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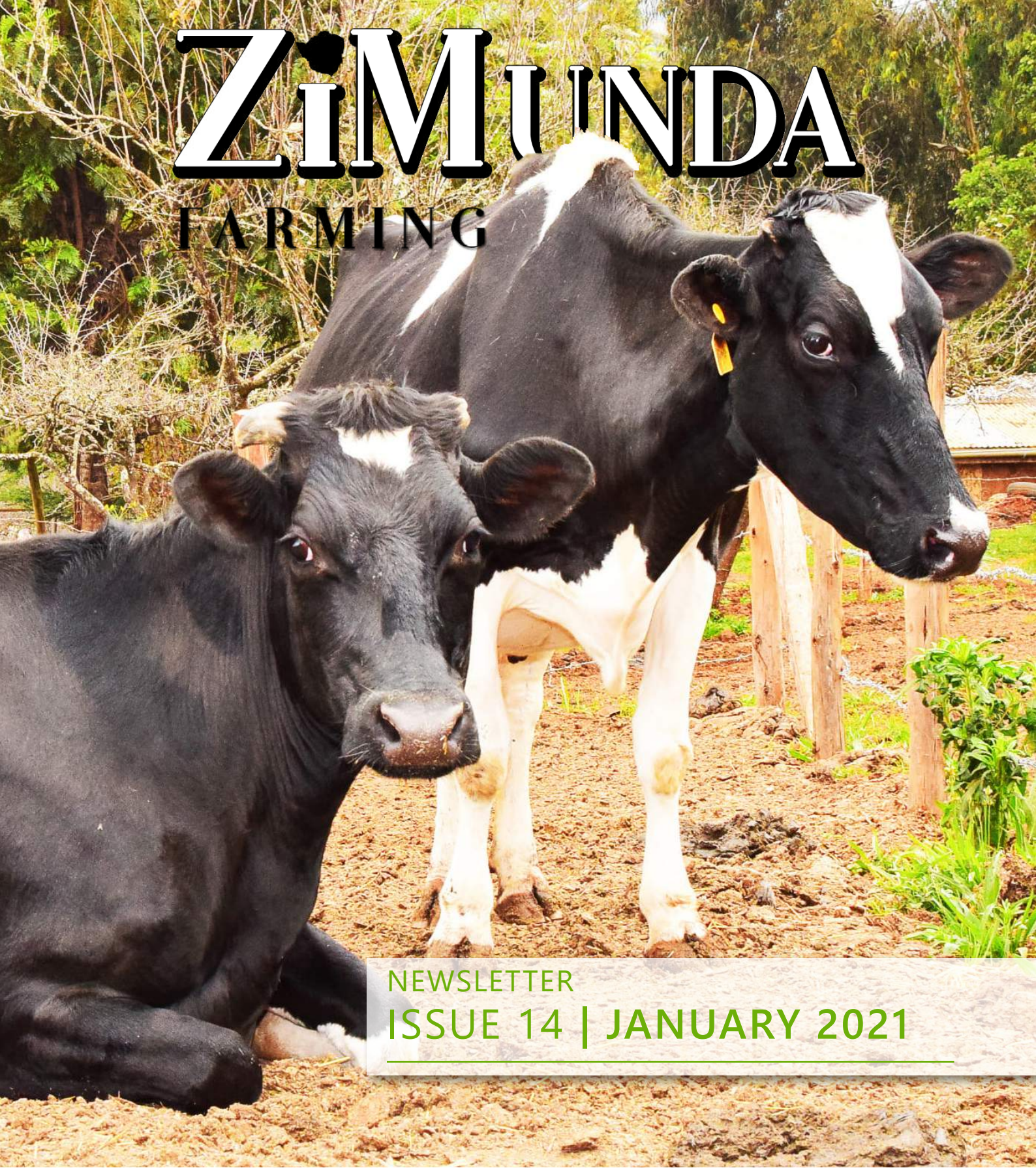

NEWSLETTER

ISSUE 14 | JANUARY 2021

AGRONOMY

THE MENACING FALL ARMYWORM

AGRI TECHNOLOGY

DRONE SPRAYING IN ZIMBABWE

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Mastitis in Dairy Cattle Production & its Management

BY EUNAH MAKONI, MSC, MBA. ABS TCM (PVT) LTD

The goal of any dairy enterprise is the consistent production of maximum quantities of high-quality milk. Mastitis is a significant contributor in reducing both milk quality and quantity produced. It is probably the most common and expensive disease affecting dairy cows the world over.

Mastitis is an inflammation of the mammary gland caused by bacterial infection, trauma, or injury to the udder. It reduces milk yield and alters milk composition resulting in decreased manufacturing properties and dairy products with reduced shelf life. The magnitude of both is dependent on the severity of the inflammatory response.

CAUSES OF MASTITIS

Mastitis is caused by many different pathogens which make its control extremely difficult resulting in potential huge economic losses. The severity of the infection is dependent on the pathogen causing the infection. The categories of mastitis causing microorganisms are the contagious pathogens, which are spread from cow to cow primarily during the milking process and environmental pathogens, which are found throughout the habitat of dairy cows.

Contagious mastitis pathogens include *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma bovis*. The primary source of these organisms is the udder of infected cows. Contagious mastitis pathogens spread from infected cows to uninfected cows primarily at milking.

Environmental mastitis pathogens include *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Escherichia coli*, and *Klebsiella*. The primary source of environmental mastitis pathogens is the environment of the cow. Infections generally occur between milkings and during the milking process.

