BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

FARMERS' PERCEPTION OF THE EFFECTS AND EFFECTIVENESS OF CONTROL METHODOF MAIZE WEEVIL ON STORED MAIZE WEEVIL ON STORED MAIZE GRAIN: CASE STUDY CENTENARY WARD 14, GATU

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF AGRICULTURAL SCIENCE HOHOURS

DEGREE (CROP SCIENCE)

DECLARATION

I Machida Tendai declare that this dissertation for the degree of Crop Science in Literature is my original work and all sources have been properly cited. It has not been submitted for any academic purpose elsewhere.

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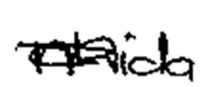
Signature: 

Date: June 2025

APPROVAL

This Dissertation Project for Machida Tendai is approved as partially fulfilling the requirements for the award of a Bachelor of Science Honors Degree in Agriculture (Crop Science) by university supervisors.

Name	**Signature**	**Date**
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ACKNOWLEDGEMENTS

Firstly I thank God for giving me life and strength through my dissertation project research period. I am great full to my supervisor Mr Mutsengi, for guiding and supporting me during this period of study. I want to extend my gratitude to Project Coordinator Mr. M. Gwazani, for overall monitoring during this phase. Lastly, many thanks to my family and fellow students for the unwavering support and encouragement throughout my studies

ABSTRACT

Maize weevil (*Sitophilus zeamais*) insect is a serious storage pest of maize grain, causing serious damage of up to 90% grain loss in Gatu of Mash central province in Zimbabwe. This study was conducted in Gatu to assess the perceptions of farmers on maize weevil effects and effectiveness of control methods on stored maize grain. The following were the specific objectives of the study: (i) to identify different sources of information for farmers on maize weevil pest and its management. (ii) To understand the different control/ management measures being implemented by farmers towards maize weevil pest and how effective are these. (iii) To assess what challenges do farmers face when dealing with maize weevil. To achieve this, a survey was conducted on sampled maize farmers in Chipiri farms, ward 14 in Gatu. The majority of respondents were female (67.5%**)**, while males made up 32.5% of the sample. Most respondents had attained secondary education (75%)**,** followed by primary education **(**22**.**5%), with only 2.5% reaching the tertiary level. The largest age groups were 20–34 years and 55–80 years, each representing of the sample. The remaining were35 –44 years (25%) and 45–54 years (15%).All respondents , indicated that they were controlling maize weevil but most of the interviewed farmers were using synthetic pesticides and the remaining farmers used cultural control methods and respondents were challenges such as lack of adequate information on other control methods other than chemical control, Most synthetic pesticides were expensive to the extent that farmers under apply the chemicals so as to treat all grain or the ended up treating their gain once per year.

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1.0: Introduction and background

Maize (Zea mays L.), which is a vital cereal crop and a global food staple. It ranks among the most widely cultivated crops worldwide and plays a significant role in food security, both directly as human food and indirectly as animal feed and industrial raw material. Believed to have been domesticated over 9,000 years ago in Mesoamerica, maize is thought to have evolved from a wild grass known as teosinte a plant native to Mexico and Guatemala (OECD, 2018.Belonging to the Poaceae (Gramineae) family, maize ranks second in terms of area cultivated and first in terms of productivity and overall grain production globally (FAO, 2013). Often referred to as the "queen of cereals" due to its remarkable yield potential, maize outperforms other cereal crops in productivity (Singh, 2021).

Maize is central to the fight against global hunger. It serves as a key source of calories and nutrients for millions. In fact, in Sub-Saharan Africa alone, nearly half the population depends on maize as a dietary staple. It's consumed in various forms tortillas in Latin America, polenta in Europe, and cornmeal in Africa (Keba & Sori, 2013).Beyond human consumption, a large proportion of maize is used for stock feeds and as an industrial raw material. It is transformed into a wide range of products including starch, corn syrup, cooking oil, biofuels, baby cereals, biodegradable plastics, and even cosmetics and soaps (Kling & Edmeades, 2021). In Eastern and Southern Africa, 30-50% households depends on it for food.

In Zimbabwe, maize is not only a staple food crop but a strategic one. It provides more than 50% of daily calorie intake for an estimated 13.1 million people and occupies nearly 60% of the country’s cultivated land. As such, protecting this crop especially during storage is a national priority (Makate, 2010). Fortunately, the development of high-yielding and drought-tolerant maize varieties has improved resilience and productivity across a range of climatic conditions (ASARECA-TUUSI, 2020).

One of the biggest threats to stored maize grain is the maize weevil (Sitophilus zeamais), a tiny but highly destructive pest. Belonging to the family Curculionidae and the phylum Arthropoda,

this pest thrives in warm, tropical climates and is considered the most serious post-harvest pest of maize (Throne, 2022; Longstaff, 2023). It reproduces sexually and undergoes complete metamorphosis from egg to larva to adult.

What makes the maize weevil particularly dangerous is its ability to infest maize both before and after harvest. Adults and larvae bore into the grain, hollowing it out and reducing its nutritional and market value. Global losses due to this pest have been estimated at 20% to as high as 90% (Giga & Mazarura, 2020; Tefera et al., 2011). In Zimbabwe and other parts of Africa, these losses translate into significant food insecurity and economic hardship, especially for smallholder farmers.

The maize weevil isn't restricted to maize alone; it also attacks crops like sorghum, wheat, cassava, and yam. Though originally native to Asia, it has now spread across Africa, Latin America, Europe, and beyond (Plarre, 2010). Countries such as Mozambique, Kenya, Egypt, South Africa, Zambia, and Zimbabwe report widespread infestations.

Historically, chemical insecticides and fumigants have been the go-to solution for controlling the pest. However, these methods have serious downsides: they can leave toxic residues in food, contribute to pest resistance, harm non-target organisms, and pollute the environment. Furthermore, access to these chemicals is often limited for rural farmers due to high costs and poor availability (Rugumamu, 2011).Given these challenges, there's a growing need to shift towards Integrated Pest Management (IPM). This approach employs multiple control strategies biological, cultural, physical, and chemical (only as a last resort) to control pests in an environmentally and sustainable way.

IPM stresses on early detection, timely intervention and empowering farmers to take control before infestations become severe. It not only reduces reliance on harmful chemicals but also helps safeguard food quality, human health, and the environment. For rural small-scale farmers in Zimbabwe and across Sub-Saharan Africa, adopting IPM practices could significantly improve maize grain storage outcomes and overall food security. This study aims to explore how farmers perceive different control methods for the maize weevil, their effectiveness, and

sustainability. Ultimately, finding long-term, accessible solutions to maize storage losses is essential for protecting both livelihoods and national food security.

