MINISTRY OF LANDS, AGRICULTURE, FISHERIES, WATER AND RURAL DEVELOPMENT

BOOK OF ABSTRACTS

AGRICULTURAL RESEARCH AND EXTENSION SYMPOSIUM
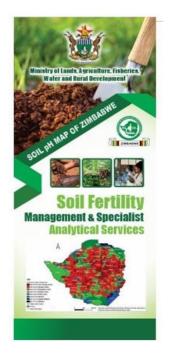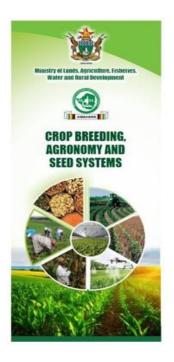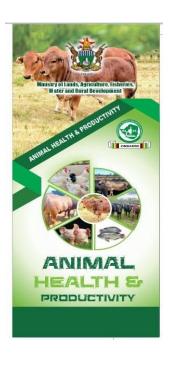
PROCEEDINGS 1-2 MARCH 2023

In Partnership with

"TRANSFORMATIVE AGRICULTURAL TECHNOLOGIES TO ACHIEVE VISION 2030"

THEMATIC AREAS

Soil Fertility Management & Specialist Analytical Services

PLANT PESTS AND DISEASES SURVEILLANCE AND MANAGEMENT

CROP BREEDING, AGRONOMY AND SEED SYSTEMS

ANIMAL HEALTH & PRODUCTIVITY

Farming systems and extension
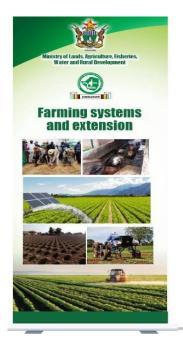

Irrigation development and water resources management

PREAMBLE

The Ministry of Lands, Agriculture, Fisheries, Water and Rural Development prioritizes research and development through its various departments. The Directorate of Agricultural Research, Innovation and Specialist Services (ARISS) is the main public national agricultural research and innovation institution. In addition, the Directorate of Veterinary Services (DVS), the Department of Irrigation (DoI) and the Agriculture Mechanization Department also conduct research to backstop the services they offer to the agriculture sector.

ARISS consists of 18 research institutes. These include seven (7) research institutes under the Crops Research department which conduct research for development of appropriate field and horticultural crop production technologies for use by farmers and provision of advisory services on crop management practices for all crops except tobacco and sugarcane. In addition, it develops new crop varieties that are adaptable to Zimbabwe's five agro-ecological zones. The institutes are Agronomy Research Institute, Crop Breeding Institute, Horticulture Research Institute, Coffee Research Institute, Lowveld Research Institute, Chisumbanje Research Institute and Cotton Research Institute. ARISS also has four (4) research institutes mandated to promote conservation of livestock breeds and develop pastures and forages adaptable to Zimbabwe's five agro-ecological zones that enhance appropriate and sustainable livestock production technologies for farmer support. The institutes are Henderson, Grasslands, Makoholi and Matopos Research Institutes. The department also has seven (7) institutes mandated to provide research based analytical services for regulatory compliance and quality assurance in the agricultural sector under the Research Services Department. The analytical laboratories provide specialist services for seed testing, plant pathology, plant entomology, nematology, soil testing, fertilizers, livestock feeds and pesticides testing. These are Seed Services (SSI), Plant Quarantine Services (PQSI), Genetic Resources and Biotechnology (GRBI), Chemistry and Soils Research Institute (CSRI), Fertilizers, Farm Feeds and Remedies Institute (CSRI), Plant Protection Research Institute and the National Herbarium and Botanic Gardens (NHBG).

ARISS collaborates with CGIARs including CIMMYT on maize and wheat, ICRISAT on traditional grains and legumes (sorghum, millets, groundnuts etc), ICARDA on wheat as well as CIAT on beans.

The Directorate of Veterinary Services also carries out research on Animal Health and Diagnostics whilst the Department of irrigation also carries out research on irrigation technologies through the Zimbabwe Irrigation Technologies Centre (ZITC) at the Institute of Agricultural Engineering (IAE). The Agriculture Mechanization Department conducts research on Soil and Water Conservation.

Dissemination of research results by Institutions under ARID is done through review and planning meetings with stakeholders by the various institutes, field days, agricultural shows across the country, farmer field schools, electronic and print media. However, there is weak linkage between research and extension which is limiting the adoption of new technologies and innovations by farmers. Research symposia are an effective information dissemination platform.

THE SYMPOSIUM

The Ministry of Lands, Agriculture, Fisheries, Water and Rural Development (MLAFWRD) organized the "Inaugural Research and Extension Symposium" from 1-2 March 2023 with participation from various directorates and innovation hubs. The directorates included Agricultural Research Innovation and Development (ARID), Agricultural and Rural Development Advisory Services (ARDAS), Veterinary

Services (DVS), the Department of Irrigation (DoI), Tsetse Control and Agricultural Mechanisation. Innovation hubs comprised of universities, parastatals, Non-Governmental Organizations CGIARs.

Researchers and extensionists from Agricultural Research Innovation and Development (ARID), Agricultural and Rural Development Advisory Services (ARDAS), Veterinary Services (DVS) Directorates, the Department of Irrigation (DoI) as well as Innovation Hubs were invited to submit abstracts and poster presentations for the symposium. This 1st Edition ran under the theme **"Transformative agricultural technologies to achieve Vision 2030"**. Participants were also invited to showcase and disseminate transformative technologies and innovations in line with this theme.

OBJECTIVES
The objectives of the symposium were as follows;
 i. To share information on new technologies and innovations with stakeholders.
 ii. To strengthen the linkage between research and extension.
 iii. To get feedback on adoption on new technologies
 iv. To set research priorities in consultation with extensionists and value chain actors.

THEMATIC AREAS COVERED
 i. Livestock Nutrition / Breeding/ Fisheries and aqua-culture resources
 ii. Animal Health and Diagnostics
 iii. Agro-Ecology/ Botany / Germplasm Conservation
 iv. Crops Breeding/Agronomy/Seed systems/Soil fertility management/Analytical services
 v. Plant Protection / Plant pests and diseases / Plant health
 vi. GIS and remote Sensing / Climate modelling
 vii. Farming systems / Extension methodologies / Feedback mechanisms
 viii. Research and extension policy environment
 ix. Irrigation Technologies

MAJOR COLLABORATING INSTITUTIONS AND SPONSORS
 i. CIMMYT
 ii. WHH-ZAKIS
 iii. University of kwaZulu Natal
 iv. University of Zimbabwe
 v. Great Zimbabwe University
 vi. Midlands State University
 vii. Marondera University of Agricultural Sciences and Technology
 viii. Bindura University of Science Education
 ix. Zimbabwe Seed Association
 x. CropLife
 xi. Zimbabwe Sugar Association Experiment Station

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CROPS SECTION

1. Climate change and predicted changes in distribution of invasive *Nassella* species in Southern Africa

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Abstract

Three South American *Nassella* species (*N. neesiana, N. tenuissima* and *N. trichotoma*) have naturalised and are invasive in South Africa but have not been reported in other southern African countries. An understanding of the current and future potential distribution of these invasive species is needed to assess the potential threats they pose to biodiversity and livelihoods in Southern Africa. Bioclimatic variables were downloaded from WorldClim database, at a spatial resolution of 2.5 arc minute which is based on climate data for 1970-2000. After testing for multicollinearity among the 19 bioclimatic variables, seven environmental variables were retained for each species for the models. Species distribution modelling was done using the 'sdm' package in R. The known global distributions of the three species and an ensemble of six algorithms were used to develop the models. To project the future distribution ranges, the four future shared socio-economic pathways to the representative concentration pathways (SSP_RCP) scenarios under version six of the Model for Interdisciplinary Research on Climate (MIROC6) for the period 2081 to 2100 were run for each species separately. All three species can potentially occupy more area than currently known under current climate envelopes. Temperature-based bioclimatic variables, especially isothermality, are important in 1determining the distribution of all three species. Compared to currently suitable areas, future projected suitable areas will be much less for the three

species. While the extent of suitable habitat for these *Nassella* species is projected to decline, high altitude mountains will face an increase in suitable areas across all future climate change scenarios. Movement of potential spreaders of the invasive grasses need to be monitored and controlled.

Keywords: *invasive Nassella species, climate change, bioclimatic variables, ensemble modelling*

2. Long-term tillage, residue management and crop rotation impacts on N_2O and CH_4 emissions on two contrasting soils in sub-humid Zimbabwe

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Abstract

The respective contribution of conservation agriculture (CA) principles (no-tillage, permanent soil cover/mulch and crop rotations) on greenhouse gas (GHG) emissions is still unclear. This study was conducted at two long term experimental sites established in 2013 in Zimbabwe, on an abruptic Lixisol at Domboshava Training Center (DTC) and on a xanthic Ferralsol at the University of Zimbabwe Farm (UZF). The purpose of the study was to unravel the individual and combined effects of tillage, mulching and rotation on N_2O and CH_4 emissions in low nitrogen (N) input maize-based cropping systems (< 60 kg N ha^{-} 1) and to compare emissions within maize rows and between maize rows. The main crop was maize (*Zea mays L.*) and treatments with rotation included cowpea (*Vigna unguiculata L. Walp.*). In 2019/20, cumulative total N_2O emissions were significantly higher in mulch treatments at DTC, while at UZF N_2O emissions were higher with cowpea rotation. Cumulative total N_2O emissions ranged from 215 to 496 g N_2O-N ha^{-1} yr^{-1} and from 226 to 395 g N_2O-N ha^{-1} yr^{-1}, at DTC and UZF, respectively. In 2020/21, N_2O emissions were much lower and no differences were found between treatments on both sites (145 to 179 g N2O-N ha^{-1} yr^{-1} and 83 to 136 g N2O-N ha^{-1} yr^{-1} at DTC and UZF, respectively). A significant relationship was found between soil nitrate and daily N_2O emissions. At UZF, highest N_2O emissions were observed at a water-filled pore space of 60–70%. There were no significant differences in yield-scaled N_2O emissions between treatments at both sites for the two seasons. DTC was a net

source of CH_4 (694 g CH_4-C ha^{-1} yr^{-1} on average), while UZF was a net sink of CH_4 (− 494 g CH_4-C ha^{-1} yr^{-1} on average). No evidence was found for *in situ* CH_4 production at DTC, and an external source is most likely. Our study indicates that for low N input cropping systems in the sub-humid tropics, N loss through N_2O is low

Key words: Conservation Agriculture, greenhouse gases, cropping systems

3. Use of computer vision and remote sensing in detecting armyworm

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Abstract

The agriculture sector has an immense potential to improve the requirement of food and supplies healthy and nutritious food. Crop insect detection is a challenging task for farmers as a significant portion of the crops are damaged and the quality is degraded due to the pest attack. Institute of Agriculture leveraged the use of computer vision and artificial intelligence algorithms for plant protection management. The algorithm can be used by android smart phone applications. The algorithm uses image recognition to diagnose armyworm. The application has a huge potential for use in pest surveillance through studying the spatial distribution of outbreaks, pests' life cycles, coupled with robust information management systems where centralised database is used to analyse regularly the spread of pests and their types based on locality and season. This is a right place, right time situation to enable farmers in Zimbabwe to upload images of armyworm and the algorithm identifies the pest. This also stands by as an intersection of advances in technology and the potential for efficacious containment of outbreaks. Prevention and early detection are critical factors in containing the spread of armyworm. Image based artificial intelligent systems are important tools in agriculture. The application uses foreground extraction and contour identification to detect armyworm. The results of classification accuracy are used to recognise armyworm in the early stages and hence reduce the time to enhance crop yield and crop quality. Armyworm feeds on over 80 plant species but prefers maize which is the staple food crop for much of East and Southern Africa causing losses. The   success of this "proof of concept'' research provides foundation for the development of remote sensing software that can identify armyworm enabling government to target scarce control resources on these hotspot areas.