PREVALENCE OF MASTITIS IN ZIMBABWE

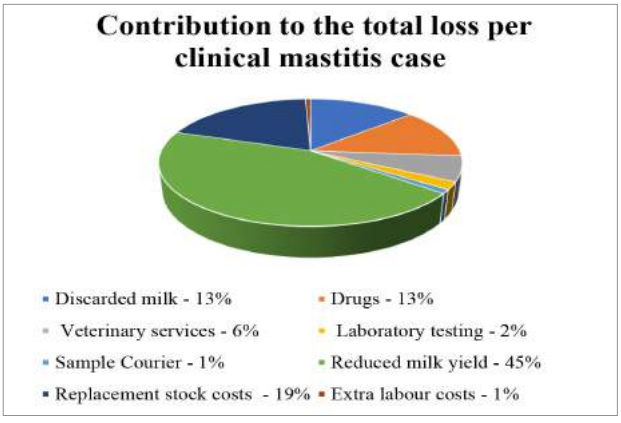
Results from a mastitis study (Katsande, S., Matope, G., Ndengu, M. and Pfukenyi, D. 2013: Prevalence of mastitis in dairy cows from smallholder farms in Zimbabwe The Onderstepoort journal of veterinary research 80(1): E1-E7) in Zimbabwe indicated that, of the total dairy population studied, 21.1% had mastitis, 16.3% had sub-clinical mastitis and 4.8% had clinical mastitis. Herd-level prevalence was 49.3%, meaning that almost half the dairy herd was infected. Coagulase-negative *Staphylococci* (27.6%), *Escherichia coli* (25.2%), *Staphylococcus aureus* (16.3%), *Klebsiella spp.* (15.5%) and *Streptococcus spp.* (1.6%) were the most common isolates.

Depending on the inflammatory response mastitis disease can be acute, clinical or subclinical. Clinical mastitis is characterised by abnormal milk and/or visible abnormalities of the udder such as hot and swollen quarters. Subclinical mastitis (often referred to as hidden mastitis), the most common form of mastitis, is not readily apparent because there are no visible signs of the disease. Cows with clinical mastitis have more dramatic changes in milk yield and composition than cows with subclinical mastitis.

ECONOMIC IMPORTANCE OF MASTITIS

From our company's field observational survey, the potential economic cost of a case of clinical mastitis was estimated as USD312 broken down as discarded milk USD42, drugs USD40, veterinary services USD20, laboratory testing USD60, sample courier USD3, reduced milk yield USD139, replacement stock costs USD60, and extra labour costs USD2. The economic loss categories and their percentage contribution are illustrated below:

Above: An udder with teats dipped in a chlorine dioxide-based teat dip, mixed with a food grade dye to aid management (any dipped teat will be seen easily).



Source: ABS TCM LTD Survey, 2020

Generally, a case of subclinical mastitis may cause a production loss of between 10% and 20% per cow per lactation. This is equivalent to losing 686 litres worth ZWLS 27,500 or USD 275 (at an average daily yield of 15 litres per day). These are conservative numbers as the daily average yield on some farms in Zimbabwe exceed 24 litres per cow per day. Subclinical infections are

important to identify as the cows can be infected for extended periods resulting in the reduction of both milk quality and volume. The greatest economic losses are due to high somatic cell counts which result in loss of quality premiums and overall reduced milk production.

APPROACHES TO MASTITIS MANAGEMENT

Controlling mastitis involves a number of steps that constitute a control program. The control program must be practical, economical, easy to customise, and effective under most management conditions. Since mastitis is caused by a broad spectrum of pathogens which behave differently, a one-size-fits-all approach to mastitis management is not possible. Control of environmental mastitis pathogens is best achieved by maintaining a clean, dry environment for cows. Given that pathogenic bacteria gain entrance into the mammary gland through the teat canal, any procedure that reduces exposure of the teat end to bacteria is likely to be beneficial. Following is such a procedure:

- Milk in a clean, dry, and stress-free environment.
- Wash hands regularly with soap and water between milking of cows.
- Wear clean protective clothes.
- Wash dirty udders with water and check udders foremilk for signs of infection. For clinical mastitis infection is relatively easy to diagnose with the naked eye; usually there are defects in foremilk such as blood, flakes, clots, or a watery appearance. However, subclinical mastitis cannot be as easily detected in foremilk.
- Minimise use of water in the milking parlour, as water can be a vector of transmission of pathogens. A wet place is ideal for germ transmission, e.g., from cow to milker, from milker to cow, from cow to cow from environment to cow and from cow to environment. To maintain hygiene water used on udders should be potable.
- Use a separate single paper towel per cow to dry the teats. Never use a communal cloth (if used) to clean more than one udder.
- Pre-dip the teats in a pre-milking teat disinfectant as this lowers the risk of new infections. It combats environmental pathogens that may have been transmitted to the teat at some point after the last milking.
- Adjust milking units as necessary. The milking timing and clusters suction pressure/ tightness have to be right otherwise there is a risk of physical injury of teats which could lead to mastitis infection, e.g., high suction pressure of milking clusters amounts to pinching of teats.
- Shut off vacuum before removing machine.
- Dip each teat immediately after milking in a teat dip that kills mastitis causing bacteria. Use of post-milking teat disinfection prevents new infections and destroys mastitis pathogens on teats after milking. The preferred teat dip should be good to use pre- and post-milking, i.e., 2 in one, with high efficacy. It should be chlorine dioxide based with a high log kill, preferably 6 and above, i.e., it should kill at least 99.9999% of bacteria on the treated surface within 15 to 20 seconds. Unlike most iodine-based teat dips, activity of chlorine dioxide teat dip is not affected by organic matter including milk and manure.
- Cows with mastitis should be milked last.
- Keep cows as clean as possible and away from wet and muddy areas.
- Treat all clinical cases with the correct drugs and for the right duration. As there is no general drug for mastitis treatment, the correct antibiotic has to be recommended by a veterinarian following a proper diagnosis.
- All cows must get dry cow therapy when they are being dried off. Dry cow therapy (DCT) is the treatment of cows at the end of lactation with a long-acting antibiotic preparation with or without a teat sealant. This is to treat for any intra-mammary infections (IMI) contracted during lactation and protects against new infections during the dry period. The dry period is usually 60 days and DCT treatment is a precautionary / preventative measure.

From the foregoing it is clear that mastitis prevention and control are key if farmers are to realise the primary goal of consistent production of maximum quantities of high-quality milk. Mastitis treatment requires that the causative micro-organism is first identified by laboratory culturing, then the effective antibiotic for therapy is selected based on sensitivity tests.

