5	25
3	-	-	-	-

$\sum d^2 = 50$