Key words: armyworm detection, computer vision, remote sensing, artificial intelligence

- Currently, the application uses the digital images as input, additionally we can include video input.
- Future improvements include expanding the use of detection to other pests of economic importance to the agricultural sector.

4. Multistrain inoculant for improved cowpea response to rhizobia inoculation under variable soil and rainfall conditions of Zimbabwe

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Abstract

Rhizobia Inoculants are commercially prepared Bradyrhizobiium bacteria responsible for fixing nitrogen and are applied to legume seeds. Despite application of rhizobia inoculants and basal NPK fertilizers, yields of cowpea rarely exceed 1 t ha^{-1}. Thus, a need exists to improve quality of commercial inoculants. A study was conducted from 2016 to 2020, to determine the effect of multistrain inoculant application on biological nitrogen fixation, biomass and grain productivity of cowpea. Treatments included single, double, triple strain combinations, uninoculated control and positive control of basal NPK and Ammonium Nitrate topdressing fertilizer. These were replicated three times in a completely randomized block design. Soybean planted in the 2016-17 season at the Soil Productivity Research Laboratory, Grasslands Research Station, Marondera; showed significant differences ($p<0.05$) across treatments in root lengthpod count, nodule weight), nodule numbers and number of leaves per plant. This proved the potential improvement in crop performance after application of at least two inoculant strains. There were significant differences across treatments in cowpea biomass productivity, nodule weights and amount of nitrogen fixed per plant, with the DS2 (MAR411+ MAR1510) treatment outperforming the rest. Nitrogen fixed ranged between 44.7–98.1 kg N ha^{-1}. There was no extra benefit in applying 3 strains together (MAR 411, MAR 1510 and MAR 471). At Mswaka farm, Seke District, biomass yield differed significantly across treatments ($p <0.05$). During the 2018-19 season at Makoholi Research Station, Masvingo, all attributes did not differ across treatments except for number of pods per plant ($p <0.05$). It can be concluded that a significant improvement in inoculation response and crop productivity can be realized by co-application of at least two strains, although there is need for evaluation, formulation and development of region and soil specific strain combinations.

Key words: *Bradyrhizobium*, inoculant, multistrain, cowpea, biological nitrogen fixation

5. Phosphorus sorption characteristics of a sandy soil amended with aluminium water treatment residual and compost

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Abstract

Soil degradation coupled with poor access to organic nutrient resources remain major constraints to increased crop productivity in sub-Saharan Africa hindering the continent's efforts in achieving the United Nations' Sustainable Developmental Goals, particularly goals 1 (end poverty), 2 (zero hunger) and 3 (improve human health). Water treatment residual (WTR), a by-product of clean water treatment has been identified as an alternative organic nutrient resource for crop production. However, there are some inconsistencies on soil phosphorus (P) dynamics following Al-WTR application. We conducted experiments to evaluate P sorption of a sandy soil amended with 10% aluminium-WTR (Al-WTR), 10% compost (C) as a quasi-control, 10% C + 10% Al-WTR (10% co-amendment) and 5% C + 5% Al-WTR (5% co-amendment), under varying levels of pH, particle size and P concentration. We calculated crop P fertilizer requirements under the different amendments. The results demonstrated that all amendments exceeded the minimum of 0.2 mg P L^{-1} needed in soil solution at equilibrium to maintain plant growth. However, the maximum P sorption capacity was higher for 10% Al-WTR single amendment, ranging from 770 to 1000 mg P kg^{-1}, and from 714 to 1000 mg P kg^{-1} and 555 to 909 mg P kg^{-1}for 10%- and 5%- co amendments, respectively, across a range of pH and soil particle size fractions. The co-amendments showed a reduction in crop P fertilizer requirements by ranges of 30 - 60% and 60 - 70% for the 10%- and 5%- co-amendment levels, respectively, across different pH and particle sizes, relative to 10% Al WTR. Results show that the use of 5% co-amendment in sandy soils increases P availability sufficiently to improve crop yields. These results provide scope for using Al-WTR co-amendments to rebuild soil health in sandy soils in urban agriculture and increase micronutrient provision in crops to support human health.

Keywords: Aluminium-water treatment residual, co-amendment, human diet, soil health, increased crop productivity, phosphorus fertilizer requirement

5. Evaluating the performance of Advanced Medium Staple *Gossypium Hirsutum L.* Genotypes under Diverse Agro-Ecological Conditions of Zimbabwe

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Abstract

The development of superior, widely-adaptable and stable cotton varieties promotes resilience and sustainable cotton production in Zimbabwe considering the ever-changing growing conditions. Multi-environmental field trials were conducted to determine the field, fiber, and seed cotton yield and yield components of fifteen different varieties including five check varieties at fifteen locations over five seasons. The experiment was laid in a Randomized Complete Block Design and replicated three times. The gross plot was 6m x 6rows, whilst the net plot was 4m x 4rows. Multi-variate Analysis of Variance (MANOVA) and genotypic and environmental mean performance and yield stability analysis on collected data was done using Genstat 18th edition. Genotypic and environmental main effects revealed significant differences (P<0.001) in seed cotton yield, average boll weight, Gin-Out-Turn, and lint yield, whilst Genotype by Environment Interaction was significant (P<0.001). Among the genotypes tested under dryland conditions, SZ-95-23 recorded seed cotton yield of 2683kgha^{-1} and 4251kgha^{-1} under wetland growing conditions, thus revealing a yield advantage of between 29-42% over the five check varieties that recorded yield of between 1881kgaha^{-1} and 2084kgha^{-1}. The results further indicated that SZ-95-23 had a high ginning percentage of between 41.69 and 42.6% and a large boll size of between 5.8-5.89g which was higher than that of CRIMS1 and CRIMS2 as well as QM301. Stability analysis results revealed SZ-95-23 as the ideal and stable candidate. Staple length (28.02mm), Micronaire (4.6), strength (32.8g/tex), and length uniformity index (84.9%) fell within the international standards category. Genotype SZ-95-23 emerged as the highest yielding, more stable and possessed good fiber quality attributes suitable for the textile industry. Therefore, the genotype was recommended for release as a new medium staple, high-yielding variety, and was released for commercial production in Zimbabwe in November 2022.

6. Evaluation of Promising Upland rice varieties for adaptability and stability in different Agro ecological zones of Zimbabwe.

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Abstract

Rice is a strategic crop for food security in Zimbabwe as witnessed by the increasing consumption trends. Lack of high yielding, bird proof, improved adapted varieties and moisture stress during critical growth stages remain key limiting factors. Zimbabwe has great potential to produce rice locally and meet growing

demand if improved varieties are availed. This has a net positive impact on food and nutrition security and economic development since Zimbabwe is a net rice importer.

Variability in genetic potential among Rice genotypes is an important component of variation in grain yield. The study was conducted during the 2016/17, 2018/19 and 2020/21 seasons to, evaluate adaptability to different environments of different varieties, to confirm the resistance of varieties to abiotic and biotic stresses   and to obtain the opinion of consumers on the performance of varieties evaluated. On-station and on-farm trials were laid out in an incomplete block design randomized with three replications (RCBD). Combined analysis revealed significant differences among the genotypes for grain yield on individual seasons (on-station). The genotype by environment interaction was significant (P < 0.01) for grain yield in all the seasons of evaluation. ART 42 was the best genotype in terms of high grain yield and stability. ART 42 was highly accepted and preferred by both male and female farmers. Cooking quality analysis results showed that ART 42 had better cooking quality than Nerica 3 and 7. ART 42 meets the consumers   preferences at it swells when cooked, is not sticky when cooked, has good taste and is aromatic. The variety is also awned.

Key words: ART 42, genotype, NERICA, Rice, yield

7. Improving extension methods through agrometeorological advisories using the Climate Field School concept: A case of Uzumba Maramba Pfungwe District, Zimbabwe

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Abstract

Extreme weather events amplify the magnitude of crop production losses experienced in Zimbabwe. Extension methods have been used to assist farmers improve productivity, however with increased swings in extreme weather events, more effort and knowledge is now required to build capacity that increases resilience. Uzumba Maramba Pfungwe district (UMP) was used as a case study in developing and improving extension methods that are consistent with the changing weather patterns. The concept of Climate Field School was developed through farmer participation apart from the extension officer. Extension agents were trained on weather and climate issues and their significance on agricultural activities. For different cases advisories which influenced agronomic practices based on past and future weather were developed. In the Climate Field School, the extension agents and farmers learned through participation on how to respond to different weather conditions in a way that minimises loss. Provision of weekly forecasts allowed extension agents to develop and provide agrometeorological services to farmers at the local scale, using local data. The paper demonstrates the willingness of farmers to access and utilise weather information for strategic and tactical decisions in farm management. The results from experiments with farmers showed a 67 % increase in weather and climate information uptake and 61% increase in application of climate smart agriculture techniques. The results also showed a 46% increase

in proactive pest and disease management strategies. The study concluded that up-scaling development of agrometeorological advisories through CFSs should be supported by well-resourced institutions and functional policies.

Keywords: Weather, agrometeorological services, Climate Field School, extension agents

8. Molecular characterization of Soya bean varieties grown in Zimbabwe using Single Nucleotide Polymorphism (SNP).

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Abstract

A study was conducted to test two methods of plant characterization which are molecular /DNA (Deoxyribonucleic Acid) and morphological in soya bean varieties. 18 soya bean varieties used in this study were registered in Zimbabwe using morphological characterization. The objective of this study was to compare molecular characterization with the current DUS testing method. The eighteen different soya bean varieties were obtained from both private and public breeders. Morphological characterization was conducted at Zimbabwe Sugar Association Experiment Station. The trial was laid out as a Completely Randomised Block Design (CRBD). All the agronomic practices necessary for proper development of soya bean were followed. Morphological characterization was performed on randomly selected 10 plants using UPOV (International Union for Protection of New Varieties of plants) methodology. Data analysis was done using Multivariate methods (Genstat and Mintab). Molecular characterization was conducted at Ratray Arnold Research Station molecular laboratory. DNA was extracted from soya bean seeds using cetyltrimethylammonium bromide. Sample preparation, PCR amplification and allelic discrimination plate was done using TaqMan (Single Nucleotide Polymorphism) SNP genotyping protocol. The results of the experiment showed that both methods were effective for DUS in soya bean. The varieties clustered the same both using morphological and SNP. Molecular characterisation was able to pick Essentially derived varieties but morphological characterisation did not. The researchers therefore recommend the use of SNP characterisation in DUS testing as it is faster and more precise than morphological characterisation. However, where resources for starting SNP are not available morphological characterization remains the most effective.