1.1: Problem statement

Maize Farmers are facing major and worrying maize grain storage loses due to distraction by maize weevil pest (Muzemu 2013). The maize weevil poses a significant threat to stored maize, leading to considerable economic losses and food security challenges. Despite the availability of various control methods, there is limited understanding of how farmers perceive these methods effectiveness and their impacts on maize infestations. Maize Weevil is prominent and distractive storage pest in maize especially for poor resourced small-scale farmers. The pest is poorly understood in terms of its development, resistance, prevention and management/ control measures among small scale farmers, (Nwosu, 2014). The pest is a threat to food security, the economy and the livelihoods of Zimbabwean people and beyond. The pest destroys the harvested maize grain by penetrating and infesting intact kernels. Adult maize weevil pest and the larvae feeds from inside (Lale and Ofuya, 2021), leaving the grain emptied of its nutritional seed value. Maize Weevil attacked seed cannot be used as production seed (For Open pollinated varieties) for planting because it will not be viable and will not germinate, the affected grain will lose its nutritional status and this will lead to food insecurity and it will be expensive for farmers to purchase grain for food and animal feed. The primary purpose of this research was to view farmers' perceptions on the effects of maize weevil on stored maize grain. The study also explored different control/ management measures being implemented by farmers towards maize weevil pest and how effective are those methods. Another purpose of this research was to identify challenges faced by the maize farmers when dealing with maize weevil. Then come up with recommendations available to help farmers deal effectively with maize weevil.

1.2: Justification

Maize weevil has caused damages which leads to economic losses of up to 90% of the harvested and stored grain if it is not controlled and on time. Culturally people are considered poor or rich in terms of their cattle herd size and quantity of crops harvested and stored especially maize gain, so maize weevil damage on maize grain in Centenary have negatively affected farmers livelihood. There have been grain losses which results in staple food shortage and livestock feed

shortages. This study helped generate an understanding of the challenges brought by maize weevil attack so that Gatu in Centenary Maize farmers can be invoved in the eradication of the pest. Farmers will be having insights with the fact that many tones of harvested maize grain are at risk of damage by the pest in Gatu. The study determined the farmer's perception and coping mechanisms and control methods of maize weevils in Gatu. All the above aims will help farmers to improve household and national food security, animal feed availability and income generation through good grain storage practices which keeps the quality of the maize grain for longer period of time.

1.3: Research questions

i. What are the different sources of information for farmers on maize weevil pest and its management?

ii. What are the different control/ management measures being implemented by farmers towards maize weevil pest and how effective are these?

iii. What challenges do farmers face when dealing with maize weevil?

1.4: General Objectives

The aim of this project was to research on farmers' perception on the effects and effectiveness of control methods of maize weevil (*Sitophilus zeamais*) in stored maize (*Zea mays*) grain.

1.5: Specific Objectives

5.1.1: To identify different sources of information for farmers on maize weevil pest and its management.

5.1.2: To understand the different control/ management measures being implemented by farmers towards maize weevil pest and how effective are these?

5.1.3: To assess challenges faced by farmers when dealing with maize weevil.

CHAPTER TWO

Introduction

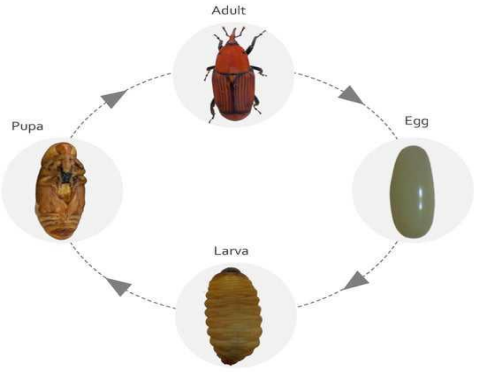
All the issues of the maize weevil pest from its origin, life cycle, host crops, damage effect and control measures available will be tackled by this chapter. The maize weevil pest is present in all the tropical and warm parts of the world. It is the stored maize pest, dry cassava, yam, common sorghum and wheat pest. Adults and larvae internally consume maize grains reducing grain waiting and nutrition value. The pest causes hollowing of whole previously solid grains with powdery white frass. Cultural, physical, traditional and chemical control of pests can be used against maize weevil pest.

Literature review

Biology of Maize Weevil

Maize weevil (Sitophilus zeamais) is also referred to as Greater grain weevil or greater rice weevil. Understanding the biology of S. zeamais is a necessity for formulating techniques of control that are effective. Maize weevil comes under the insect beetle family, Curculionidae, out of which a total of 60,000 species exist worldwide. There are 30 pest species of stored product, three of which are Sitophilus species and are of utmost importance (Siwale, et al 2007).

Maize weevil life cycle



The maize weevil Sitophilus zeamais undergo holometabolous type of postembryonic development of 36 days of duration. They pass through egg, larva, pupa and adult stages to complete its life cycle. The female lay eggs inside the maize grain and a single female can lay up to 300-400 during her lifespan. After 3-10 days the egg hatches to larvae. The larvae are legless and internally consume the grain. The larvae, when matured, pupate inside the grain and takes 5-10days. The adults emerge from the grain to mate once again. Adults measure 3 – 3.5 mm long, dark brown – black color and shining and pitted with numerous punctures. The thorax punctures are in uneven lines whereas the punctures of elytra (wing cases) are in rows. The elytra usually also has pale reddish-brown or orange-brown oval spots. Maize weevil has the characteristic rostrum (beak or snout) and elbowed antennae of the family Curculionidae (weevil family). The antennae has eight divisions and usually gets up in a straight manner when they move.

Adult females release a sex pheromone that attracts the males. Dull red brown to nearly black is female weevil and is usually marked on the back with yellowish or reddish light spots. Maize weevil possesses well-developed wings under its wing covers and can fly without any difficulty. Weevils are very suited to darkness and to moving in confined spaces and among stored grains (Derera, et al., 2021). When mated, Females bite into corn grains on where they lay eggs during the most part of their adulthood for a period of one year, although 50% of their eggs would be laid during the first 4-5 weeks. Small, isolated oval white eggs are laid and develop by cleavage and differentiation in a minute hole bored on the grain by the mother plant and plugged by a waxy secretion. A single female lays 300 to 400 eggs in a lifetime and adults have a lifespan of five to eight months. Eggs hatch into larvae that feed intensively on the grain internally, growing and shedding their skins before pupation, larvae inflict most of the damage on maize because

they feed from the inner part to complete maturity (Abebe, et al., 2019). Adults come out of the grain and are found crawling on the grain surfaces. Emergence holes created by adults are large with coarse edges. Maize weevil larvae are white, legless and soft. Being feeders of inner parts of the grain, infestation detection becomes difficult in its early periods.

Distribution

Distribution of maize weevil in Asia, Africa, North, South and Central America, the Caribbean, Europe and Oceania. It is found in Australia, Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Tonga. These beetles are distributed everywhere around the world through grain shipments and are able to infest wherever food is present and where there is proper temperature and moisture for grain. In certain locations, one of the two species will be more dominant than the other. A global survey of pesticide resistance (Champ and Dyte, 1976) has extensive lists of places for specie.