For more information on mastitis in dairy cows, contact African Breeders Services TCM (Pvt) Ltd at +263 778 223 367 or e-mail: eunahm@abstcm.com or visit http://www.abstcm.com

Images provided by African Breeders Services TCM Ltd

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Indigenous Goat Farming

BY CHRISTINE ZIMBANGO, RARECRAY FARMING

Zimbabwe has two types of indigenous goats that exist and these are namely; the small Mashona, found mostly in the Eastern and Central parts of Zimbabwe, and the Matebele goat, largely found in the Southern and Western parts of the country. The rise of exotic and hybrid breeds has resulted in some farmers overlooking indigenous goat breeds which are popular for their ability to survive in difficult conditions, their resistance to diseases, and their lower management requirements. More of these advantageous capabilities are discussed below:

Feeding - Indigenous goats are often left to feed off the veld and fend for themselves with little or no supplementary feed. As we are currently in the rainy season, animals have plenty of feed. However, feed quality deteriorates early in the dry season and becomes scarce as the season progresses. The small frame size of the goats gives them an ability to browse in poor and dry areas; an advantage over other ruminants such as cattle that cannot feed in these areas.

Hardiness - As locally adapted breeds, the indigenous goats are hardy and resistant to diseases. They are highly adaptable and can strive in difficult conditions due to their high tolerance, hence require less management.

GOAT MANAGEMENT

Good management practices play a key role in optimising indigenous goat production. This however, requires a mindset shift towards commercialisation of the enterprise. Housing, nutrition and breeding management are key factors to consider in achieving a commercial indigenous goat enterprise.

Housing - Provision of proper shelters for the goats is very important; one can look at different housing designs that are budget-friendly. Good goat structures will help to ensure that your animals stay healthy and it will help prevent the occurrence of diseases.

Nutrition - In the dry season the quality and amount of grass available decreases, it is important to provide supplementary feed especially during late pregnancy and early lactation. While feed can be expensive to purchase you can make your own by harvesting veld grass in the rainy season and using this to feed your goats in the dry season. At RareCray farms, we have invested in a diesel-powered chopper that we use to chop grass and green forage which we then preserve for the dry season. It is important to always provide your goats with clean water.

Breeding - Avoid inbreeding by implementing systems like record keeping and separation, the latter needs to be supported by the right structures. Start implementing selective breeding by monitoring your herd for infertility, slow growth, or any other unwanted traits. Choose your rams/bucks carefully and only allow the best to become breeders. Castrate male kids to avoid having multiple bucks within a herd. Separate does (female goats) from bucks/rams to control breeding and establish proper breeding seasons.

"While indigenous goats have a competitive edge under prevailing climatic and environmental conditions, they are still generally viewed as less productive than exotic breeds. Therefore, practical selection programs are needed to improve productivity and add more value to indigenous goats" (Monau, P et al. Sustainable Utilisation of Indigenous Goats in Southern Africa. Diversity 2020, 12, 20).

Commercially rearing indigenous goats can be disconcerting, but we at RareCray Farming are a good example of the optimisation of the enterprise. We started with a couple of Mashona does which have now since proved to be highly adaptable, resistant, and fertile. As we improved our management practices, we saw our herd improve incrementally in value and growth.

Left: Part of the indigenous goat flock at Rarecray Farms

Below: A doe and a kid at Rarecray Farms

Images provided by Christine Zimbango

Deep-Green Fish Pond Water

BY DAVIDZO CHIZHENGENI, KVD LIVESTOCK CONSULTANCY

In aquaculture production technical difficulties may arise during fish culture such as deep-green pond water (plankton bloom). The deep-green colour of the pond water is due to the presence of excessive algae in the water. This algae bloom is a result of high fish stocking density , an overabundance of nutrients , calm weather, and the warmth of the water.

EFFECTS OF DEEP-GREEN POND WATER

The major negative effects of algae occur indirectly.

- Excessive algae growth can lead to a lack of dissolved oxygen in the water. Dissolved oxygen content significantly drops at night due to the absence of photosynthesis which replenishes oxygen content in water, and excessive consumption of oxygen by both fish and algae (algae respire at night, taking in oxygen). In this situation, fish start grasping on the water surface for breathing and sometimes face mass mortality due to the shortage of dissolved oxygen.
- Phytoplankton blooms can also cause large diurnal fluctuations in water quality variables in mid-afternoon, for example, very high pH and ammonium nitrate levels caused by excessive utilisation of free carbon dioxide for photosynthesis.
- Blue-green algae can also produce toxic substances that are lethal to some fishes.

PREVENTATIVE MEASURE AND REMEDIES

The previously mentioned conditions are stressful to fish. The best preventative measure to algae control is to regulate nutrient inputs by moderate stocking and feeding rates. In the case of algae bloom, the following remedies can be employed;

- Temporarily suspend the application of feed and fertiliser application to the pond.
- Drain away the water from the pond and refill with fresh water.
- Apply lime at a rate of 150-200 kg/ha.

For more information on aquaculture management, contact KVD Livestock Consultancy at 0784458565 or email: davidzochizhengeni@gmail.com

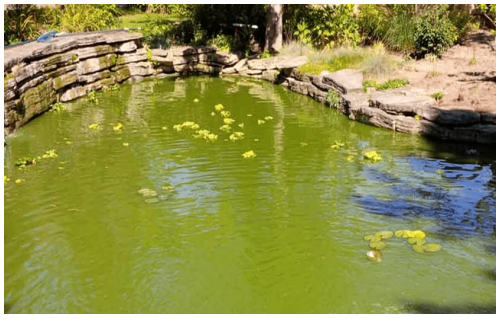


Image provided by Davidzo Chizhengeni

A Profeeds Story

BY A PROFEEDS BEEF FARMING WORKSHOP TRAINER

One day on my way to Zhombe East, I was on a long-distance bus nicknamed 'Roadrunner'. I overheard two gentlemen discussing how a Mr Zvimba lost his herd of cattle. Mr Zvimba is said to have had about 60 cattle. He lost most of them and is said to have only 3 skinny heifers, a bull and an ox left. The conversing gentlemen were of the view that Mr Zvimba's traditional medicine (voodoo) had expired. This got me thinking about inviting these gentlemen and their community to the Profeeds beef farming training session in their area.

I am happy to say they accepted my invitation and within a month's time we set up a training workshop and they attended. The major highlights of the seminar were as follows:

The first topic discussed was how to apply livestock medication especially injections. It is important to know the animal weight so as to ensure correct dosages are given. A cattle weigh band or tape can be used to check the animal's weight.