Keywords: DUS, molecular characterization, morphological characterization.

9. Potency of Bitter apple fruit (*Solanum incanum* L.) and contact time against fall armyworm on maize foliage diet

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Abstract

Solanaceae plants such as *Solanum incanum* L. have enormous potential to yield new chemicals for crop protection against insect pests. Fall armyworm (FAW) (*Spodoptera frugiperda* J.E. smith) is an invasive pest of global economic importance that requires the incorporation of low-cost alternatives including the use of botanical pesticides. The aim of this study was to evaluate the potency of raw bitter apple (*Solanum incanum*) liquid against third-instar FAW larvae and contact time with corn (Zea mays L.) leaf diet. A laboratory experiment was performed with treatments of 0% (distilled water/control), 10% (10 g *S. incanum* per 100 ml distilled water), 30% (30 g *S. incanum* per 100 ml distilled water), 50% (50 g *S. incanum* per 100 ml distilled water); 70% (70 g *S. incanum* per 100 ml distilled water), 100% (100 ml *S. incanum* liquid). Results showed that S. incanum fluid was effective against FAW at higher doses. Doses less than 30% recorded no deaths; while higher doses (50, 70, and 100%) recorded significantly higher (p<0.001) FAW mortalities after 2-hour exposure to the treatments. Cumulative larval mortality showed no significant differences in mean FAW larval mortality (p>0.05) at the lower doses (<30%). However, significant differences in larval mortality (p<0.05) were observed at concentrations >50% after 2-hour exposure to the treatments. According to this study, the most effective *S. incanum* liquid dose for effective fall armyworm control was >70%.

Keywords: Invasive, FAW larval mortality, *Zea mays*

10. Effect of different watering regimes on nitrogen use efficiency, yield and water productivity of drip irrigated cabbages (*Brassica oleracea*)

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Abstract

Water scarcity and droughts are the main factors limiting horticultural crop production in Zimbabwe. A study was conducted to determine the effect of different water application levels on nitrogen use efficiency (NUE), yield and water productivity (WP) of cabbages grown under drip irrigation. The research was conducted on a clay soil (Rhodic nitisols) at Harare Research Centre. Cabbage plants were spaced 60 cm between rows and 60 cm between plants. Three irrigation application levels of 50%, 75% and 100% of crop water requirement (ETc) translating to 252.50mm, 378.75mm and 504.00mm/ha respectively were applied. Nitrogen, phosphorus and potassium were supplied at rates of 90 kg N/ha, 40kg P_2O_5/ha and 50 kg/ha K_2O, respectively. Nitrogen top dressing was applied as ammonium sulphate while basal applications were applied as single superphosphate and muriate of potash. An equivalent amount of 90 kg N/ha was applied as ^{15}N labelled isotopic ammonium sulphate with 2% atom excess enrichment to micro-plots. There were significant differences (p<0.05) in cabbage yield, NUE and water productivity irrigated at different irrigation levels. Full irrigation (100% ETc) level produced the highest cabbage fresh head yield of 4.47kg while 75% ETc and 50% ETc resulted in fresh cabbage head yield of 3.38kg and 2.46 kg respectively. Deficit irrigation at 75% ETc and 50% ETc resulted in a cabbage head yield reduction of 24.4% and 45% respectively. The 50% ETc water level had significantly higher water productivity of 27.06 kg/m³ while 75% ETc and 100% ETc had almost similar water productivity of 24.81kg/m³ and 24.61kg/m³ respectively. Cabbages irrigated at full irrigation (100% ETc) had significantly higher NUE of 66.9% than those at deficit irrigations of 75% ETc and 50% had NUE of 50.7% and 37.3% respectively. Higher water application rates result in higher NUE and cabbage yield while deficit irrigation increases water productivity.

Key words: water scarcity, ^{15}N labelled isotopic ammonium sulphate, crop water requirement

11. The impacts of climate change and variability on inland freshwater fisheries sector of Zimbabwe.

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Abstract

The effects of climate change are expected to be widespread across ecosystems, placing a greater strain on all forms of livelihoods, including those in the fisheries sector. The fisheries sector is widely recognised for its significant contribution to poverty alleviation, promoting socio-economic growth, enhancing food security and improving the livelihoods of marginalised communities. The sector is experiencing a plethora of anthropogenic stressors such as overfishing, pollution, illegal fishing, land-use change, and climate change. Research indicates that climate change presents the most significant threat to fisheries among other stressors, as its effects interact and amplify existing stresses. It impacts freshwater fisheries in several ways including warming temperatures, increased rainfall variability, habitat loss and the increasing occurrence and intensity of extreme weather events which affect the fish's physiological and biological process, consequently affecting fishery-dependent people. This study assessed fisher's perceptions of climate change, its impacts on fishery resources and livelihoods, and their adaptation

strategies in fishing communities found on the shores of Lake Kariba. A mixed method approach was used to collect data from 120 fishers and data were subjected to descriptive statistics and thematic analysis. Findings indicate that most 83.8% of the fishers believe that temperatures have increased and 76.3% state that rainfall has decreased over the past 10 years and the perceived changes of the climatic variables have led to a decline in fish productivity and fish catches. To cope with declining fish stocks and catches, fishers have adopted several adaptation strategies including, changing fishing gear, targeting new fish species, and increasing fishing efforts. The study findings help to set a path towards local-specific climate change adaptation strategies for small-scale fishers. This study provided relevant information for policymakers and fisheries stewards to formulate appropriate policies and programmes aimed at enhancing fisher's adaptation to climate change and promoting sustainable fisheries.

12. Predicting the Spatial Extent of the Potentially Invasive Species Giant Milkweed (*Calotropis procera* L. Aiton) in Zimbabwe.

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Abstract

Alien plant species contribute most to plant invasions, hence the need to monitor their distribution. Determining invasive tree's geographical distribution and abundance within the country facilitates their proper management and prioritization of resource allocation. Traditional surveys of mapping trees involve field counting of individual trees, which is often tedious, time-consuming, and expensive. However, remote sensing tools have enabled data acquisition in a more effective way. *Calotropis procera L*. (Aiton), known as giant milk weed, has the potential to become invasive and has detrimental effects on agricultural productivity such as inhibition of seedling germination, allelopathic effect on field crops and fatalities due to indigestion in livestock. In Zimbabwe, it was first recorded around the 1960s and currently has shown invasive characteristics in areas such as Beitbridge, Nyanyadzi and Birchneough Bridge. Using Maxent and QGIS, the current distribution of *C. procera* was mapped using known locations from herbarium specimens, citizen science records and field data collected along the major highways of Zimbabwe. Distribution data was modelled against independent environmental variables ($R < 0.7$) to identify the most suitable habitats prone to invasion by *C. procera* and determine the most influencing factors responsible for its invasion in Zimbabwe. The model performance was good (AUC>0.89). C. *procera* has not saturated its current potential distribution and poses as a threat in the low-lying semi-arid and arid regions of Zimbabwe. Its distribution and invasion success was somewhat disturbance-dependent. Temperature is also an important determinant of the occurrence of the species as it is mainly observed in areas that do not experience frost conditions. Species loss has become a cause of concern especially during the Anthropocene era and alien invasive species are largely contributing to this loss as climatic conditions alter, hence the need to adopt management strategies that minimize the loss of vegetation.

Keywords: *Calotropis procera*, Species Distribution Modelling, Maxent, invasive species

13. Optimising targets for tsetse control: Taking a fly's-eye-view to improve the colour of synthetic fabrics

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Abstract

The savannah tsetse flies, *Glossina morsitans morsitans* and *G. pallidipes,* are important vectors of Rhodesian Human African trypanosomiasis and animal African trypanosomiasis in east and southern Africa. We tested in Zimbabwe whether robust, synthetic fabrics, and innovative fly's-eye-view approaches to optimise fabric colour, can improve insecticide-treated targets employed for tsetse control. Flies were caught by electrocution at a standard target comprising a 1m x 1m black cotton cloth panel with 1m x 0.5m black polyester net panels on each side. Catches were subdivided by species and sex. Tsetse catches were unaffected by substitution of the black cotton with a blue polyester produced for riverine tsetse targets. Exchanging the net panels for phthalogen blue cotton to simulate the target routinely used in Zimbabwe significantly reduced catches of female *G. m. morsitans (*mean catch 0.7 times than at standard), with no effect on other tsetse catches. However, significantly greater proportions of tsetse catch were intercepted at the central panel of the Zimbabwe (means 0.47-0.79) versus standard designs (0.11-0.29). We also engineered a new violet polyester cloth using models of tsetse attraction based upon fly photoreceptor responses. With and without odour lure, catches of females of both species at the violet target were significantly greater than those at standard (means 1.5-1.6 times those at standard), and typical blue polyester targets (means 0.9-1.3 times those at standard). Similar effects were observed for males under some combinations of species and odour treatment. The proportions of catch intercepted at the central panel of the violet target (means 0.08-0.18) were intermediate between those at standard and typical blue polyester. Further, the reflectance spectrum of violet polyester was more stable under field conditions than that of black cotton. Our results demonstrate the effectiveness of photoreceptor-based models as a novel means of improving targets to control tsetse and trypanosomiases.

14. Zimbabwe is free from Maize Chlorotic Mottle Virus (MCMV): The chief virus for maize lethal necrosis.

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Abstract

Surveillance for the status of maize Chlorotic Mottle Virus (MCMV) in Zimbabwe was done from 2016 to 2022 maize cropping seasons. The surveillance covered all the maize production areas of the country. This was the first surveillance to determine the status of MCMV ever done in the country. All maize seeds and grain imported and transiting Zimbabwe were sampled and tested for the presence of MCMV. Bioreba agristrips and ELISA were used to test for the presence of MCMV. Maize green tissue samples were collected and tested from grain maize fields, experimental maize fields and seed maize fields. Grain and seed samples for maize were collected from all entry border ports, agro dealer shops selling maize seeds, maize seed companies and maize grain storage depots. A total of 1,030 fields were visited and tested for the presence of maize chlorotic mottle virus for four years from 2016 to 2022 using the Bioreb Airstrips. 1700 seed and maize grain samples collected from various border ports, agro-dealer shops and maize grain storage depots were tested for MCMV using ELISA. All test samples tested negative for maize lethal necrosis and it was safely concluded that Zimbabwe is free from MCMV, the chief Maize Lethal Necrosis (MLN) causing virus in maize by this period.