Host Plants

The maize weevil is found in all of the world's warm and tropical areas. It is a store pest of maize grain, dried cassava, yam, sorghum, wheat and also dried stored products, such as pasta. (CABI, 2010) informs that Sitophilus zeamais most typically infests maize grain. Maize weevil does not breed readily in finely milled grains but can breed easily in foods such as macaroni and noodles and milled cereals that have high moisture (Alter, 2013). The storage type or maize form may lead to additional weevil infestation or not. The climatic conditions and the grain moisture are also additional factors. Husk cover protection is partial for early infestation (Savidan, 2020)

Economic importance of weevils

Maize weevil is an important infestation pest of stored maize grain for seed and food. Normally, weight loss varies between 20 and 90 % of the stored untreated maize grain (Pingali and Pindey, 2017). The weevil is important in that it is the most economically significant pest of stored maize grain in Eastern and Southern Africa (Giga and Mazarura, 2020). Worldwide, the area upon which maize was sown in 2020 exceeded 243.2 million hectares and yielded a sum of 1423.2 million tons with a production of 5.85 tons. The storage losses due to storage insects are generally estimated as 20-30%. Sitophilus zeamais (Motschulsky) (Coleoptera: Curculionidae) is

an immensely important and destructive grain pest of the world, particularly for maize. Apart from that, S. zeamais is sold worldwide. Particularly for S. zeamais, losses were 10 to 20%. Losses can be up to 6.9% after a storage period of three months, which amounts to 112.4 million tons annually (Tefera, 2013).

Chemical bases of maize grain resistance against infestation and damage by the maize weevil, Sitophilus zeamais. S. zeamais infests ears in the maize field when drying grain and before harvest or when grain is stored. Adults and larvae cause maximum damage on the grain. Adults enter into the grain to deposit eggs, whereas larvae feed on the endosperm of the grain to become pupae. When pupae fully mature to adults, they enter into the grain and come out into the environment. Maize weevil is an important food and seed stored maize grain pest. In most cases, there is weight reduction of between 20 and 90 % of the untreated stored maize grain (Pingali and Pindey, 2020). Maize weevil is important as it is the important stored maize grain pest within Eastern and Southern Africa (Giga and Mazarura, 2020). It has been established by some workers that S. zeamais, the maize weevil causes severe quantitative and qualitative damages to the stored maize grain in Africa (Adedire, 2022; FAO, 2022). As a serious pest of stored maize, S. zeamais penetrates and infests entire kernels of grain, inside which immature stages develop (Lale and Ofuya, 2020) making the maize devoid of its nutritional as well as seed worth, leading to complete loss of aesthetic value in the local and international markets.

Symptoms of Maize Weevil Infestation

Adult and larva damage the grain through chewing. Infestation can start in the field but most damage is achieved in storage. The pest dehulls whole previously intact kernels. Only the grain hull is left in heavy infestations with powdery white frass. The large emergence holes with coarse edges are diagnostic. Floaters in water typically indicate larval damage. The direct damage brought about by weevils is that they can result in the reduction of seed viability, loss of weight of up to 90% during severe infestation; the affected seed whose germ will not germinate. This, therefore, can reduce future maize production for farmers who use saved returned grain as seed, which is a widespread practice among Eastern and Southern Africa according to (Siwale et al., 2021). The indirect damage includes loss of maize quality which can include loss of nutrients,

heating and rancidness, off flavor development, browning and susceptibility to disease. Secondarily, harm is caused by mites, insects and mold.

Detection and inspection

It is difficult to detect the weevil unless populations are high as it spends most of its life inside grain. One must look for a dull red-brown to nearly black weevil, with faint yellowish or reddish spots on its back at the corners of the wing cases. Look for the characteristic large emergence holes in the grain with irregular edges. Look for the adults, with long snouts about 1 mm.

Flight traps

Types are Probe, Cone and Sticky. The results (Weston and Barney, 2019); show that a combination of sticky traps in the grain bin headspace and probe traps set immediately below the surface of the grain was most successful in detecting the presence of pest and beneficial insect species in grain storage. Shaking of the grain causes adult Sitophilus spp. to migrate upwards and become visible on the surface.

2.4.2: pheromone

There is a male-produced aggregation pheromone attracting males and females in Sitophilus spp., 5-hydroxy-4-methyl-3-heptanone, that was demonstrated to be the aggregation pheromone common to S. zeamais (Levinson, et al. 2018).

Prevention of Maize weevils

Prevention is the best method to avoid insect infestation of stored grains. Sanitization of storages in position prior to bringing in new grain minimizes the use of pesticides. Good sanitation means the removal of previous storage material such as sacks and bins and dust around and within them. This involves removal of grain spilled in corners, walls, and floors and old grain in these places. Any remaining grain when a bin is emptied can carry infestations of insects that will invade the new grain.

Once the storage structure is cleaned and all repair work has been done, floor and wall surfaces inside and around the storage equipment need to be treated. Be very careful when treating all crevices, cracks, and around doorway areas and other areas in which insects will hide or enter. Spray the storage material four to six weeks prior to filling with grain.

Before loading into a storage commodity, grain must be screened out to eliminate fine material and broken kernels. Grain to be stored for longer than six months will need a protective treatment with an approved insecticide. Treatment can be administered while the grain is being loaded into the storage building by utilizing a metering device that has been calibrated to utilize the proper amounts. After binning and leveling the grain, it can be dressed on the surface to prevent insects from entering the grain on the surface. In the event of infestation despite these precautions, fumigation of the grain will be necessary.

Importance of Grain Conditioning Prior to Storage

Above 16 percent moisture exposes types of maize to attack by storage insects such as S. zeamais (Lale, 2020). This generates the requirement for grain conditioning before storage. Sun or air-temperature and relative humidity exposure of grains for 2–4 weeks (drying or acclimatization) conditions maize grains for storage to avoid weevil infestation. This declaration is not absolute in terms of location and fluctuation of weather. Ambient environmental condition is at the mercy of on-the-spot micro-climate condition (weather). The tropical convergent zone, in fact, is very variable with different levels of temperature and relative humidity at any point in time depending on where one is.

There is a requirement to establish good sanitary practice so as to reduce weevil infestation in storage. Proper warehouse and container cleaning before storage of new products is normally

overlooked. Residues of infested products were thereby reported to be the sources of fresh infestation (Lale, 2020). Therefore, farmers, traders, and home consumers are strongly recommended to include proper hygienic practices. This will significantly reduce possibilities of new S. zeamais infestation from residues.

Maize weevil control methods

A range of storage facilities and mixtures of pesticides (usually fumigants) have been used to store maize grain against insects since the 1950s. Recently, there has been increased awareness regarding the effects of synthetic chemicals on human health and the environment. It is confirmed that use of the synthetic chemicals in the preservation of food and food products leads to death and has negative impacts on the health of human beings (Nwosu and Nwosu, 2012). Excessive use of the chemicals like insecticides for control of storage pests is reported to be of worldwide concern due to associated environmental hazards, pest resistance to the chemicals, chemical residues in the food. Environmental safety is the problem that has resulted on research aiming to the development of alternative management practices which entail use of resistant maize varieties and bio pesticides against the insects in storage (Abebe, et al, 2020).

Cultural control Methods

It is important to dry the grain thoroughly, to ensure clean storage spaces and to examine the grain regularly and often. Proper storage hygiene is important in minimizing infestation by S. zeamais. Removal of infested remains of the former harvest is essential. Phenolic substances have been linked to resistance of the grain to S. zeamais (Arnason, et al., 2018).