During the beef training session, discussions were held on how best beef cattle farmers can protect their herds from tick-borne diseases. Ticks are parasites and they complete their life cycle with a phase during which they feed on animal blood. A bite from an infected tick introduces an infection into the animal. Treatment is usually expensive and depending on the disease, identification may require expertise and may not be readily available. It is important then to avoid these costly options by focusing on prevention from tick bites. This is achieved by proper animal dipping. The following tips on dipping animals are important:

i) When dipping cattle, make sure the beast is restricted from free movement (better use a handling crush pen).

ii) For a small beast (<200kg), use 2-4L of dipping solution. Spray against the fur, make emphasis on hidden parts where ticks hide.

iii) For a beast (>200kg) use 4-6L of dipping solution.

iv) Those farmers that are in very dry areas, there is no need to use dip that need to be diluted in water, use dip that can be applied as a topical application. However, take care not to overdose during application as the dip can damage the animal's skin.

The training also gave insight into supplementary feeding. Profeeds beef feed supplement can set the tone for a healthy animal for its betterment in terms of survival. Profeeds has developed two superior multi-purpose feed products - Beef finisher meal and Beef finisher concentrate. Never use the concentrates unless you have good snap corn in stock for adequate mixing. When using concentrates, thoroughly mix the concentrate with the snap corn. Performance of feed is greatly reduced if feeding instructions are not followed. Mix with snap corn or the equivalent in the ratio of 1-part concentrate with 4-parts snap corn. Snap corn is a milled cob of maize (grain and sheath). The Beef finisher meal is a straight feed. These two feeds are fed 8-13kg per animal or feed 3% of body weight per day.

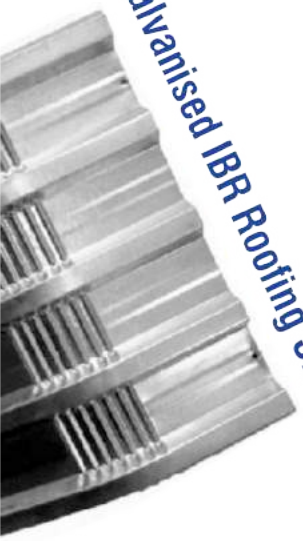
You can give feed to beef cattle that have lost condition and it is also good for fattening before slaughter. Consider deworming the cattle first, then start giving small quantities of feed and gradually increase over one to two weeks. Cattle rock blocks should be made available to your cattle. It is advisable to make these blocks available to your cattle all year round. The salt stimulates the appetite, enabling the cattle to consume more feed, especially when grazing.

Managing your herd is important; embrace good health husbandry and understanding of the use of your store-bought feed supplements for good results.

Image provided by Rudo Nhamoinesu

Afri-Roof and Chromadek IBR Roofing Sheets

Galvanised IBR Roofing Sheets



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U-Beams & U-Columns

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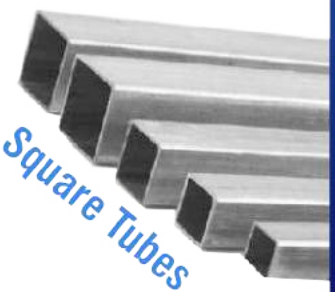

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Drone Spraying Technology for Sustainable Farming in Zimbabwe

BY TAKUDZWA CHIPADZA AND PIWAI CHIKASHA, ALLEY CAPITAL GROUP

Agro-chemicals such as fertilisers and pesticides are a major source of environmental and water pollution, and they threaten the health of farm workers who can be exposed to them. These negative effects are due to the shortcomings of traditional crop spraying methods. The drone sprayer replaces traditional methods of tractor-drawn boom sprayers, knapsacks and manned aeroplanes, which are by far less efficient and reliable leading to environmental pollution levels that will surely impact the future generations.

THE ENTREPRENEURIAL JOURNEY

In August 2018, two aeronautical engineers, well versed in aeronautics and drone technology, joined forces to make a difference in Zimbabwe's agricultural sector by creating Alley Capital Group; an engineering company offering crop spraying services using drones. At the 2018-2019 Green EnterPRIZE Innovation Challenge, implemented by the International Labour Organisation (ILO) with support from the Government of Sweden, Alley Capital Group was awarded the "Best Young Entrepreneur" prize and received financial support in the form of a grant. The funds were pivotal for the mobilisation of the additional equipment required for the commercialisation of the business. In February 2020, Alley Capital Group was awarded the Public Vote award at the Africa Drone Business Challenge in Kigali.

Local assembling and maintenance of drones

Preparation of drone for spraying mission

DRONE MEETS FARMERS

In June 2019, Alley Capital Group introduced drone crop spraying to the farm operations of three horticultural farmers in the Goromonzi district. In this exercise, the technology matched their particular requirements.

The objective was to improve the effectiveness and efficiency of crop spraying operations, as this would help reduce their operating costs. More importantly, it would also lead to a *reduction of the chemical pollution levels*. Farmers regularly rely on tractors for spraying their crop, and apply recommended rates of active ingredients, but lack the accuracy offered by a GPS guided drone to make sure that the distribution of the chemicals is optimised. This results in excess quantities applied in certain areas of the field due to overlapping passages or wastage of it along the sideways. All this affects the biotic environment and the natural water system. Other farmers use knapsacks for spraying, a method that is even less accurate. Our calculations showed that one farmer applied an excess of 120 litres of chemicals per hectare per year. For large-scale operations, the potential negative environmental impact becomes apparent. The drone sprayer cuts this excess down by a significant margin, providing millilitre accuracy and control with each litre of chemical used. Drones employ an ultra-low-volume spray technology, which has been scientifically proven to be more effective than traditional spraying. In lettuce and cabbage spraying, it was established that where a farmer used to spray 75 litres of solution per hectare using a tractor with boom sprayer, a drone operator would need 20 litres of solution at higher concentration, but with 5% less pesticide per hectare.

Alley Capital Group also aimed to *minimise the harmful side-effects* that farm workers are exposed to due to pesticide poisoning during crop spraying. During a given season, workers can be exposed up to four consecutive days of constant exposure to chemicals.

In addition, the drone is battery-powered, *eliminating the need for fossil fuels*. On average farmers require 6 to 10 litres of diesel per hectare for spraying. The drone offers the opportunity for making use of an alternative power source and offsets the need for diesel which is increasingly scarce and expensive in Zimbabwe.