Key words
MCMV, maize chlorotic mottle virus, ELISA, Bioreb Agristrip, maize lethal necrosis

15. Evaluation of the effects of crop variety and fertilizer rates performance of cereals under Pfumvudza through on-farm Triadic Comparison of Technologies (Tricot)

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Abstract

Zimbabwe's two major cereal crops, maize and sorghum, have been grown in a wide range of agro-ecologies. The government of Zimbabwe has embarked on a campaign to promote the climate-smart programme 'Pfumvudza/Intwasa' in which the two crops dominate. A research study was conducted to generate evidence to support the program, with maize and sorghum under different production

conditions. The farmer-led innovation Triadic Comparison of Technologies (Tricot) was used. The experiments were conducted in one ward per district in the districts of Mutare, Murehwa, Guruve, Hurungwe, Umguza, and Chivi under agroecological regions 1, 2a, 2b, 3, 4, and 5, respectively. Sixty (60) maize farmers and 20 sorghum farmers per ward, giving a total of 360 maize farmers and 120 sorghum farmers. Participating farmers were provided with three technologies to compare on their own farms and record their observations. The technologies tested were combinations of five hybrid maize varieties (ZAP 31, ZAP43, P2809W, 30G19, and PAN 7M81), three sorghum varieties (Shirikure, SV2 and Marcia) and three rates each of basal compoud D and top dressing ammonium nitrate fertilizers (0kg/ha. 177kg/ha and 355kg/ha). Crop varieties and fertilizers allocation was systematically balanced between farmers and AERs. The ClimMob (climmob.net) free online software was used throughout all the processes of designing the experiments to data capturing, and analyses. Each participant assessed 3 different items and provided rankings for 8 traits. The ODKCollect application was connected to the project on the ClimMob digital platform. Agricultural Extension Officers (AEOs) or Field Agents on the ground registered farmer participants, collected data and captured it using the ODK application on data tablets. Two data collection moments on both maize and sorghum trials were successfully made and the results captured. The first moment was made three weeks after establishment and the second at the beginning of May 2022. In the maize overall ranking of observations (answers) from farmers, there were no significant differences in technologies performance for each trait except for crop maturity. The treatments ZAP31 supplied with 356kg/ha fertilizer, ZAP3 supplied with 177kg/ha fertilizer, and 30G19 supplied with 177kg/ha fertilizer were the best performing while the treatments PAN7M-81 supplied with 356kg/ha fertilizer, ZAP43 supplied with 177kg/ha fertilizer, and P2809W supplied with 0kg/ha fertilizer were the worst performing. In the sorghum overall ranking of observations from farmers, there were no significant differences between technologies in all traits measured.

Key words: Pfumvudza, climmob, fertilizer, variety, maize, sorghum

16. Effectiveness of Different Management Strategies on Fall Armyworm (*Spodoptera frugiperda)* (JE Smith) in White and Yellow maize

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Abstract

Fall armyworm (*Spodoptera frugiperda) (JE* Smith*)* is a polyphagous pest which was first noticed in Zimbabwe at the end of 2016. The pest prefers grass family hosts and is a threat to the food security of Zimbabwe since maize is a staple food in Zimbabwe. A field experiment laid out in 2 x 4 split plot design with two main plots/factors (white and yellow maize) and 4 subplots (the subplots consist of the following treatments: i. Fortenza Duo ii. Emamectin benzoate+ lufenuron iii. Deadzone iv. Control) in each main

plot Seed used was treated with Fortenza Duo and none treated seed packs. Yellow and white maize was used in the field work and Field assessments on maize (leaf) damage were done once a week to ascertain the preference level using the Davis scale damage rating. Field experiment results indicated that the yellow maize was damaged to a lesser extent by 35% compared to the white maize. The results indicated that Fortenza Duo recorded a higher FAW mortality in the first 4 weeks, no visible FAW damage/Severe damages (rating of 8 and 9) were recorded from week 3 to week 10. Farmers are therefore recommended to apply Emamectin benzoate + lufenuron to manage FAW. Further research on the integration of the use of chemical and Deadzone to improve efficacy is recommended.

Key words: Fall armyworm, Fortenza Duo, yellow and white maize

17. Effects of Seed Storage Period on the Viability of Genebank Conserved Fingermillet (*Eleusine Coracana* (L.) Gaertn) accessions.

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Abstract

- Finger millet (*Eleusine coracana*) is an important food security crop especially in the marginal regions of Zimbabwe. More research on the development of improved varieties and conservation of finger millet genetic resources is required to improve conservation and sustainable utilization of finger millet germplasm in the country. Successful crop improvement requires broad genetic base sourced from genebank collections from which selections of suitable genotypes are made. Maintenance of viable germplasm under *ex situ* conservation is critical for the supply finger of millet genetic material for use by users. Gene bankers struggle with the challenge of loss of seed viability in storage after long term storage and it remains unclear as to the actual time intervals at which seed regeneration can be conducted. A study to determine the effect of storage time on finger millet germplasm kept under gene bank storage conditions (-21 Degrees Celcius) was conducted at the Genetic Resources and Biotechnology Institute in Harare. The study aimed to guide gene bank managers to estimate the appropriate time intervals at which seed viability is critically reduced such that seed regeneration can be conducted. The laboratory experiment was laid out in a completely randomized design with two factors which are finger millet varieties at 2 levels (Mutangatsapi and Chichena) and storage time at 6 levels (36 years, 19 years, 15 years, 13 years, 7 years and 4 years) seed germination tests were conducted using the between paper method as outlined in the International Seed Testing Standards. Analysis of variance was conducted on the germination test results data using GenStat Undergraduate Release 16.1 software. There was interaction between variety and storage time ($p < 0.001$). The best combination of variety and storage time being Mutangatsapi at 7 years which performed very well with 96.01% germination rate. The least germination (0%) was observed on Mutangatsapi at 36 years with no seeds germinating. The study showed that as seed ages, germination rate decreases. For Mutangatsapi, seed regeneration should be carried out at 19 years. The minimum regeneration interval for finger millet under genebank storage conditions is 19 years as observed from

the study which is the average interval at which seed viability begins to fall below required genebank standard of 80%

Key words: finger millet, viability, storage time, germination rate

18. Surveillance for the early detection and early warning of the *Candidatus Liberibacter asiaticus* and its vector, *Diaphorina citri* authority in Zimbabwe.

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Abstract

The Zimbabwean citrus industry is threatened by pests such as the Asian greening disease, Candidatus Liberibacter asiaticus authority (CLA), a bacterial pathogen vectored by Asian citrus psyllid (Diaphorina citri authority). The surveillance for the early detection of citri and Asian citrus greening/Huanglongbing (HLB) in Zimbabwe is critical for biosecurity of our citrus orchards. Sustainability of pest surveillance is key to successful early detection and early warning. The Citrus Research International (CRI) has developed a risk heat map to determine the probable pathways for D citri and Asian citrus greening/Huanglongbing (HLB) to the southern African citrus producing countries. The presence of ACP reported near the Naliendele Research Institute (10˚ 21' 14.33" S, 40˚ 10'05.62" E) in the Mtwara district of Tanzania. This detection presents a strong possibility that ACP could spread to Zimbabwe via Mozambique. This surveillance project was therefore aimed at establishing a sustainable surveillance network, to ascertain the status of the Asian greening diseases and its vector for the country. Regions in Zimbabwe along the northern and eastern borders with Mozambique were identified as possible entry points for ACP as depicted by the ACP risk heat map. A framework for the surveillance network was established where at least 99 double-sided sticky lime-green (14.0 x 18.4 cm) ACP traps (Alpha-Scents, USA) were placed in Citrus trees. The trees were also inspected for the presence of ACP and HLB symptoms. No ACP or HLB symptoms were observed. Signs of Trioza erytreae feeding were observed only in the Chitakatira region, in Burma Valley Mutare. Pock-marked leaves were collected for analysis for Liberibacter species in the pathology laboratory in Department of Research and Specialist Services at the Plant Quarantine Station in Mazowe, Mashonaland Central Province, Zimbabwe. No CLAs species have been detected in Zimbabwe. The northern low-lying regions do not have a high abundance of citrus trees, and therefore are not deemed as high-risk entry points or pathways for ACP. In the northern regions of Zimbabwe, where climatic conditions are suitable for T. eritrea, most citrus occurs in the higher lying areas (>1000m), and so the Eastern borders with Mozambique between Gairezi in the North, and Chiredzi in the South, were prioritized for more intensive early detection surveillance. Zimbabwe remains pest free area for D citri and Asian Citrus greening/Huanglongbing (HLB). Continued trapping and surveillance is key to maintaining this status.

Key words: ACP, surveillance network, early warning, HLB.

19. Management and suppression of tomato late blight disease (*Phytophthora infestans authority*) using plant extracts in Zimbabwe.

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Abstract

A survey was conducted in selected tomato growing areas in Mashonaland West, Mashonaland East and Masvingo provinces to assess the occurrence and management of late blight disease (*Phytophthora infestans*). A laboratory experiment, CRD design, was carried out at Plant Protection Research Institute to assess the effects of plant extracts of *Brassica napus*, *Cleome gynandra*, *Annona senegalensis* and *Clausena anisata on P. infestans* in tomato. Plant extracts were taken from fresh leaves of these plants and extracted in acetone solvent. The extracts were applied into autoclaved potato dextrose agar (PDA) in 20% and 40% concentration levels. The treatments were replicated three times under comparison with non-treated agar medium and that of one commonly used fungicide chlorothalonil in 20% and 40% concentration levels of the manufacturer's recommended rates. *P. infestans* diseased plant disks were each centrally placed on agar before incubating at 28^0C for 7 days. Survey results showed a high disease occurrence of 64% recorded in Mashonaland West, while Mashonaland East and Masvingo a low occurrence of 11% and 22%, respectively. Crop rotation and field sanitation were leading cultural control methods, though chemical and botanical methods were limited. Results of the *in-vitro* experiment showed that all plant extracts inhibited the growth of *P. infestans*, mostly during 2 days and 3 days after incubation (DAI). *C. anisata* significantly showed highest inhibition, 2 DAI, of 68.87% and 69.47%, followed by *B. napus* 64.43% and 66.67% in 20% and 40% extract concentration, respectively. The former out-performed all other extracts in all periods of incubation alongside the high inhibitory activity of chlorothalonil fungicide throughout the incubation period. *C. gynandra* was less effective in reducing the growth of *P. infestans* throughout the incubation period. The inhibition rates of extracts and the chemical were decreasing with increasing time of incubation owing to gradual
depletion of plant metabolic products for disease control. Since plant extracts were effective on inhibiting the growth of *P. infestans*, it is economic to use them to suppress the growth and development of *P. infestans* in tomato.

Key words: *Annona senegalensis*, *Brassica napus*, Chlorothalonil, *Clausena anisata*, *Cleome gynandra*, inhibition rate, *Phytophthora infestans*,

Key Highlights

- The inhibition rates of extracts and the chemical were decreasing with increasing time of incubation owing to gradual depletion of plant metabolic products for disease control.
- Highest *Phythopthora infestans* disease occurrence of 64% recorded in Mashonaland West, while Mashonaland East and Masvingo a low occurrence of 11% and 22%, respectively.