Cultural control practices

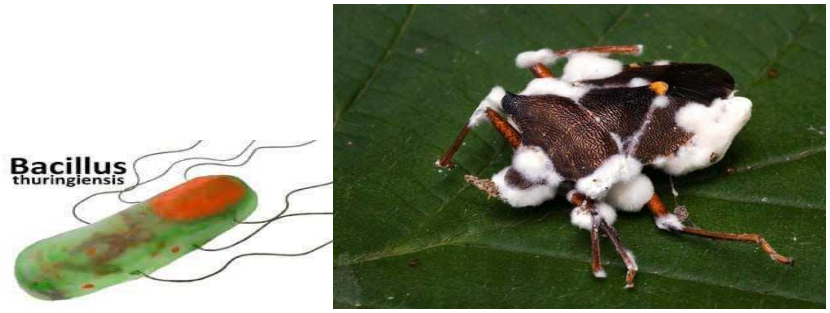
Cultural controls are always the least costly of all the control measures because they usually entail merely modifications in standard production practice. They even don't require extra labor, but only adequate planning is essential. Very often, they are the only control measures that can be economical for substantial amounts of crops of low value. Cultural controls are dependable, and are accurate. They do not have some of the undesirable side effects of pesticides, such as developing resistance to pesticides, so-called "pesticide residues" in food, feed crops and the environment, and eliminating non-target organisms.

Limitations of cultural control methods

Cultural controls require long-term planning to be optimally effective and they need accurate timing. They have a tendency to depend on replacing knowledge and skill for purchased inputs like, more demanding on the farmer's knowledge. They may control one pest but fail to control a very similar species. Cultural controls are difficult to assess for efficacy and they do not necessarily lead to complete economic control of pests. Harmful cultural controls to fish and wildlife and likely to cause erosion problems as well.

Biological Control Methods

Beauveria bassiana fungus is a potential biological insecticide to control maize weevil in stored maize. Bacillus thuringiensis bacterium is used on adults. The bionomics of the pteromalid parasitoid Lariophagus distinguendus and its controlling effect on S. zeamais were examined by Li et al., (2017). L. distinguendus was found to have five generations annually in the laboratory, with parasitoid final-instar larvae over-wintering within S. zeamais larvae. The parasitoid Theocolax elegans has also been found to parasitize S. zeamais (Helbig, 2021). The effect of different isolates and formulations of Beauveria bassiana on S. zeamais in maize store are reported by Adane et al., (2019), B. bassiana is an effective microbial control agent when used as a preventative treatment (Moino, et al., 2018). Oduor et al., (2000) conducted a survey of fungal pests of maize storage insects in Kenya. The insects collected (mostly S. zeamais) had 0.08 to 0.94% infection.



Botanical insecticides

The toxicities of the majority of essential oils and plant components of numerous spices and herbs have been evaluated against S. zeamais. A number of citrus oils are toxic to adults of S.

zeamais through vapour; oviposition and larval emergence are deterred by lime, mandarin and grapefruit peel oils (Don-Pedro, 2020). Garlic oil is poisonous to adults (Ho, et al., 2017), while coconut, sunflower, sesame and mustard oils, alone and combined with eucalyptol, eugenol, or camphor are poisonous to S. zeamais in wheat- and maize-treated grains (Obeng-Ofori and Reichmuth, 2020)

Advantages of Biological Control Strategies:

Biological control is a very selective strategy. In most situations, any introduced predator will only manage the pest population they are meant to control, thus a green form of control compared to the application of chemicals or mechanical control. Introduced natural enemies can sustain themselves by often reducing pest population which they are meant to control. Once it has been introduced, there is little maintenance to keep the system running at a high level of operation. Biological control can be sustained for a longer period than other forms of pest control and can be potentially long-term cost-saving. It just has to be done once since it sustains itself

Disadvantages of Biological Control Method

Biological control is unpredictable. This method cannot control whatever natural enemy released into an ecosystem. While it's to control one pest, there's always a possibility that the predator would prey on another target - they might opt to consume the crops instead of the insects. Introduction of a new species to an ecosystem threatens to disrupt the food chain. Although it's a slow process. A great deal of time and patience are required for the biological agents to have their magic on a pest population, compared to other methods like pesticides work that immediately take effect. The benefit of that is the long-term effect biological control has. Biological control can never eliminate a pest completely. Predators only reduce the number of destructive pests. Installing an actual biological system is a costly. It takes a lot of money and planning to establish an effective system.

Means of chemical control

Maize weevil infestations rise the longer maize is kept in store so it's worth checking the stock regularly. If the pest is found then there will be a requirement of some form of treatment. Insecticide is any substance employed for killing insects. It is very effective in eliminating

insects and any phase of life, e.g., ovicides, larvicides, eggs and larvae. Synthetic parathyroid insecticides like deltamethrin and permethrin are ineffective against maize weevils and they are more sensitive to organophosphorus insecticides like fenitrothion and pirimiphos-methyl. Phosphine fumigation is very effective against bulk stores. Even grain stores were fumigated with phosphine. Pesticides are poisonous chemicals and thus it is necessary to read all safety guidelines on labels. Sitophilus has been controlled by De Carmago Casella et al., (2023), using a synthetic atmosphere and 0.5 or 0.75 g of phosphine per cubic meter for 120 hours of exposure. Should pesticides be necessary, use the following: Frequent hygiene treatments Malathion to the walls, floor and bin interiors in which the grain is stored.

Benefits of using chemical methods of control against pests

Effectiveness: Chemicals eliminate any pest that has not been able to build immunity against the toxic substance in the agent. According to (Dobie 2021)They die instantaneously and with an effectiveness of up to 100%.

Speed: Most pesticides are produced to kill the rodents within less than 3

CHAPTER THREE

Introduction

This case study was carried out in ward 14 of Gatu in Centenary Mashonaland central, Zimbabwe. The study area is in natural ecological region IV. A research design was based on a survey carried out using researcher administered questionnaire for farmers, Agritex staff key informants and the questions clarity will be discussed using focus group. The collected data was analyzed and presented using Microsoft excel.

Methodology

Site description

The study was conducted in Ward 14 of Gatu in Mashonaland province, Zimbabwe. Ward 14 has smallholder maize farmers who produce maize better than most farmers in Gatu's but one of the most foods insecure as they always complain of maize weevil problems to Agricultural Technical and Extension Services Department (AGRITEX), this motivated this research to try and get a lasting solution for the farmers. The area experiences cool and dry weather from May to July, hot and dry weather from August to November and hot and wet weather from November to April. Gatu district is composed of Agro ecological regions 3 and receives average annual rainfall of 450mm-650mm according to Muvengwi et al., (2021).Centenary is a communal farming area where diversified agriculture is practiced. Livestock production is practiced alongside crop production. Crops grown includes maize (*Zea mays*), Cow peas (*Arachis hypogea*) and sweet potatoes (*Ipomoea batatas*), Ward 14 have 1255 households. 70% of the arable land is under maize production according to recent Crop surveys carried out by Agricultural Research and Extension Services Department (AGRITEX) in 2023/24 farming season. An average of 0.8 tonnes per hectare is realized by the area's farmers. The stored and harvested grains are at risk due to maize weevil attack which can cause damage of up to 90% if not controlled at all.

3.2: Research design

Mixed research methods were used to get qualitative and quantitative data for analysis. Survey research was carried out using questionnaires with both qualitative and quantitative questions.