Another of Alley Capital Group's objectives is to localise drone production by using available skills and expertise in aeronautical engineering, *making the purchase and maintenance of the equipment more cost effective*. One of the most advanced crop spraying drone systems is

a Chinese manufactured platform, with a purchasing price of approximately US$ 18,000 and each battery costing US$ 900. To make a profit operating this particular drone, a service provider will need to charge at least 18 dollars per hectare. Such a price discourages farmers, especially medium- and small-scale farmers. Alley Capital Group assembled a suitable drone for under US$ 4,000, fit for cheap in-house maintenance and repair and capable of using common off-the-shelf batteries worth approximately US$ 375 each. This enables Alley Capital Group to charge a significantly lower price which most medium-scale farmers are willing to pay, especially those currently using fuel-powered tractors with boom a sprayer.

ADOPTION OF DRONE SPRAYING TECHNOLOGY IN FARMS

One of the ways to measure success is by seeing how well the drone crop spraying technology is adopted. Alley Capital Group is currently working with select farmers in citrus, soybean, and vegetable farming in Zimbabwe, according to current capacity.
The farmers have since expressed genuine understanding and appreciation of the importance of the technology and are willing to pay for the service.

Regular recording of data for each flight is essential for evaluating service's efficiency

Alley Capital Group increased understanding of drones by *presenting the technology* to the farmers. Successful exhibitions were held at the Youth in Agriculture Conference, at the Green EnterPrize Launch ceremony and the 2020 Africa Regional Forum on Sustainable Development, catching the attention of thousands of individuals combined. While most of those spoken to said they understand how drones work, up to 15% of those spoken to during these events (mostly farmers) indicated that the drone crop sprayer seemed a little too technical and complex.

Policies and Regulations regarding drones can be a challenge, but this challenge has been managed well so far. As required by law, an application for the registration of the drone is pending. This drone has gone through the due processes at the Civil Aviation Authority of Zimbabwe. Even though the registration framework is yet to be published and implemented by the Civil Aviation Authority, all operations were pre-approved prior to deployment. Several control documents, matching international standards, to manage the safety and quality of operations have been developed. These include flight management documents, reporting documents and operational manuals.

FINAL THOUGHTS AND THE ROADMAP

Africa's agricultural productivity is growing steadily, but with a cost to the environment. The work with drone spraying technology shows that it can protect the environment without compromising on sustainability and food security. The r environment today is under massive stress, with ever-growing pollution levels resulting from an inadequate and unsustainable use of chemical inputs. This harmful exposure extends to all farm workers, with severe poisoning being reported frequently. Drone crop spraying reduces these health hazards, while cutting crop protection costs by up to 30%, and increasing productivity significantly.

Plans for the future include researching traditional crop protection techniques used by the forefathers, which used less chemicals, discovering how this can be combined with drone spraying. It is recommended there should be active support for such innovations across the continent, so that such multilateral backing can transform agriculture so that generations may inherit land that can supply their farming needs, while at the same time supporting the local biodiversity. As a company that genuinely felt the impact of external support at an early stage, Alley Capital Group acknowledges the support received from the ILO through the Green EnterPRIZE Innovation and Development Project in Zimbabwe, with support from the Government of Sweden and encourage continued support across the continent.

We hope that through our work at Alley Capital Group, drones for crop spraying will in time become the preferred solution.

For more information on drone spraying technology please email piwai@acg.co.zw / takudzwa@acg.co.zw or visit www.acg.co.zw

Images provided by Takudzwa Chipadza & Piwai Chikasha

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Cloud Cover, Photosynthesis, and Brix Level

BY DAMARA BIO-AGRI

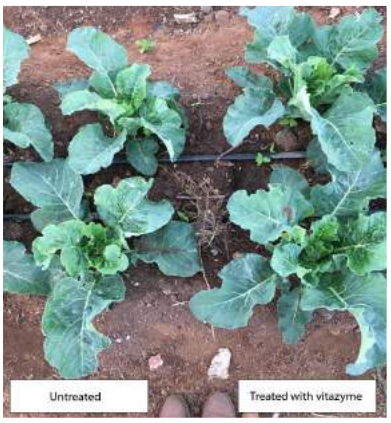
Cloud cover, a plants brix levels, and its photosynthetic capabilities are tied together in a complex web of interaction. The aim of this article is to get to grips with understanding how a plants energy, ultimately their brix level, is impacted because of prolonged cloud cover, and how this influences the plants natural process of photosynthesis.

BRIX LEVEL

It is important to understand beforehand what a brix level is and why plants with a higher brix level are healthier. Brix is the measurement of sugar levels, vitamins, minerals, proteins, and other solid content in plants and is measured using a refractometer. When a plant has a high brix level it is an indication that the plant has been grown in a healthy medium, with sufficient nutrients and water. The plant has the capacity to build essential oils to protect itself from diseases, UV radiation, or overgrazing by insects or herbivores. This plant functions at an optimal level of photosynthesis, turning light into yield at its maximum capacity. However, when a plant has a low brix level, this signals a weak plant, one that has not been grown in a healthy medium and is not only underperforming but is also susceptible to pests, disease, and climatic changes. This plant will tend to photosynthesize less, during which time the plant is not able to efficiently use the energy input from the sun to absorb carbon dioxide from the air, and water from the soil, to produce the necessary sugars and carbohydrates that coincide with a high yield.

THE IMPACT OF CLOUD COVER ON PHOTOSYNTHESIS

This is where the effect of cloud cover is most prominent on crops. If you think about it, Zimbabwean summers are characterised by hot sunny days only alleviated by the cool afternoon thunderstorms. Although we all wait in anticipation of rain, have you ever given thought to how those thunderstorms impact a plants energy level? Firstly, have a think about what constitutes a thunderstorm. The answer to that is clouds! Not only when a thunderstorm is building, but also after a thunderstorm, there tends to be an increase in cloud cover. This increase in cloud cover can persist for hours if not days. Thus, if your crop is already failing to photosynthesize optimally, as a low brix level would highlight, because it has not had access to the correct soil nutrition, persistent cloud cover would only serve to disturb the process of photosynthesis even further. This will have a detrimental impact on the overall crop performance, where studies have predicted that this costs plants 7.5 to 40% of their yield, depending on the type of plant and temperature.