20. Effects of different organic manures on sprouting of cassava cuttings

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Climate change has brought with it a myriad of challenges which demand mitigatory strategies which are smart and resilient. Cassava (*Manihot esculenta* Crantz L) is a sub-tropical crop grown in most parts of Southern Africa, Zimbabwe included. It is one of the few crops that are climate resilient among sweet potato, aroids and traditional grains that can be produced by the Zimbabwean farming community, in support of the National Agricultural Policy Framework (Pillar No 1) which boldly supports food and nutrition security and resilience. Cassava has not received much adoption by farmers in Masvingo Agro-Ecological Region IV which receives an average of 450mm of rainfall per annum. Due to lack of its propagation and production techniques, most farmers have shied away from it. With the onset of a multitude of climate change induced challenges on food security and production, Cassava has proven to perform better in the semi-arid regions. The study sought to establish the most effective soil media for optimum shoot production in cassava cuttings at planting. It was carried out under laboratory-controlled conditions for a period of 6 weeks. Cassava cuttings of the same variety (MX7) were planted in pots with different soil media.9 treatments were used and were replicated 5 times. Treatments used: Sand +cattle manure, Sand +goat manure, sand +poultry manure, Clay soil, sandy soil, clay+poultry manure, clay +cattle manure, clay + goat manure and NPK as a control at a ratio of 30:30:30. All these were measured at a rate of 10t/ha. All treatments received equal inputs of water and amounts of manure. Shoot development and growth measurements were taken weekly in each replication. Nutrient analysis of each organic manure was done before the onset of the study. Poultry manure proved to be more effective and had a higher number of shoots promoted by its high Nitrogen content which promotes shoot development and growth. Data collected exhibited that poultry manure mixed with clay +sand gave optimum results for faster shoot production and growth if all conditions are at ceteris paribus.

Key words: Food security, Climate Change, Propagation, Cassava, Soil media

21. Effects of different rates of Colophospermum Mopane mulch on the emergence, days to 50% emergence and growth of sorghum.

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Abstract

Farmers have adopted various ways of water harvesting and moisture conservation. They have adopted various cascaded technologies which among them includes minimum tillage through digging basins, and mulching and the use of adapted crop varieties like sorghum. Lack of veld for mulching has seen them resorting to the use of *C. Mopane* organic fractions as mulch. There has been an outcry of poor crop stand due too poor crop emergence despite the use of this mulch. A study with the objective of determining the probable allelopathic effects of soil incorporated organic fractions of *C. Mopane* when used as mulch under field conditions, on Sorghum was done. The study was conducted as a field experiment in a Randomized Complete Block Design (RCBD) in basins measuring 0.15m^3 marked as planting stations, in plots measuring 0.06ha with, 5 treatments (Control 0t ,0.8tha-1, 1.6tha-1 ,3.2tha-1, 4tha-1) of C. Mopane Organic Fractions with four replications. Days to 50% emergence, emergence, percentage, seedling length, plant height at 11 weeks and germination index and seedling vigor index were calculated. The phytotoxic effects of the mulch were observed with pre-mature death of seedlings soon after emergence, Data collected (days to emergence, emergency, germination index, and seedling vigor index and plant height) were subjected to Analysis of variance (ANOVA) using GenStat 17th version. Where there was significant difference mean separation was done using Fischer's protected least significance difference (LSD) at 5% significance level, at nine days 1.6tha-1 and 3.2tha-1 had statistically similar cumulative germination, the germination with on the 4tonnes/ha MOF was still significantly lower than with the 1.6tha-1 organic fractions and control ($P < 0.05$). Emergence % at MOF treatments took longer days (10 days) compared to the control (4 days).

Key words: Water harvesting, Moisture conservation, Minimum tillage, Mulch

22. Evaluation of the effect of Trichoderma harziaaison L. on common bean (*Phaseolus vulgaris L.*) productivity.

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Abstract

On-farm Common beans (*Phaseolus vulgaris* L) yields are far below experimental yields in Africa, although total production is increasing, this is due to increased area planted. Declining yields in Africa are due to the extension of the crop into marginal production areas with poor soil fertility and / or drought (Buruchara, pers. communication). Zimbabwe like any other country is experiencing the effects of climate change. Plants have evolved a wide range of physiological, biochemical and molecular mechanisms to tolerate water deprivation (Douman et al 2005). The mechanisms employed to tolerate water deprivation can be altered using Trichoderma. Trichoderma is A fungus which improves photosynthetic efficiency and nutrient uptake of plants. Trichodermised improves root and shoot development in plants which may result in reduction of the adverse effects of climate change and drought. Field experiments with the objective of determining the effect Trichoderma on drought adaptation in common bean was carried out at Harare Research Station from 2020 to 2021. The experiment was laid out in a Random Complete Block Design with three replicates. Plant spacing was inter-row 45cm and in row 10cm. Basal fertilizer was applied at 300kg/ha of Compound D. Sweet violet was the bean variety used in the No Trichoderma and Trichoderma treatments. The results of Effect of soil application of Trichoderma on growth parameters and yield components of dry bean grown under field conditions during the 2019/20 and 2020/21 seasons reveal that Trichoderma significantly reduced the number of days to emergence and significantly increased plant shoot height and rooting depth, leaf chlorophyll content at mid pod fill and grain yield. Correlation between grain yield and parameters days to emergence, plant height, root length & leaf chlorophyll content was positive. Net income from Trichoderma higher than control. From the results obtained Trichoderma can be recommended for use in increasing bean productivity to farmers.

Keywords: *Phaseolus vulgaris,* Trichoderma, drought adaptation, rooting depth

23. Variation in grain yield, protein and oil content among soybean genotypes and their relationship to other agronomic traits.

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Abstract

Soybean (Glycine max L.) is an important crop for feed and food in the Sub Saharan Africa. In Zimbabwe its demand is driven by the oil and feed industries. Therefore, the objectives of this study were to (i) identify high yielding genotypes with high protein or high oil concentration (ii) determine the relationship between grain yield, protein content, oil content and other agronomic traits measured among different soybean genotypes. Twenty-five soybean genotypes from the Zimbabwe national breeding program and five standard checks were planted on a 4 row plot which was 5m long with row spacing of 45cm and in-row spacing of 5cm during the 2019/20 season on a 5 x 5 alpha lattice design. META-R software was used to compute the genotype x environment interaction, correlations and heritability of the traits and GGE bi plot analysis was used to determine the stable and high yielding genotypes. Significant (P < 0.001) variation was observed among genotypes for grain yield, oil and protein concentration, plant height and maturity date. Grain yield was positively correlated with protein and negatively correlated with oil. An inverse relationship was observed between protein and oil concentration. The highest yielding and stable genotypes was 13(1072/6/2) and this has outperformed all the commercial check varieties. Genotypes 27(1083/6/7) and 17(1075/6/2) had high oil concentration above 42% and genotypes 20 (1055/6/6) and 26 (1094/6/1) had high protein concentration above 23%. Genotype 17 (1075/6/2) combined high grain yield and oil concentration, therefore it can be recommended for release and commercialization in soybean growing regions in Zimbabwe. Additionally, the availability of high yielding soybean genotypes with high oil and protein content depicts the potential for breeding for high yield, protein and oil content.

Key words: Soyabean, Protein content, Oil content, Seed yield, correlations, variance components.

24. Efficacy of Emamectin Benzoate + Acetamiprid 112EC on Lepidopteran pests of cotton in Zimbabwe.

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Abstract

The bollworm complex is the most destructive in cotton, capable of causing yield losses of up to 60% if not controlled. Bollworms feed on the reproductive parts of the crop, the buds, flowers and bolls. Five field trials involving Emmamectin benzoate + acetamiprid 112 EC at three rates of 200 ml/ha, 300 ml/ha and 400 ml/ha, Larvin 375 SC at 1100ml/ha, and a no control treatment were laid out in a Randomised Complete Block Design with four replications at Cotton Research Institute (CRI), Dande, Shamva, Matikwa and Umguza in 2018/19 and 2019/20 with the objective of evaluating the efficacy of Emamectin benzoate + Acetamiprid 112 EC. Larvin 375 SC was the positive standard treatment and the zero chemical treatment was used as the negative control. The gross plot was 8m x 1 m x 10m. The sprayed area was 6m x 8m. The net plot was 4m x 6m. Measurements were taken on the number of heliothis, spiny and red bollworm larva and predators of bollworms namely *Chrysopa spp*, Spiders, Lady bird adults and larva. Data analysis was done using Genstat 18th Edition. Significant treatment means were separated using Duncan `s multiple range test. Over the two seasons, Emamectin benzoate + Acetamiprid 112 EC controlled Heliothis and red bollworms at 400ml/ha better than Larvin 375 SC, in some cases compared closely with Larvin 375 SC. Predators thrived better in Emamectin benzoate + Acetamiprid 112 EC treatments than in Larvin 375 SC treatment. Emamectin benzoate + Acetamiprid 112 EC was recommended for registration on control of red, spiny and heliothis bollworms at the rate of 400ml/ha.

Keywords: Bollworm, Predator, Emmamectin benzoate + Acetamiprid 112 EC.

25. Preliminary evaluation of iron and zinc rich Irish potato (*Solanum tuberosum)* genotypes in Zimbabwe.

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Abstract

Crop bio-fortification is considered as the most powerful approach to enhance the nutrient content of crops, and thus increasing dietary intake of various nutrients as well as alleviating nutritional deficiencies. Potato bio-fortification will go a long way in securing food security and nutrition when yield and nutrition are combined as it is a strategic crop in Zimbabwe. A potato yield trial was established at Harare which

consisted of 47 biofortified genotypes from International Potato Center (CIP) and three local check cultivars. The objective of the trial was to evaluate the performance of biofortified lines in local environment for desired traits like nutrient content (iron and zinc), yield, days to reach physiological maturity and disease tolerance. The trial was laid out in an alpha lattice design with two replicates. The trial had a plot size of 2.7m[2]. Collected data was analysed using Genstat version 18 and Fisher's protected LSD was used to separate the means. There weere significant differences in yield (P< 0.05), the genotypes CIP 16 and 34 were the best with an average yield of 38.6 and 26.2 tonnes per hectare respectively. They out competed all check varieties. Diamond, a local check was third with an average yield of 24.3 and CIP 45 fourth with 22.3 tonnes per hectare. Number of days to reach physiological maturity was also significantly different with Diamond and CIP 34 performing comparable to each other, they matured early with 84 and 88 days respectively. CIP 10 and CIP 43 lines followed with 96 days to physiological maturity. However, CIP 10 and CIP 43 were amongst the least in terms of yield of 0.5 and 2.2 metric tonnes respectively. The experimental line CIP 34 combines the following traits of being high yielding, early maturity, shallow eyes, red skin, medium tuber size and oblong shape at the same time which makes it the best line in the trial comparable to the check variety Diamond. The highest yielder CIP 16 was in the medium maturity group with 104 days to physiological maturity.

Key words: alleviating, bio fortification, dietary intake, genotype, physiological maturity

26. The Distribution and Abundance of the Devil's Claw (*Harpagophytum Spp*) in Zimbabwe

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Abstract

An assessment of the distribution and abundance of *Harpagophytum spp* was conducted in Victoria Falls, Matabeleland North, Zimbabwe. Data from 120 10mx10m plots was collected from five Wards. It was analyzed and the results showed a 50% frequency or presence of the plant in the area. *Harpagophytum* is endemic to the kalahari sands of Southern Africa. It is internationally traded and exploited for its medicinal properties. The tuber is traditionally used for fever relief, blood diseases, muscular aches and pains, and as an analgesic during pregnancy. In addition, pulverized root material is used as an ointment for sores, ulcers and boils, and for difficult births. Infusions of the dried root are also commonly used as a cure for digestive disorders, to stimulate appetite, and for postpartum complaints. Internationally, *Harpagophytum spp* is registered for pharmaceutical use in Europe where it is widely used to treat rheumatism and arthritis. Tubers are harvested and prepared for local utilization and mainly sold for export. The increased harvesting of indigenous plants and the trade in natural products is the result of the need for rural communities to generate additional income, as well as an increase in the demand for plant products, primarily those with medicinal values. This bio-trade makes an important contribution to improved livelihoods of the primary producers, however, it may result in over harvesting and hence a

drastic decline of the Devil's claw population. The study was carried out in Victoria Fall and villagers guard against misuse of the plant that is, the headmen and his counsel the police do allow people to harvest but they make it a point that the gathered plants is put to correct use. They use the powder to treat sick cows and recovery is almost instant. There is a research gap here and for commercialization there is need for replicating the Kalahari sands.