Quantitative research questions focused on explaining and understanding experiences and perspectives, use of non-numerical data, such as words and observations. Focus group discussions were conducted in order to have clarity on all qualitative questions answered by the farmers from the questionnaire. Stratified sampling and then random sampling method was used to select the 40 interviewed farmers. The 40 sampled maize farmers interviewed, were grouped into two groups. One comprised of males and the second one was made up of females. The other data collection method used was Key Informant Interviews with AGRITEX Officers, Supervisor and Specialist who cover the study area. A Key Informant Guide specifically designed for them was used so as to get more information about their experience on maize weevil effects and effectiveness of control methods used by farmers.

3.3: Target Population

The population for this research was 442 maize farmers in Ward 14 in Gatu. Raosoft sample size online calculator using population size of 442, 90 percent confidence level, and 50 percent response distributio and margin of error of 8 percent was used to calculate the sample size. A total of 86 questionnaires were produced for 86 maize farmers as per calculator, however the researcher used 40 questionnaires for 40 sampled farmers due to financial problems as the survey was self-funded. Farmer's perceptions and opinions were considered according to the questionnaire questions on maize weevil in the area. The questionnaire was developed in English but was explained to responding farmers in their local language which they understand better.

Sampling

Probability sampling was used to select sample farmers using stratified random sampling to have an equal representation of the sample. Sex and age characteristics were used to form strata so that the whole Maize producing population under study was represented and every maize farmer in the population had equal opportunity to be selected. A total of 40 maize farmers were asked to complete a research administered questionnaire each. The 40 maize farmers selected represented the maize producers.

Research instruments

A questionnaire containing both qualitative and quantitative questions was used to extract specific information from respondent, a key informant guide was presented to key informants from AGRITEX Department working the study area and focus group discussion guide was produced and used for discussions with farmers to get clarity on key study questions. The collected information enabled the researcher to get facts and opinions from the farmers on their perception of effects, resistance and control/management methods of maize weevil on stored maize grain. The questionnaire consisted of both open and close ended questions. According to Bhattacherjee, (2019), close ended questions are useful for extraction of factual information and open ended questions are useful for getting opinions, perceptions and attitudes of responding people. The questionnaire question was based on the research questions to be answered. The farmers, key informants guide questionnaires and the focus group questions are found in the appendix section at the end of the document.

Ethical Considerations

These are moral principles that the researcher observed when conducting a research. The researcher got approval from the Ministry of Agriculture to conduct the survey. Permission was sought from respondents to administer the questionnaires. The responding farmers were promised that information to be obtained will be only for academic purposes and privacy will be greatly considered in handling of data. Identity the respondents was protected.

Data analysis

The information to be obtained from the survey was coded, tabulated and analyzed by using Microsoft Excel. The collected data from the questionnaires and focus group discussions was entered into Microsoft Excel, Data was exposed and analyzed using Microsoft Excel and both qualitative and quantitative data results were presented.

CHAPTER FOUR

Table: Demographic Characteristics of Respondents (n = 40)

Variable	**Categories**	**Frequency n (%)**
Gender	Female	27 (67.5%)
	Male	13 (32.5%)
Education Level	Primary	8 (22.5%)
	Secondary	30 (75.0%)
	Tertiary	1 (2.5%)
Age group	20-34	12 (30.0%)
	35-44	10 (25.0%)
	45-54	6 (15.0%)
	55-80	12 (30.0%)

The majority of respondents were **female (67.5%)**, while males made up **32.5%** of the sample. Most respondents had attained **secondary education (75%)**, followed by **primary education (22.5%)**, with only **2.5%** reaching the tertiary level. The largest age groups were **20–34 years** and **55–80 years**, each representing **30%** of the sample. The remaining were **35–44 years (25%)** and **45–54 years (15%)**.

Table: Association between access to information and demographic variables

Variable	Degrees of freedom	Chi-square Value (χ^2)	p-value
Sex	3	4.759	0.046
Age group	9	15.180	0.015
Education level	6	4.678	0.07

Sex is a **statistically significant association** between **gender and access to information** on improved practices (**p = 0.046** < 0.05). This suggests that access to information may differ between males and females. A **significant relationship** also exists between **age group and access to information** (**p = 0.015**), indicating that access to information varies meaningfully across age groups. The association between **education level and access to information** is **not statistically significant** (**p = 0.070** > 0.05), although it's close to the threshold. This implies that education level may influence access, but the evidence is not strong enough to confirm a significant relationship based on this sample. The findings indicate that **gender and age**

significantly influence whether farmers have access to information on improved practices, while **education level shows no statistically significant impact** in this context.

Total responses in categories

Category	Details	Percentage
Total responses	72	100
Satisfaction level		
Satisfied	48	66.7
Very satisfied	5	6.9
Not satisfied	5	6.9
Strongly agree	10	13.9
Agree	4	5.6
Access to maize weevil		
Have access	19	26.4
No access	53	73.6

A total of **72 responses** were collected, representing **100%** of the target respondent's .**Satisfaction Levels is 66.7%** of respondents reported being **satisfied** with their current situation or services. A smaller group (**6.9%**) indicated they were **Very Satisfied**, Similarly, reported being **Not Satisfied**. Additionally, **13.9%** of respondents **strongly Agreed** with positive statements (likely from a Liker scale), while **5.6%** simply **Agreed**. This suggests a generally positive outlook among respondents, with over 73% expressing satisfaction to some degree.