So, the question becomes, *'How can one increase the photosynthetic ability of crops during periods of consistent cloud cover?'*

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For more information on Vitazyme, please contact +263 086 77005277 . or email bioagri@damara.org or alternatively visit our website, www.damarabioagri.com.

Images provided by Damara Bio-Agri

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Fall Armyworm Invasion & Control Practices

BY P. M. MATOVA, C. N. KAMUTANDO, C MAGOROKOSHO, D. KUTYWAYO, F. GUTSA, AND M. LABUSCHAGNE

The following excerpts related to the Fall Armyworm (FAW) are taken from the paper Fall armyworm invasion, control practices, and resistance breeding in Sub-Saharan Africa (SSA) written by Prince M. Matova, Casper N. Kamutando, Cosmos Magorokosho, Dumisani Kutywayo, Freeman Gutsa, and Maryke Labuschagne.

The fall armyworm, Spodoptera frugiperda is currently the most damaging crop pest affecting maize in SSA. It is a polyphagous (feeds on several hosts) and migratory (can spread to other countries) pest that survives on at least 80 plant species, including maize, wheat (*Triticum aestivum L.*), sorghum [*Sorghum bicolour* (*L.*) Moench], and rice (*Oryza sativa L.*). The consequences of FAW invasions on food and nutrition security have been made worse by lack of resistant/tolerant cultivars, poor capacity to control and manage the pest, and the suitability of the climatic conditions for the rapid multiplication and perpetuation of this pest. The fall armyworm, riding on migratory winds, has the potential to travel for long distances, and can prolifically breed in suitable environmental conditions typical of SSA.

MORPHOLOGY AND BIOLOGY OF FALL ARMYWORM

The Fall armyworm resembles both the African armyworm [*Mythimna unipuncta (Haworth)*] and corn earworm [*Helicoverpa zea (Boddie)*]. However, the FAW has some distinct features that can help separate it from its close relatives, these include:

(a) a white-coloured inverted "Y" mark on the front of the dark head,
(b) a brown head with dark honey-combed markings (Figure a) and,
(c) four dark spots displayed in a square on top of the eighth abdominal segment, as shown in Figure b.

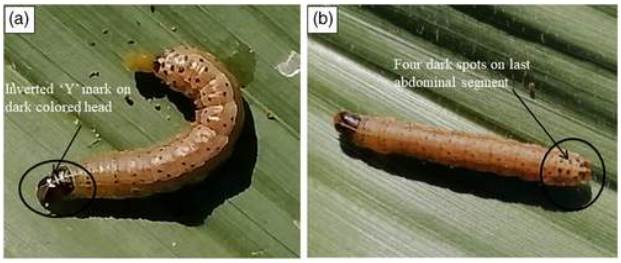

Figure 1 - Physical appearance of the fall armyworm (FAW) larvae highlighting the most distinguishing features of the worm.

FAW INFESTATION SIGNS AND SYMPTOMS

Typical early FAW infestation signs and symptoms include small "pinholes" and "window panes" (Figure 2a), resulting from the feeding of the small worms on leaves (Figure 2b). Damage of maize plants caused by FAW attack is severe during the late pre-tassel stage (Figure 2c). Bigger larvae consume large amounts of tissue and do much more damage compared to small larvae, resulting in a ragged appearance of the leaves (Figure 2d). It is also important to appreciate that foliar damage on maize may look serious but may not necessarily translate into high grain yield losses, as reported by a study carried out by the U.S. Department of Agriculture - Agricultural Research Service (USDA - ARS), in which they noted that FAW defoliation as high as 70% at 12-leaf stage could cause just about 15% grain yield loss. Fall armyworm defoliation on maize rarely goes above 50%.

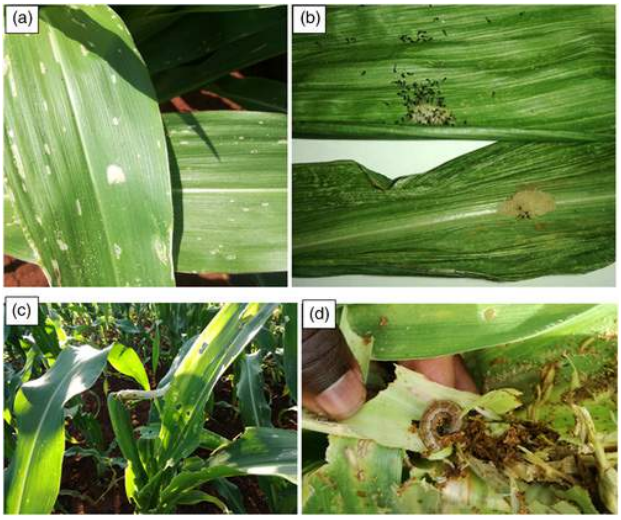

Figure 2 - (a) Fall armyworm (FAW) egg masses and first signs of FAW infestation on leaves. (b) Young FAW larvae (black heads) emerging from egg masses on window pane damaged leaves. (c) Advanced FAW damage, showing dead heart on the growing point. (d) Large FAW larvae protected by 'frass plug' while feeding in the whorl during tasselling stage.

REPRODUCTION AND MULTIPLICATION RATES

The FAW's rate of reproduction and multiplication is rapid; coupled with the fact that FAW does not have a diapause (the biological resting period), it can establish as an endemic pest. For instance, one adult female moth is capable of laying between 1,000-2,000 eggs during its lifetime. Eggs are laid in egg masses of between 100-200 eggs. In warmer climates, the duration of the egg stage is only 2-3 days. The larval stage lasts between 14 and 30 days in warmer summer and cooler winter months, respectively. Whereas the lifespan of an adult moth is approximately 10 days. The pest can complete its life cycle in 30 days at an average daily temperature of 28 °C. This implies that in warm climates, such as those experienced in SSA, FAW can

have multiple generations in one season.

FALL ARMYWORM CONTROL STRATEGIES

Currently, researchers are working on immediate and long-term solutions to the problem. Breeders are developing cultivars that can offer native resistance to the pest, while chemical companies, entomologists, and other researchers are developing insecticides, bio-controls, and cultural-methods, respectively, to minimize crop damage that can result after infestation.