27. Genetic analysis of maize streak virus disease resistance on tropical maize

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Abstract

Maize streak virus (MSV) disease, transmitted by leafhoppers (*Cicadulina mbila*) is a major contributing factor to low maize yields in Africa. Nine (9) newly developed tropically adapted maize inbred lines developed by CIMMYT-Zimbabwe for Maize Streak Virus (MSV) resistance were screened together with 3 elite lines known to harbor MSV resistance, under artificial MSV infestations in a greenhouse in order to identify candidate lines with complete resistance to the MSV disease and also to understand disease progression after disease inoculation in maize inbred lines. Genotype effects on MSV scores were significant ($p < 0.05$) from week 1-6 as well as for the average. Significant effects on MSV scores were also observed on each week interval, except for week 4. Broad-sense heritability ($H2$) estimates for MSV scores were high (i.e., <50%) on each week interval as well as for the average MSV score. Genotypic effects showed to be more important than the environmental variances on each week MSV recordings were taken. The study showed that elite line CML536 was highly resistant confirming previous observations made with artificial infection in Zimbabwe. Candidate lines CL1210634 and CL1210635 showed complete resistance to MSV meaning they may share the same major gene Msv1 with elite line CML539 and CML536 check inbred. Overall, we recommend that, in order to avoid over-dependence of the Msv1 gene, further studies should be carried out to identify a second gene for Maze Streak Disease (MSD) resistance to compliment Msv1 gene in conferring enhanced and durable resistance to MSD. Enhanced resistance through additional phenotypic selection will also help prevent possible breakdown of Msv1.

Keywords: Cicadulina mbila, inbred line, Msv1 gene, Maize streak virus, resistant cultivar

28. Determination of the critical weeding period in soybean (*Glycine max*)

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Abstract

The critical period for weed control is the period in the crop growth cycle in which weeds must be controlled to prevent yield losses. This study aimed to determine the critical weeding period in soybean. The experiment was conducted at Henderson Research Station, Mazoe, Zimbabwe on medium grained sand clay soils, during the summer season of 2020. Total rainfall received at Kadoma was 1181 mm which I was evenly distributed throughout the season. The experiment was arranged in randomized complete block design (RCBD) with single factor of treatment with three blocks as replications. The treatments were, weed 2 weeks after crop emergence (WACE) + weed free onwards, weed 4WACE + weed free onwards., weed 6WACE + weed free onwards, wed 8WACE + weed free onwards, weed-free (control), and no weeding (control). Statistical analysis was done using Genstat 18 th Edition. The soybean yield decreased exponentially when weeding was delayed. The soybean yield was influenced by weed biomass yield, pest management was done meticulously to minimise pest effects on soybean grain yield. Full weeding resulted in high soybean grain yield compared to no weeding. Weeding at 2 4, and 6 weeks after crop emergence yielded the same as the weed free treatment statistically. According to these results weeding can be delayed by 6 weeks without suffering significant yield loss. This gives the farmer time to work on other farm enterprises.

Key words: Yield losses, Critical weeding period, weed free

ANIMAL HEALTH, BREEDING AND PRODUCTIVITY

29. Optimizing targets for tsetse control: Taking a fly's-eye-view to improve the colour of synthetic fabrics

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Abstract

The savannah tsetse flies, *Glossina morsitans morsitans* and *G. pallidipes*, are important vectors of Rhodesian human African trypanosomiasis and animal African trypanosomiasis in east and southern Africa. We tested in Zimbabwe whether robust, synthetic fabrics, and innovative fly's-eye-view approaches to optimise fabric colour, can improve insecticide-treated targets employed for tsetse control. Flies were caught by electrocution at a standard target comprising a 1m x 1m black cotton cloth panel with 1m x 0.5m black polyester net panels on each side. Catches were subdivided by species and sex. Tsetse catches were unaffected by substitution of the black cotton with a blue polyester produced for riverine tsetse targets. Exchanging the net panels for phthalogen blue cotton to simulate the target routinely used in Zimbabwe significantly reduced catches of female G. m. morsitans (mean catch 0.7 times that at standard), with no effect on other tsetse catches. However, significantly greater proportions of tsetse catch were intercepted at the central panel of the Zimbabwe (means 0.47-0.79) versus standard designs (0.11-0.29). We also engineered a new violet polyester cloth using models of tsetse attraction based upon fly photoreceptor responses. With and without odour lure, catches of females of both species at the violet target were significantly greater than those at standard (means 1.5-1.6 times those at standard), and typical blue polyester targets (means 0.9-1.3 times those at standard). Similar effects were observed for males under some combinations of species and odour treatment. The proportions of catch intercepted at the central panel of the violet target (means 0.08-0.18) were intermediate between those at standard and typical blue polyester. Further, the reflectance spectrum of violet polyester was more stable under field conditions than that of black cotton. Our results demonstrate the effectiveness of photoreceptor-based models as a novel means of improving targets to control tsetse and trypanosomiases.

Keywords: Insecticide, treated target, photo receptor, violet polyester cloth

30. An atlas of tsetse and animal African trypanosomiasis in Zimbabwe

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Abstract

In the 1980s and 1990s, great strides were taken towards the elimination of tsetse and animal African trypanosomiasis (AAT) in Zimbabwe. However, advances in recent years have been limited. Consequently, freed-areas have been at risk of reinvasion, and the disease in tsetse infested areas remains a constraint to food security. As part of ongoing control activities, monitoring of tsetse and AAT is performed regularly in the main areas at risk. However, a centralized digital archive is missing. To fill this gap, a spatially explicit, national-level database of tsetse and AAT (i.e., an atlas) was established through systematic collation, harmonization and geo-referencing of data for the period 2000 to 2019. The atlas covers an area of approximately 70,000 km^2, located mostly in the at-risk areas in the north of the country. In the tsetse component, a total of 33,872 entomological records were assembled for 4894 distinct trap locations. For the AAT component, 82,051 samples (mainly dry blood smears from clinically suspicious animals) were collected at 280 diptanks and examined for trypanosomal infection by microscopy. *Glossina pallidipes* (82.7% of the total catches) and *Glossina morsitans morsitans* (17.3%) were the two tsetse species recorded in the north and northwest parts of the country. No fly was captured in the northeast. The distribution of AAT follows broadly that of tsetse, although sporadic AAT cases were also reported from the northeast, apparently because of transboundary animal movement. Three trypanosome species were reported, namely *Trypanosoma brucei* (61.7% of recorded infections), *Trypanosoma congolense* (28.1%) and *Trypanosoma vivax* (10.2%). The respective prevalences, as estimated in sentinel herds by random sampling, were 2.22, 0.43 and 0.30%, respectively. The patterns of tsetse and AAT distributions in Zimbabwe are shaped by a combination of bioclimatic factors, historical events such as the rinderpest epizootic at the turn of the twentieth century and extensive and sustained tsetse control that is aimed at progressively eliminating tsetse and trypanosomiasis from the entire country. The comprehensive dataset assembled in the atlas will improve

the spatial targeting of surveillance and control activities. It will also represent a valuable tool for research, by enabling large-scale geo-spatial analyses.

Keywords: Reinvasion, digital database, archive, entomological records

31. Knowledge, attitudes and practices of abattoir operators and meat handlers on hygiene and food safety

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Abstract

Meat hygiene can be defined as all conditions and measures that are necessary to ensure the safety and suitability of meat at all stages of the food chain. Traditionally, meat has been viewed as a vehicle for a significant proportion of human food-borne diseases. Although the spectrum of meat-borne diseases of public health importance has changed with changing production and processing systems, continuation of the problem has been well illustrated in recent years by surveillance studies of specific meat-borne pathogens such as Escherichia coli O157:H7, Salmonella spp., Campylobacter spp. Foodborne illnesses are unpleasant and can be fatal. Apart from that, outbreaks of foodborne illness can adversely affect consumer confidence, damage trade and tourism, and can also lead to loss of earnings, unemployment and litigation. In that regard, effective hygiene control and food safety is vital. At the abattoirs, there are perennial challenges of non-compliance to the meat hygiene regulations, standards and general requirements. Therefore, to ensure that meat is safe and suitable for human consumption; abattoir operators and meat handlers among other players involved in the meat value chain are expected to adhere to the set prerequisite programs that are necessary for ensuring meat hygiene and safety. This proposal is for a study that is intended to assess and analyse the knowledge, attitudes and practices of abattoir operators and meat handlers on hygiene and food safety with the goal of using the findings to identify the main drivers leading to non-compliance and to develop targeted interventions that will be used to promote the production of meat that is safe and suitable for human consumption. A cross-sectional study will be conducted which will employ both qualitative and quantitative survey methods to gather the required data.

Keywords: Food safety, public health, consumer confidence, practices

32. Establishment, Importance and Implementation of NAREC in the Regulation of Research in Animal Health and Production

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Abstract

Globally, animals have been extensively used in the research fields of biomedicine, veterinary medicine as well as animal production. In biomedical and veterinary research, they have been used as models to study disease and to develop and test potential forms of treatment. In all these research activities, the welfare of the study animals should be considered and hence conform to the stipulated research ethics. The National Animal Research Ethics Committee (NAREC) is a statutory body borne out of the Animal Health Act [Chapter 19:01] 's NAREC Regulations of 2021, through multi-stakeholder collaboration involving the Agricultural Research Council (ARC), the Departments of Veterinary Services & Livestock Research, ZIMPARKS and academia from the university of Zimbabwe. NAREC's overall role is to cater for the welfare of animals used in scientific research in Zimbabwe. NAREC, which is chaired by the Head of Research in the Department of Veterinary Services, draws its membership from various organizations including government departments, parastatals, universities and farmer representatives. The major functions of NAREC include the evaluations of research proposals for ethics compliance certification and conducting inspections for research being conducted to ensure compliance to required ethics. It also regulates the shipment of biological samples outside the country for research purposes. Moving forward, NAREC looks forward to continually work cordially with researchers, and remains fully committed in upholding high ethical standards and animal welfare in research in the country.