Access to Maize Weevil Information or Resources

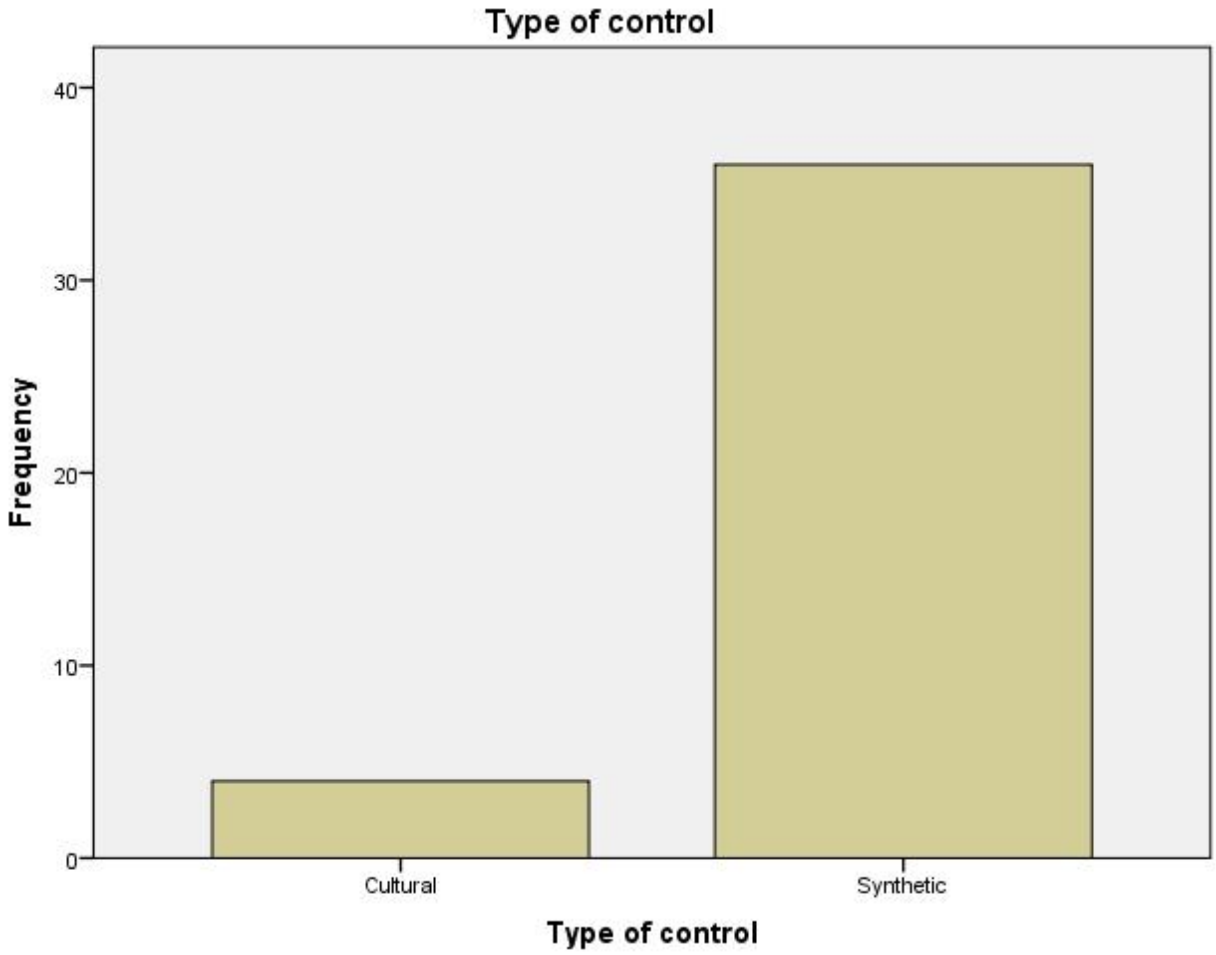
Only **26.4%** of respondents (19 farmers) indicated that they **have access** to maize weevil control resources or information and a significant **73.6%** (53 farmers) reported **no access**. This indicates a major information or service delivery gap concerning maize weevil management.

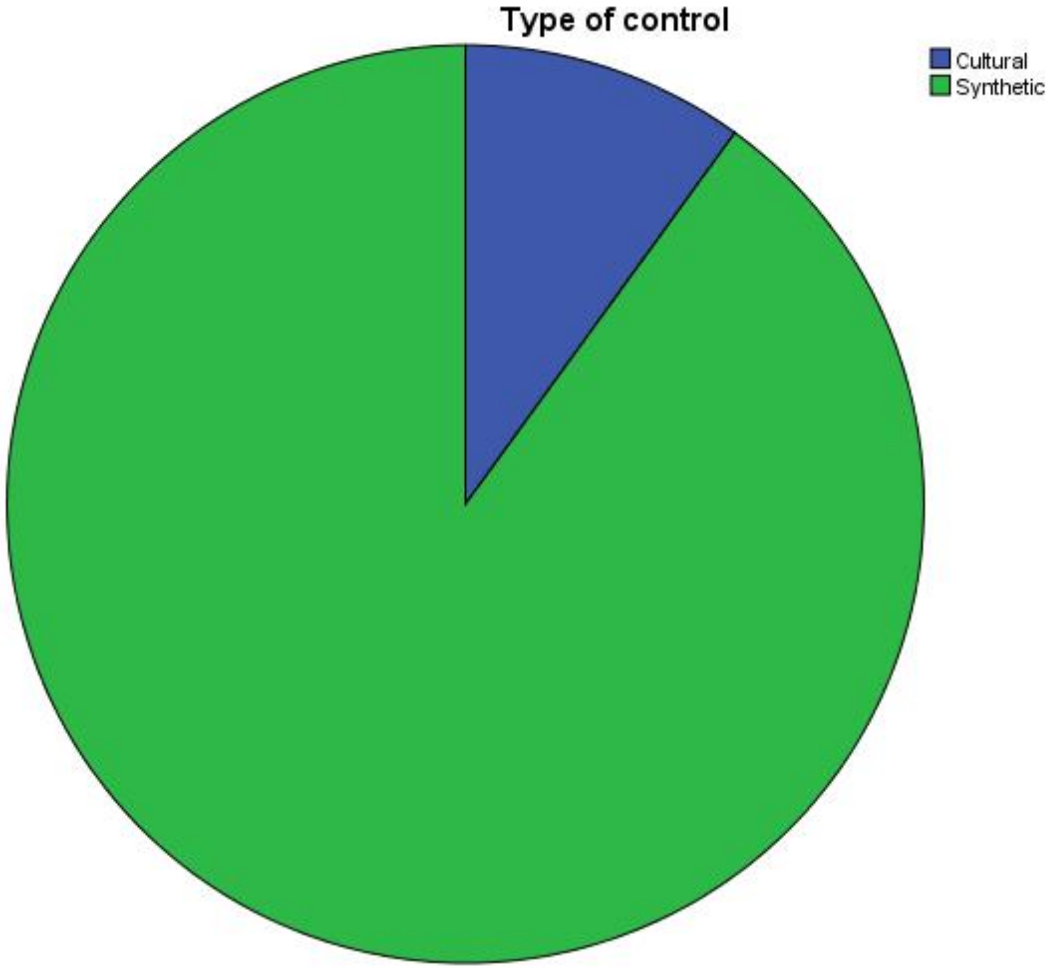
Number of Farmers Affected

The number of affected farmers per area ranged between **30 and 80**. Measures of central tendency show that Average **(Mean) of** 60 farmers, **Median of** 60 farmers and **Mode of** 60 farmers were affected. The identical mean, median, and mode indicate a consistent pattern of impact across most areas.

Grain Loss Due to Maize Weevil

Reported grain losses ranged between **40% and 80%** with an average percentage loss of **62.5%**. The **median and mode** were both **60%**, showing that this was the most common loss level reported. These high loss percentages point to a severe and widespread issue with maize weevil infestations, likely linked to the low access to control methods or information.




Type of control
Cultural
Synthetic

CHAPTER FIVE

Introduction

This chapter gave a detailed discussion of the obtained study results. The discussion will be based on the corroboration of the study results and other research done in the past about the maize weevil pest. The discussion also highlighted the scientific reasons behind some pest incidences such as pest resistance and recurrent after synthetic pesticide control.

5.0 Discussion

Two of the four interviewed key informants covering the study area were females and this indicated the gender balance in the Zimbabwean government employment recruitment policy. All the interview key informant have at least a diploma in agriculture qualification and this shows that they are moving with the technical and technological advancement in agriculture. The key informants have more than ten years working experience in the agriculture sector which makes them experienced enough to know farmers perception on maize weevil pest, challenged faced by farmers and control methods most used.