1. Synthetic and botanical pesticide control practices

As an emergency response strategy to FAW invasion in 2016, most governments in Africa distributed chemical insecticides to farmers through extension. Some of the broad-spectrum pesticides that were being used included Thionex [Endosulfan 50%], Carbaryl [Carbaryl 85WP], Dimethoate [Dimethoate 40EC], and Karate [Lambda cyhalothrin 5EC].

These were later replaced by more efficient and eco-friendly pesticides, which included Ecoterex [Deltamethrin ($C_{22}H_{19}Br_2NO_3$) and Pirimiphos methyl ($C_{11}H_{20}N_3O_3PS$)], Emamectin benzoate (4''-Deoxy-4''-epi-methylamino-avermectin B1) Macten (Emamectin benzoate 5%), Super dash [Emamectin benzoate and Acetamiprid [N-(6-Chloro-3-pyridylmethyl) -N'-cyano-acetamidine)], Ampligo [Chlorantraniliprole (3-Bromo-4'-chloro-1-(3-chloro-2-pyridyl)-2'-methyl -6'-(methylcarbamoyl)pyrazole-5-carboxanilide, 3-Bromo-N-[4-chloro-2-methyl-6-[(methylamino) carbonyl] phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide, DPX E2Y45) and Lambda-cyhalothrin ($C_{23}H_{19}ClF_3NO_3$)], and Belt [Flubendiamide (N2-[1,1-Dimethyl-2-(methylsulfonyl)ethyl]-3-iodo-N1-{2-methyl-4-[1,2,2,2-tetrafluoro-1-(trifluoromethyl) ethyl]phenyl}-1,2-benzenedicarboxamide)].

2. Cultural agronomic practices

Different cultural practices that have been utilized across SSA in managing and controlling FAW infestation and maize yield losses include, handpicking and killing of larvae, placing sand or wood-ash in whorls of maize plants, drenching plants with tobacco extracts, deep ploughing to kill overwintering pupae, early planting, destruction of ratoon host plants, burning infested crop residues after harvesting, intercropping with non-host plants, use of multiple cultivars, and rotation with non-host crop.

3. Biological control practices

Studies show that Push and Pull Technology (PPT) based on intercropping maize with Greenleaf desmodium [*Desmodium intortum (Mill.) Urb.*] and bordering the intercrop with Brachiaria 'Mulato II' is effective in FAW control. The Desmodium protects the maize by emitting semiochemicals that repel (push) the moths that are concurrently attracted (pulled) by semiochemicals released by the border crop. ICIPE (2018) and Midega et al. (2018) reported that FAW infestation can be reduced by at least 80% in a field where the technology is being practised.

4. Host plant resistance strategy

Access to cultivars with some level of resistance or tolerance to FAW brings cost-effective control to the resource-poor smallholder farmers in SSA. Native resistance is defined as resistance that is naturally available in the gene pool, harnessed through selection for effective use in agricultural production systems. Native resistance offers minimal but significant protection to a crop, but it is usually combined with other management measures in an Integrated Pest Management (IPM) strategy.

5. Integrated pest management strategies

The FAW IPM strategies are targeted at preventing or avoiding pest infestations, and management of established infestations. This involves routine scouting to identify and respond to infestations, to suppress the pest using the IPM triangle strategies, that is, minimum application of safe pesticides, provision of safe, scientifically proven or evidence-based options to farmers, and managing insect resistance to pesticides. The IPM triangle is a practice that enhances effective application of IPM strategies by considering control as a three-pronged strategy comprising of chemical, biological, and cultural control, all based on effective pest monitoring.

For full academic references and citations of the article, please refer to Irwin Goldman, Introduction to the special Crop Science issue: Celebrating the International Year of Plant Health, Crop Science, 10.1002/csc2.20342, 60, 6, (2841-2842), (2020). Wiley Online Library.

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Sugar Bean

A Strategic Crop

BY WENDY MADZURA, CHIEF AGRONOMIST, SEEDCO

Climate change vagaries have prompted the need for farmers to adopt climate-smart crops that help mitigate the effects of climate change. The false starts to the seasons, recurrence of mid-season droughts, heat waves, floods and the premature termination of the rainfall season over the years has seen the need for farmers to diversify cropping programs in a bid to spread risk and increase chances of increased productivity in their cropping programs.

CROP DIVERSIFICATION

Diversification promotes farm viability by improving income streams and liquidity. The good recent rainfall activity recorded across the country brought a sigh of relief to farmers across the country. This has enabled farmers to consider growing lucrative crops like sugar beans. Sugar bean is one of the crops that is well within its planting season seeing as it can be established from January to mid-February depending on the predicted rainfall forecast of a farming region. Farmers who intend to establish rain-fed crops should constantly refer to seasonal forecasts to enable them to make informed decisions ***(see** ZiMunda Farming Newsletter Issue 11 **- Rainfall Patterns and Forecast, 2020/21 Farming Season Preparedness)***.

ECONOMIC IMPORTANCE OF THE SUGAR BEAN CROP

Sugar bean is a crop of economic importance with a potential Return on Investment (ROI) of two dollars fifty to four dollars for every dollar invested. This makes sugar bean a lucrative cropping venture to consider. Sugar bean is a crop with a wide market range making it profitable to grow for commercial use, provided the yield levels are optimized. In addition to this, sugar bean like most legumes is a rich source of protein (15% - 25%). This is an important attribute given the growing percentage of health-conscious consumers. The sugar bean crop has significant importance in the drive towards sustainable agriculture because of its nitrogen fixing ability which enhances soil fertility. It is important for farmers to incorporate crop residue after harvesting or to use it as ground cover (mulch) to align with one of the key principles of conservation agriculture of having (>30%) ground cover.

SUGAR BEAN VARIETY SELECTION

Sugar bean variety selection as is the case in any profitable cropping venture should be guided by market research, expected yield levels, disease tolerance and growth habit in relation to season length to ensure that productivity is optimised. Farmers are encouraged to grow certified seeds from reputable suppliers. Variety preferences include speckled beans like SC Bounty and SC Sharp indeterminate varieties with a yield potential of 1.5 – 2.5t per ha under good management. Ukulinga and Gadra are the new sugar bean varieties on the market with a yiled potential of up to 3t/ha under optimum management. Certified sugar bean varieties have a good disease tolerance package which saves on the cost of buying fungicides, thereby increasing profit margins.