Keywords: Animal welfare, research, ethics compliance, sample shipping

33. Acaricide resistance and dip concentration monitoring as part of integrated tick and tick-borne disease Control Strategy implementation

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Abstract

Resistance of ticks to acaricides is a growing threat to livestock production globally. Continuous exposure of ticks to the same acaricides, as well as application of sub-lethal doses, are amongst the major drivers of resistance to the detriment of livestock production. In this study the larval packet test was used to evaluate the resistance of a one and three-host tick, (*Rhipicephalus decoloratus* and *R. appendiculatus*)

to commonly applied acaricides in Zimbabwe, following increased incidences of theileriosis for which *R. appendiculatus* is a carrier. This pilot study was carried out in hot spot districts namely Bindura, Hwedza, Chikomba, Zvimba, Makoni and Marondera as part of the tick and tick-borne disease control strategy implementation. The implications of the current tick management practices on the development of acaricide resistance were also assessed. Results confirmed moderate resistance of *R. decoloratus* populations at 50% of the sampled dip tanks (4<RR<10) while two dip tanks also had moderate resistance to deltamethrin. On the contrary, tested *R. appendiculatus* populations were susceptible to both amitraz and deltamethrin despite an indication that management practices by farmers may subsequently lead to resistance development in the future. These results suggest that increases in theileriosis incidences may be linked to other epidemiological factors rather than acaricide resistance of the vector R. appendiculatus. However, the role of acaricide resistance may not be dismissed in future transmission dynamics of the disease. These findings, therefore, support the need for a holistic tick- and tick-borne disease management approach incorporating the correct and consistent application of available acaricides, acaricide rotation, acaricide resistance monitoring, controlling animal movement, quarantining of affected areas, as well as vaccination against tick-borne diseases (TBDs).

Keywords: Larval packet test, Rhipicephalus, Theileriosis, tick-borne disease management

34. Rolling out of the National Artificial Insemination Program for Cattle Genetic Improvement

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Abstract

The National Artificial Insemination (AI) roll-out program commenced in May and June 2022 in Gutu and Mhondoro-Ngezi districts. The program is a component of the Agriculture and Food Systems Transformation Strategy (2021-25) under National Development Strategy 1 which entails a Livestock Development Plan which seeks to grow the dairy and beef herds from 38 000 to 60 000 and from 5.4 million to 6 million respectively by 2025. The three specific objectives of the roll-out included: to build the Ministry of Lands Agriculture Fisheries Water and Rural Development capacities in Reproductive Technologies (human and infrastructural), to improve cattle breeds using predominately climate smart locally adaptable indigenous breeds namely Mashona, Nkone and Tuli, to conserve (cattle) genetic resources and to shorten inter-calving period by use of hormone analogues. With support of the International Atomic Energy Agency (IAEA), laboratory technologists were trained and the Mazowe Bull Centre and Semen Processing Laboratory (MBCSPL) was equipped to produce 200 000 straws of cattle

semen annually. Chinhoyi University of Technology (CUT) facilitated in the training of 163 extension/field officers in basic artificial insemination techniques (theory and practical). A local consultant provided back-stopping for semen laboratory staff. One thousand nine hundred and seventy (1 970) cattle were synchronised using prostaglandin analogues and 713 of the synchronised cattle were AI. Bulls identified in the community were used to mop up cattle not inseminated. More than 70% of the inseminations were done using the locally adaptable breeds. It was observed that most farmers were still unaware of the benefits and requirements of the AI exercise. Most farmers still perceived the exotic breeds with bigger frames as better. Extension staff still needed additional practical training in AI. Whilst the actual numbers of cattle that conceived are yet to be ascertained preliminary findings indicate that the exercise was to a larger extent successful but an extensive evaluation needs to be done. In conclusion, the use of prostaglandin analogues once off as opposed to fixed time AI could be a cost-effective method to roll-out AI in extensive cattle production systems. Molecular techniques such as genotyping need to be also explored in identification of resistance and production traits.

Keywords: local capacity building, artificial insemination, genetic improvement and conservation, climate-smart cattle

35. Communication medium used in Theileriosis control: the factors that determine disease knowledge among smallholder farmers in Zimbabwe.

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Abstract

Theileriosis is one of the most important tick-borne diseases that has been affecting farmers and thousands of livestock in Zimbabwe. The main government strategy to combat Theileriosis is use of plunge dips with anti-tick chemicals at specified times; however, an increase in number of farmers caused a strain on government services resulting in disease outbreak. One of the key issues that have been highlighted by department of veterinary is the strain in communication and knowledge of the disease with the farmers. Hence, it is important to evaluate the communication between farmers and veterinary services and identify possible areas of strain. A field survey was conducted with 320 farmers in Mhondoro Ngezi, a district badly affected by Theileriosis. Face-to-face interviews with smallholders and communal farmers were conducted between September and October 2021, and the data were analyzed using Stata 17. Communal farmers relied mainly on oral communication and had limited knowledge of theileriosis; therefore, dead cattle % was high among them. Though veterinary extension officers were the prime source of information, oral communication medium affected knowledge transferred. The results of this study recommend adoption of communication mediums that encourage retention, such as brochures and posters by veterinary extension services. The government may also partner with private players to ease pressure of increased farming population due to land reform.

Keywords:Tickborne, plunge dipping, extension, print media

36. Effect of mealworm larva (*Tenebrio molitor*) meal in pre-starter diets on broiler performance and carcass yield.

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Abstract

The experiment was carried out in phase one and phase two to evaluate the effects of utilising mealworm larvae meal as protein for broiler chicks. A total of one hundred and fifty unsexed day-old Ross 708 broiler chicks per each phase were used to investigate the effects of dietary replacement of blood meal for mealworm larvae, and mealworm larvae inclusion rate on growth performance and carcass traits. The birds were randomly allotted to 5 treatment groups of 30 birds with each treatment having three replicates of 10 birds each per experimental period. In phase one five starter diets were iso-energetic and iso-nitrogenous formulated, as follows control (0%); 25% 50%; 75% and 100% mealworm larvae replacing blood meal in equi-protein bases. During phase two, three diets were transferred from phase one with inclusion rate of 0%, 1.76%, 3.52% which is equivalent to replacement rate of 0%, 50% and 100% respectively, the two diets were formulated isonitrogenous 7%,and 14% to commence phase two. The birds were reared in deep litter house and they were given feed and water *ad-libitum*. The performance results suggested feed intake, daily gains, and live weight were not ($P>0.05$) significantly different for both phases, feed conversion ratio of phase two was significantly different ($P<0.05$) at week five reported an increase in feed conversion ratio at 14% inclusion rate. The aggregate performance for both trials shows that, there were ($P>0.05$) no significant differences. The carcass traits findings indicated that, there were ($P>0.05$) no significantly difference for both phase. According to this study mealworm larvae meal can replace blood meal by 100% and can be included in the diet up to 14% without depressing broilers performance and carcass yield.

Key words: starter diets, mealworm larvae meal, growth performance, carcass yields

37. The potential of Marula tree fruit pulp and skin as a palatability/flavour enhancer to improve intake of late cut hay fed indigenous goats.

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Abstract

Goat farmers use hay as a dry season supplementation option but the hay is known for its poor quality and palatability thus reducing intake. The dry season is known for high poverty deaths, indicating a gap in nutrition. Most resource poor farmers have poor access to commercial palatability enhancers thus require a cheaper and readily available resource. The study was done to assess if Marula (*Sclerocrya birrea*) fruit flavor in the dried skin and pulp is useful in adding flavor to late cut highly lignified hay in trying to improve palatability and intake on Matebele goat breed which are predominantly browsers. The objectives of the study were to find out the possibility of using Marula fruit pulp and skin (wine brewing by-products) crush in enhancing flavor and palatability to increase intake of late cut hay to compensate for poor nutritional status and poor digestibility and maintain body condition score and reduce poverty deaths in goats during the dry season. Twenty-eight (28) castrated males of 12-32 months of age and approximately 22 kg were randomly allocated to 4 treatments, namely, Marula unfermented, fermented, plain hay and molasses sprayed. The goats were individually-housed in digestibility crate pens (1.2 × 2 m) for the 2 hour daily feeding time. Animals were fed in the morning and allowed to drink water adlibtum. They were offered 500g each and feed intake was calculated from the refusals weighed post feeding. The hay was offered in plastic dishes and the experiment was run for 6 weeks. Animals were weighed weekly to assess weight changes. Negative average gains were observed in plain hay and unfermented marula. Positive growth performance was observed on fermented marula and molasses supplemented goats though no significant differences were observed on average daily gains across all treatments (P=0.203, sed=0.0266).
The results indicated that fermented marula treated hay performed equally with molasses sprayed hay in improving intake. The results showed that molasses can be replaced by fermented Marula to get the same level of hay intake as they had similar intake according to Fischer level of significance.

Key words: Palatability, Scerocrya birrea, flavor, fermentation

38. Pregnancy rate of artificially inseminated cattle in a communal production system. A case of Mwenezi district Zimbabwe

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Abstract

The study was conducted to determine the pregnancy rate of artificially inseminated cattle in a communal production system. A total of 298 animals were subjected to artificial insemination (AI) using a fixed time AI protocol. Data were analyzed by binary logistic regression where pregnancy rate was the measured response while period post calving, parity, suckling status of animal and body condition score were the non-treatment factors. Observed overall pregnancy rate was 51.66%. Body condition score significantly affected pregnancy of inseminated cattle with animals with a higher body condition score of ≥3-4 showing a higher pregnancy rate (52.07%) in comparison to those with a body condition score 2.5 recorded 48.28% pregnancy rate. Period post calving, parity, and suckling status affected pregnancy rates though the differences were not significant. Animals with a post calving period of >than 12 months recorded a pregnancy rate of 52.18% and those of ≤12 months a pregnancy rate of 51.61% ($P > 0.05$). A greater portion of the non-suckling animals conceived, recording 53.13% pregnancy rate compared to the suckling animals that recorded 50.86%. In conclusion, the study confirmed that artificially insemination improved conception rates for communal cattle. As such, the technology can successfully be used for breed improvement and, to complement natural service in indigenous communal cattle production systems.

Key Words: pregnancy rate, artificial insemination, communal production system.

39. Isolation and identification of lactic acid bacteria for goat milk yoghurt starter culture development.

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Abstract

The study aimed to isolate lactic acid bacteria (*Streptococcus thermophilus* and *Lactobacillus delbrucki*) from raw Matabele goat milk for use as starter culture in goat milk yoghurt production and to evaluate certain technological properties of the starter culture and quality parameters of the yoghurt produced. The potential of the isolates was assessed basing on their ability to produce acid, tolerance to acidic conditions and a safety assessment was also conducted. Parameters such as acidity, pH and post acidification were assessed, the product was subsequently evaluated for consumer acceptability by administering a questionnaire to panelists for sensory evaluation using a 9-point hedonic scale. Molecular identification was done using 16S RNA amplification. Isolates were significantly different in pH tolerance at different pH levels ($p<0.001$) presumed *Lactobacillus delbrueckii* showed medium to high acidification activity as they reduced the pH of the skim milk powder from initial values of 6.62 to final pH values of 4.51and 3.85 while *S. thermophilus* strains, T11 and ST12 were fast acidifiers as they reduced the pH of skim milk from 6.62 to 4.53 and 4.56 respectively. Three selected isolates LB137, LB1042, and ST11 showed amplification of the 16S region of the genomic region with 1500 bp DNA fragments. All the isolates did not show any haemolytic activity. However the selected isolates did not show antimicrobial activity to pathogenic strains of E.coli. The isolates were susceptible to most antibiotics but were resistant to oxacillin, vancomycin and nalidixic acid. After storage, lower acidification was observed in the product formed (4.42) as compared to the control (4.29). Overall, results from the sensory evaluation showed that goat milk yoghurt produced is moderately acceptable. The isolated lactic acid bacteria showed remarkable technological properties hence can be used as a starter culture for yoghurt production.