The study revealed that most of the interviewed farmers were females; these results showed that females are now more into grain crop production other than too much concentration in to horticulture production. Most males are migrating to urban areas in search of jobs and level females back in the rural areas. A total of (2.5%) of interviewed maize farmers obtained a tertiary level of education qualification, Most of the interviewed farmers, reached at least secondary level of education.

SOURCES OF INFORMATION ON MAIZE WEEVLE AND ITS MANAGEMENT

The Ministry of Agriculture's AGRITEX department was reported by all interviewed Gutu farmers and key informants as the main source of information, this was in support with the discovery (Wang *et al*., 2020), that 70% of surveyed farmers were getting pests control information from governmental agricultural extension agents. Of the interviewed farmers, the majority were satisfied with the information they were getting on maize weevil pests. Some interviewed famers said they were not satisfied with the information they were getting on maize weevil.

Most of the respondents were getting information as per request. Information maize weevil management proved to be vital because the highest number of respondents strongly agreed that the information they got on maize weevil pest and its management as improved their grain storage. All the interviewed farmers shared the same sentiments with (De Groote *et al*., 2021) that highlighted that information on grain storage has further improved grain quality and safety. His resulted in farmers having improved food security, feed availability and income generation improvements.

DIFFERENT MAIZE WEEVILE CONTROL / MANAGEMENT MEASURES IMPLEMENTED BY FARMERS AND THEIR EFFECTIVENESS.

All respondents indicated that they were controlling maize weevil pests. Synthetic pesticides proved to be the most used method as most farmers indicated that Synthetic pesticides were the most used control method, as supported by the revelations that an arrays of pesticides (usually in the form of fumigants) have been used by most farmers to preserve maize grain against pests since the 1950s (Olakojo and Akinlosotu, 2019) and (Nwosu, 2016) who said conventional synthetic insecticides are chief weapons in minimizing continuous infestation of pests. The highest number of respondents acknowledged controlling maize weevil pests once per year and the rest controlled maize weevil once per month. Maize weevil resistance to pest control methods was reported by majority of respondents, this is in support of literature (Busvine (2018) who indicated that once resistance occurs in a pest population, there are no ways to restore susceptibility. Majority of the respondents acknowledged that the maize weevil control method

they were using was between (51-75%) effective. During focus group discussions, all interviewed farmers highlighted that they were not getting any assistance in controlling maize weevil pests. All four interviewed key informants concurred with farmers that they trained them mainly on chemical maize weevil pest control method and acknowledged that this the major method used by farmers.

CHALLENGES FACED BY FARMERS IN CONTROLLING MAIZE WEEVIL

The Gatu interviewed farmers highlighted many challenges they faced in their pursuit to control and eradicate maize weevil pest from their maize grain. This was discovered during focus group questions conducted after the survey. These challenges include lack of information on other control methods, high cost of synthetic chemicals which leads to under applications. This resulted in most farmers experienced moderate grain loses. This was in agreement with (Kfir *et al*., 2002), who said that it was estimated that 10-88% of the total maize produced in the region is lost due to field and storage pests. These loses have resulted in interviewed farmers highlighting that they faced food insecurity. The remaining respondents had their income negatively affected due to the purchase of expensive synthetic pesticides , this confirms (Tefera et al., 2010) who agreed that maize grain lost due to pests affects farmers' income. Some farmers bemoaned cost of pesticides as the other setback in their control efforts, these results coincides with those of Mendesil *et al*. (2020) who reported cost of pesticides as one of the challenges faced by farmers in controlling the pests. A total of 34 respondents reported (0-50 kg) kg stored maize grain loss due to the maize weevil pest. A total of 5 of the 40 interviewed farmers reported maize grain loses between (51 – 100 kg) of their total harvested grain and a single respondent reported more than (100 kg) of grain loss due to grain weevil pests. All key informants acknowledged that sun drying, re application of chemicals and selling of grain before attack were some of the methods implemented by farmers in trying to reduce the damaging effects of the maize weevil.

Conclusions

According the results obtained, the interviewed farmers got their information of maize weevil pest management from on main source which limited them to less information on other management practices against the maize weevil pest. Most farmers were satisfied and not very satisfied with the information they got. The high cost of pesticides was highlighted as the main reason behind why farmers are under applying the pesticide and also the reason why farmers are treating their grain with dusts once per season. The discussion also paved way for the recommendations to be provided based on this case study.

CHAPTER SIX

Introduction

This chapter summarizes all the chapters of this case study. These include the introduction and background of the study. The study area, research design, data analysis methods and the results obtained. The results discussion also helped in coming up with study conclusion and recommendations to be used in order to eradicate this maize weevil pest which is causing economic losses to farmers and the nation at large.

Conclusion and recommendations

Conclusion

This study showed that most farmers in Ward 14 of Gatu District were getting information from one source (AGRITEX). Majority of respondents who were only satisfied with the information they got instead of being very satisfied. A single source of information highlighted by the majority respondents, is like to be the reason why most farmers not very satisfied with the information they got. The study also discovered that the majority of farmers were using synthetic pesticides as the major control method, however this method have detrimental effects to the lives of the people, livestock and the environment. The majority of interviewed farmers indicated that none of the used control method of weevils was 100 percent effective. The respondents highlighted many challenges which hinder their progress towards the eradication of the pest and safe keeping of their stored maize grain. Lack of information on maize weevil control methods other than synthetic pesticides use, high cost of purchasing pesticides, pest resistance and recurrent of pests after control were the main challenges shared by farmers. The study showed that those challenge are some of the contributing factors to the maize grain losses in storage which have resulted in farmers realising loss of income and experienced food and feed insecurity. All farmers were recording losses due to the maize weevil storage pest although the losses are of different quantities. This study showed that maize farmers are trying different ways of solving the highlighted challenges. The counter ways included sun drying of the infected grain, re application of synthetic pesticides and selling of grain before attack.

Recommendations

Household and national food security is undoubtedly continued to be under threat from the maize grain damage effects of maize weevil pest. Most of the pest's control methods used by ward 14 farmers is centred on synthetic pesticides which have a negative and toxic effects to the environment. Food security and household income generation increase can be achieved through safe and secure storage of maize grain against destructive post-harvest storage pests such as maize weevils, therefor it is recommended that:

Private sector

I recommend that the private sector as the main beneficiaries (financially) of maize production through seed and chemical sales, to help the government and other stakeholders in information dissemination to the last poor farmer on the ground. I also recommend the private sector companies who are associated with maize grain production to come up with innovations and create control method which are environmentally friendly such as us of biological methods.

Farmers

I recommend farmers to use integrated pest management (IPM). This is the combination use of all control and treatment methods such as good agronomic practices, cultural methods, biological methods and use of synthetic pesticides as the last option. Farmers should practise good agronomic practises such as drying grain to required (12.5% moisture content), field and storage facility hygiene before using any other control method. It is advised that farmers should use control method they afford in order to reduce the challenges of pesticides exorbitant market prices which results and pest resistance and recurrence due to under application. It is also recommended that farmers should also try and use environmentally friendly methods such are plant based repellents, neem extracts and garlic and minimise the use of dangerous and expensive pesticides.