AGRONOMIC REQUIREMENTS

Profitable sugar bean production hinges on the ability to couple seed selection and Good Agronomic Practices (GAP'S). It is important for farmers to observe planting dates so that critical growth stages such as flowering and grain filling do not occur during periods of moisture stress or frost. This is because sugar bean thrives in warm climates with an optimal temperature range of 18-24 degrees Celsius. For rain-fed crops, the ideal amount of rainfall is in the ranges of (450mm to 650mm). Sugar bean grows best in well drained sandy loam or clay loam soils. This promotes good seed to soil contact which is key in the achievement of the desired crop stand and plant population. Soil pH level affects crop growth in most cropping programs. In sugar beans production, the ideal pH level is in the range of 5.5 – 6.5 (Calcium chloride scale). It is important to promote good drainage of excess water in the field as waterlogging conditions tend to affect germination and effective crop growth.

PLANTING GUIDELINES

Yield per plant and yield per unit area is a direct function of the plant population. The recommended seed rate for sugar bean production is 80kg to 100kgs/ha. The interrow spacing is (45cm - 50cm) while the inrow spacing is (5cm - 10cm) to achieve a plant population of between 220 000 to 330 000 plants per hectare. The planting depth (2.5cm - 4cm) is also key to ensuring

effective germination and crop establishment. At planting land preparation should aim to achieve a fine tilth for a good seed to soil contact to enable sugar bean to germinate well above ground (epigeal germination).

CROP HUSBANDRY

It is recommended for farmers to apply basal fertilisers when planting sugar beans; quantities applied must however, be guided by soil analysis and previous cropping programs. Sugar bean, being a leguminous crop, fixes nitrogen in the presence of nitrogen fixing bacteria. This process can be amplified by the application (coating) of an inoculant bacterium (*Rhizobium*) on the seed before planting. It is imperative to note that *rhizobium* meant for soya beans is not interchangeable with that of sugar beans. As a living organism, *rhizobium* is sensitive to a number of conditions including direct exposure to fertiliser, heat, and large quantities of water. *Rhizobium* should be kept in a cool environment and direct contact with fertiliser at planting should be avoided.

Rhizobium inoculant should be applied using about 1 litre of water with 50g of sugar per 100kg of seed enough to plant a hectare of sugar bean. If the process of root nodule-colonising is successful, the *rhizobium* reduces the need for top dressing with ammonium nitrate, resulting in the reduction of production cost and consequently increase in profit margins. If the crop appears pale there might be need to apply ammonium nitrate as it may be a failure of *rhizobium* to fix nitrogen. It is encouraged for the farmer to contact agronomists for consultancy as this colour may be from other causes rather than just the lack of nitrogen.

PEST MANAGEMENT

Effective pest control can be achieved if regular scouting is religiously followed so that insect pests are controlled before they reach optimum threshold levels. In sugar bean production the bean stem maggot is a pest of economic importance especially in the first month of production and as such farmers should adequately prepare for it. The adult bean stem maggot moth (fly) lays its eggs inside the stem. When the eggs hatch, the larvae start feeding on assimilates generated by the plant and block the vessels, hence cutting water and nutrient supply leading to wilting and eventually death of the plant. Farmers should spray recommended insecticides at least four times in the first month of crop emergence for effective control of bean stem maggot. Other pests such as cutworms, aphids, bollworms and leafhoppers must be controlled before they reach economic threshold levels that can cause significant yield losses.

Having received significant rains across the country, farmers should establish their sugar bean crop as soon as possible to reduce chances of crop failure. Crop diversification plays a pivotal role in climate-smart mitigation initiatives. Remember farming is a potentially lucrative business that requires good genetics and strict adherence to Good Agronomic Practices (GAP's).

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The ART of Farming

BY ROB JARVIS, AGRICULTURAL RESEARCH TRUST

On the outskirts of Harare is the well-known institution, the Agricultural Research Trust (ART), which was set up as a centre for practical research and development in 1981 when the farm was purchased and over the next decade it was knocked into shape. Today it has a first-class field laboratory where critical replicated small-plot trials are undertaken. The trials are done either in the national interest to independently test prospective crop cultivars extensively before their release or to provide agricultural input, irrigation, and equipment suppliers with areas to test innovations designed to make farming more resilient, intensive, high yielding, and resource-efficient.

The Trust is a base for more than thirty off-station trials each year, independently conducted, on farmers' fields, but still done to the same high standard. These trials can be found from Arcturus to Zaka in the summer season, and a winter series of the cereals can also be found around the country. Much emphasis has been placed upon exhibiting horticultural crops over the years as the commercial farming base in Zimbabwe has looked for alternative crops to get their teeth into when economic conditions made the staple crops of maize and soya in summer, unviable.

We have an *incredible human resource* with practical experience going right back almost to the inception of the Trust, the Board of Management and actual Trustees over the years. Great men and women of vision, who had the sense and fortitude to take a concept through to a working model mixed farming enterprise feeding off findings of the research. Today on the commercial side we have a small commercial pig unit and a cattle section. The feed produced on the farm is channelled through this livestock to secure value and mirror the activities of a typical Highveld mixed farm with good soils, unpredictable weather, limited water and ready markets.

In the heydays of the late 1980s and 1990s, a Field day at ART was attended by almost every progressive farmer in Zimbabwe, and beyond. At its infancy commodity associations that started ART, the Oilseeds and the Grain and later the Cattle producers could fund new concepts for investigation in the research blocks or on the farm. However, due to the restructuring of the land system in Zimbabwe, ART has had to match self-generated resources to its activities and a tightly-knit team now runs the operations. Over the years many other organisations have contributed funding, buildings and equipment - we hope to attract many more.

We will, in the months and years ahead, bring you a regular column in ZiMunda, which will highlight topical issues relevant to farmers growing similar crops and using the people, inputs, services, equipment and accessing the same markets, available to Zimbabwean farmers.

It is going to be quite a ride!

Image provided by Rob Jarvis

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