Extension staff

I recommend extension officers to learn and the train farmers on all control methods available for maize weevil pest control. The extension staff should also help farmers with scouting, good agronomic practices to reduce the infestation of pest in the field and storage facilities so as the save farmers' money from purchasing expensive chemicals after heavy infestations. The staff should also teach farmers on chemicals mixing ration, application methods and quantity of chemicals required per given quantity of stored grain.

Policy makers

I recommend policy makers to consider and gazette laws which declare maize weevil pest as an economic pest. They should also help farmers with control measures like they do when there is an outbreak of other pests like the African armyworm and livestock diseases such as foot and mouth.

Conclusion

The study discovered that farmers were limited in terms of sources of information so that is why it was recommended for the public/private partnership in providing farmers with different sources of information. From the results, most farmers were using synthetic pesticides to control the maize weevil pest but they were under applying the pesticides due to inability to purchase enough to meet their grain demand. The recommendations advocated for the use of integrated pest management with synthetic chemical control as the last option due to its toxic effects to humans and the environment. If all stakeholders fail to take some of the above recommendation seriously, then maize weevil pest will remain the major pest responsible of the loss of stored maize grain which will affect the current and future generation of humankind.

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APPENDICES

Appendix 1

QUESTIONNAIRE FOR MAIZE FARMERS IN G ATU DISTRICT

My name is Machida Tendai. I am student at Bindura University studying towards a BSc Honors Degree in Agriculture (Crop Science). I am conducting a research on the topic entitled "Farmers Perceptions on the Effects and Effectiveness of control methods of maize Weevil in stored maize grain in Gatu of Mashcentral Province. I kindly ask for your assistance in filling out this questionnaire. The research is purely for academic purposes and shall not be used for any other purpose without the permission of the participants. Ethical considerations of confidentiality and privacy are honored and guarantee of anonymity of respondents is assured. I value and appreciate your willingness to help me in my research process.

GENERAL INSTRUCTIONS

Kindly attempt all indicated questions and complete the questionnaire by completing in the blank

SECTION A: Demographic information

1. Gender (please tick where suitable)

Male□ Female□

2. Age (please tick where suitable)

Less than 30 years [ ]

Between 30 and 40 years [ ]

Between 40 and 50 years [ ]

Above 50 years [ ]

3. Farmer level of education (please tick where suitable)

Tertiary level [ ]

Advanced level [ ]

Secondary level [ ]

Primary level [ ]

No formal education [ ]

4. How many hectares of maize did you plant during 2022-2023 season? (Please tick where suitable)

Below 1 [ ]

1– 2 [ ]

3 –4 [ ]

Above 5 [ ]

SECTION B: sources of information

1. Do you get any information on maize Weevil? Yes/No

2. If yes, where do you get the information on maize Weevil?

Agritex [ ]

NGOs [ ]

Radio/TV [ ]

Others [ ]

3. Are you satisfied with the services from your source of information?

Very Satisfied [ ] Satisfied [ ] Not Satisfied [ ] Not very Satisfied [ ]

4. How frequent do you get information from your source?

Daily [ ] Weekly [ ] Monthly [ ] as per request [ ]

5. Do you think access to the information has benefited/improved your grain protection? Strongly Disagree [ ] Disagree [ ] Neutral [ ] Agree [ ] Strongly Agree [ ]

SECTION C: Control methods of maize weevil

1. Are you controlling maize weevil? Yes/ NO

2. Which method are you using to control maize weevil? ....."....."

3. How often do you control the maize weevil pest?

Weekly [ ] Forty night [ ] Monthly [ ] Yearly [ ]

4. How effective are this control methods??

CONTROL METHOD	EFFECTIVENESS (%)
Cultural	
Mechanical	
Biological	
Chemical	

5. Are you facing any pest resistance to control methods used? Yes/No

6. Are you getting any assistance in controlling maize weevil? Yes/No

7. If yes, where do you get the assistance …….....

.....

8. Have you ever used different control methods at the same time? Yes/No

SECTION D: Challenges faced in controlling maize weevil

1. To what extent is Maize weevil affecting you as a farmer?

Heavy losses [ ] severe losses [ ] moderately severe [ ] moderate losses [ ] mild losses [ ]

2. How has Maize weevil affected you?

Wealth [ ] food security [ ] cost of pesticides [ ]

3. How many kg of maize grain did you lose in the past 12 months due to Maize weevil?

…….....
.....

4. What challenges are you facing in controlling Maize weevil?

…….....
.....……
…….....
.....

5. How are you coping with these challenges?

…….....
.....……
…….....

Appendix 2

FOCUS GROUP CHECK LIST

PART A: Sources of information

1. Who are your main providers of information about Maize weevil and how do you receive the information?

2. Explain what exactly you are being tough about Maize weevil pest.

3. How are you benefiting from the information you receive on Maize weevil.

PART B: control methods of maize weevil

1. Explain on maize weevil control methods you are using and how effective are they?

2. Which control methods do you commonly use and why?

3. What do you think are the causes of your failure to completely control the maize weevil pest?

4. Are you using different methods of pest control at the same time and how are you achieving that?

5. Explain the sources of money used in control of pesticides and are able to treat all your grain?

PART C: Challenges faced in controlling maize weevil

1. Explain the main challenges you are facing during storage of maize grain?

2. Explain ways you are employing in trying to cope up with maize weevil attack?

3. What do you think are the best methods of controlling maize weevil and why?

4. Explain, in what ways is maize grain loss due to Maize weevil attack is affecting you.

Appendix 3

KEY INFORMANT INTERVIEW GUIDE FOR AGRITEX STAFF

My name is Machida Tendai. I am student at Bindura University (GZU) studying towards a BSc Honors Degree in Agriculture (Crop Science). I am conducting a research on the topic entitled "Farmers Perceptions on the Effects and Effectiveness of control methods of maize Weevil in stored maize grain in Gatu of Mashcentral Province. I kindly ask for your assistance as I carry out this interview. The research is purely for academic purposes and shall not be used for any other purpose without the permission of the participants. Ethical considerations of confidentiality and privacy are honored and guarantee of anonymity of respondents is assured. I value and appreciate your willingness to help me in my research process.

PART A: Qualifications and experience

1. What is your name, designation and work qualification?

2. How long have you been working in AGRITEX and in this area?

PART B: Information dissemination

1. Do you carry out any trainings or demonstrations with maize farmers on maize weevil control?

2. Do farmers attention your trainings and how do you rate their participation?

3. How often do you meet the farmers and what topics to you cover on maize weevil?

4. What are the general Farmers' perceptions on maize weevil attack and effectiveness of control measures the use?

5. What are the economic impacts of maize weevil on these farmers' livelihood?

PART C: Maize weevil control methods.

1. Which maize weevil control methods did you train farmers on?

2. Which method (s) is being adopted by the farmers and why?

3. According to your experience is this adopted method being effective or not and why do you think so?

4. What do you think should be done to effectively control the maize weevil from storage facilities?

PART D: Maize weevil control challenges

1. As an AGRITEX staff member, what challenges are you facing when doing training on maize weevil?

2. What do you think are the major challenges face by farmers in trying to reduce the effects of maize weevil to minimum level?

3. Are these farmers getting any help or support in the fight against this maize weevil pest?

4. What should be done to counter all those challenges?

The End!!