Keywords: lactic acid bacteria, goat milk, yoghurt, acidification

40. Effects of partially substituting Soya bean meal with Cowpea in Broiler rations on broiler performance

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Abstract

The aim of the experiment was to evaluate the effects of partially substituting soya bean meal with cowpea on broiler feed intake, weight gain and feed conversion ratio (FCR). Four iso-nitrogenous and iso-energetic diets were compounded into diets containing 0%, 10%, 20% and 30% cowpea respectively. The research trial was conducted for 42 days. A total of 500 broilers were used and each treatment had a total of 69 birds. Each treatment had 3 replicates of 23 birds. A Complete Randomized Design model was used. ANOVA was analysed using SPSS Version 21. Mean separation was done using Least Significance Difference (LSD). Mean feed intake ranged from 3.948kg for the control diet to 4.106kg for the 20% diet. There were no significant differences in terms of feed intake ($p < 0.05$). The 20% cowpea diet had the lowest weight gain of 2.074kg, while the control diet had the highest weight gain of 2.229kg, and 20% cowpea diet was significantly different from the control diet at ($p<0.05$). (FCR) ranged from 1.767 for the control diet to 1.977 for diet with 20% cowpea. The diet with 20% cowpea was significantly different from the control diet at ($p < 0.05$). Cowpeas appear to be suitable for use in poultry feeds due to a much higher level of lysine than soya bean. There is still need to increase the cowpea content in the diets, so that we are able to determine the optimum inclusion level.

41. Developing Dairy Climate Smart Business Model by Calculating the Carbon Footprint of Dairy Farms in Zimbabwe.

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Abstract

Greenhouse gas emissions from dairy farming have been a topic of concern all over the world with some countries having taken pilot studies in quantifying the emissions in their farms. This study was done to

calculate and compare the carbon footprint in small and large-scale dairy farms in Zimbabwe. A sample of 24 farmers, thus 12 small-scale and 12 large-scale farmers were interviewed in Mashonaland Central and Mashonaland East provinces of Zimbabwe. The objective of the study was to quantify the carbon footprint per kg of milk for small- scale and commercial dairy farms then develop dairy business models for sustainable climate smart dairy in Zimbabwe. Data was collected from farmers using a fully structured questionnaire and analysis for comparison of means between the two groups was done using Statistical Package for Social Science (SPSS). Life Cycle Assessment computation tool developed by VHL staff was used to calculate the carbon footprint per farm. Canvas business model was used to identify current business models and come up with new inclusive climate smart business models. The average herd size was 249.6 and 25.6 for large and small-scale dairy farms respectively. Average milk production was 4889 and 2837 litres per cow per year for the two farming systems. On climate smart dairy practices there was poor management of manure in both production systems. However, farmers practiced growing of fodder crops with 42% large-scale and 25% small-scale already cultivating Katambora Rhodes grass on their farms. Feeding of concentrates and straight feeds as supplement feeding was another climate smart practice identified of which 92% large-scale and 75% small-scale of the farmers interviewed were feeding their animals with dairy meal some were using concentrates, cotton seed cake, soya bean meal and sunflower meal. Another interesting result was the feeding of crop residues and by-products to animals; maize stover, maize bran, wheat straw, soya bean straw, brewery waste, molasses, orange peels and poultry waste were among the identified list used as feed to dairy animals. Of these maize stover (58% and 50%) and brewery waste (67% and 17%) large and small-scale farms respectively were commonly used. Hay and silage making were the major feed preservation methods identified in the farms interviewed. Enteric fermentation was the primary producer of CH_4 emissions producing 0.92 and 1.8 CO_2 eq/kg FPCM for large and small-scale farms respectively. The second category was emissions from off-farm feed production, by-products and concentrates which emitted 0.27 and 0.53 CO_2 eq/kg FPCM. Manure and fertilizer application, fodder and fertilizer production were other sources of greenhouse gases in dairy farms. The carbon footprint of milk in small-scale dairy farms was 2.97 while for large-scale farms was 1.30 CO_2 eq/kg FPCM. The analyses showed that emissions CO_2 eq/kg were higher in small-scale farms than large-scale farms. New business models were developed which focused on productivity, sustainability and resilience while addressing environmental issues to achieve climate smartness in dairy farming.

Key words: Carbon footprint, Greenhouse gas, Climate smart practice, Dairy business model

42. The risk status of Zimbabwean indigenous cattle breeds under conservation programs.

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Abstract

Population structure and risk status in three indigenous beef cattle in Zimbabwe were investigated. The investigation was based on two main factors: the number of females (L) and effective population size (Ne); as well as an additional factor (D) composed of 6 elements: geographical concentration, demographic trend, the cultural value of a breed, parentage control, ex-situ conservation, and anthropogenic factors. Pedigree records of 37081 Tuli, 12935 Mashona, and 9489 Nkone cattle breeds were analyzed using the online POPREP software system. Pedigree completeness over six generations varied with the lowest completeness in the Nkone and the highest in the Mashona. The average generation interval ranged between 6.4 and 11.0. The rates of inbreeding per year were 0.05%, 0.07%, and 0.03% in Mashona, Tuli, and Nkone respectively. Effective population sizes were 266, 182, and 135 in Tuli, Mashona, and Nkone respectively. Using the factors and elements above, among the examined three breeds of cattle, the Mashona and Nkone breeds were assessed as being endangered and in need of conservation and the Tuli breed was determined to be less endangered, but in need of constant monitoring. The results confirm that the three cattle breeds under study are endangered and there is a need to strengthen and continue genetic resources conservation programs for the breeds.

Keywords: Risk status, Pedigree completeness, Generation interval, Inbreeding, Effective population size.

43. Production and performance of mealworm (*Tenebrio molitor*) fed on sorghum in Matabeleland South, Zimbabwe.

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Abstract

The study evaluated the effect of sorghum stover (SV4) on mealworm growth performance. Five treatments, 100% sorghum stover (100 SV4), 75% sorghum stover + 25% sorghum grain (75 SV4), 50% sorghum stover + 50% grain (50 SV4), 25% sorghum stover + 75% sorghum grain (25 SV4) and 100%

sorghum grain (0SV4 control), were randomly assigned to mealworms and replicated three times in a completely randomized design. The nutritive value of mealworms was recorded before and after the trial. Weight gain, feed intake, mortality, and pupae of the mealworms were recorded on a daily and weekly basis respectively. There were no significant differences among the treatments (P >0.05) in the body weight of mealworms. Feed intake of mealworms showed no significant differences (P > 0.05) between all treatments. After proximate analysis of mealworms, there were no significant difference (P >0.05) in dry matter and crude protein (P>0,05) content across all treatments. The results concluded that dual-purpose sorghum stover can replace sorghum grain at 25%, 50%, 75%, and 100% without affecting feed intake, growth performance, and nutritive value of mealworms.

Keywords: Mealworms, Crude protein, Dry matter, Sorghum stover, Feed ingredients, Weight gain

44. Multi-locational evaluation of Sorghum for grain and fodder yield: A step towards dual purpose varieties.

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Abstract

Competition over land between food and fodder production, along with recurrent droughts and increasing population, has put mixed crop–livestock farming systems in the drylands under pressure. Dual-purpose crops hold huge potential to ease this pressure and simultaneously improve food and fodder availability in these systems. Currently, the local seed system is limited to varieties that are primarily used for domestic grain purposes. There is great interest in sorghum for promoting dual purpose varieties for grain and fodder. Sixteen sorghum genotypes were evaluated together with three checks both on-station and on-farm at five locations for two seasons. The experiment was laid out in a randomised complete block design replicated three times. Across site analysis of variance (ANOVA) showed significant genotypic effects on grain yield (GYD), Days to 50% flowering, as well as the other quality traits, including fodder yield, sugar content (SC), Crude protein (CP) and Nutrient detergent fiber (NDF). Based on fodder quality (fodder yield, sugar content, crude protein and nutrient detergent fiber), overall results revealed that PVK 801 and NTJ 2 as superior than all other genotypes. Overally PVK 801 was identified as the highest

yielder in terms of grain (4.2 tha-1) and dry fodder (31tha-1) yield, On-farm, PVK 801 gives an average yield of 2.tha[-1] and was ranked first for grain and fodder yield. It was also high in sugar as well as crude protein content (15.5 and 19.5%). Most of the plant growth and yield parameters recorded higher heritability (<0.75) compared to fodder quality parameters. Genotype PVK801 is recommended for commercialization as a dual-purpose sorghum variety.

Keywords: Dual purpose varieties yield fodder grain

45. Chisumbanje Vertisols Potential as a Feed Additive in Beef Feedlot Rations: A Systematic Review.

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Abstract

Besides their excellent cation exchange capability, clays have unique physical and chemical properties that make them ideal as animal feed additives. The global use of various clays and commercial derivatives as feed additives has sparked interest in using Vertisols in cattle feedlot rations. The review's ultimate goal was to assess the potential efficacy of bentonite/smectite clays as feed additives in beef feedlot rations. This review included a mini-survey on Zimbabwean feed companies use of clay based feed additives. Thematic analysis was used to pick relevant research from a broad pool of literature. Notably, none of the research examined the Chisumbanje Vertisol, but rather it's near relative, bentonite. The basis for the review was that bentonite studies could potentially forecast Chisumbanje Vertisol's potential as a feed additive. Zimbabwean livestock feed manufacturers are not using clay based feed additives. However, inclusion of clay in diets of cows results in a higher rumen pH, a scenario ideal for the rumen microflora. Smectite clay supplementation reduced rumen Ammonium-N concentrations three hours after feeding. Addition of 12 grams dolomite and bentonite per head/day to sheep feeds improved (p<0.05) total volatile fatty acids (TVFAs) in the rumen. Smectite clays can be used to improve rumen pH, reduce bloat, bind aflatoxins, and increase volatile fatty acid percentage. The researchers suggest characterising Chisumbanje Vertisols as binders and rumen buffers.

Keywords: bentonite, rumen pH, total volatile fatty acids, aflatoxins

46. The impacts of climate change and variability on inland freshwater fisheries sector of Zimbabwe.

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Abstract

The effects of climate change are expected to be widespread across ecosystems, placing a greater strain on all forms of livelihoods, including those in the fisheries sector. The fisheries sector is widely recognised for its significant contribution to poverty alleviation, promoting socio-economic growth, enhancing food security and improving the livelihoods of marginalised communities. The sector is experiencing a plethora of anthropogenic stressors such as overfishing, pollution, illegal fishing, land-use rainfall variability, habitat loss and the increasing occurrence and intensity of extreme weather events which affect the fish's physiological and biological process, consequently affecting fishery-dependent people. This study assessed fisher's perceptions of climate change, its impacts on fishery resources and livelihoods, and their adaptation strategies in fishing communities found on the shores of Lake Kariba. A mixed method approach was used to collect data from 120 fishers and data were subjected to descriptive statistics and thematic analysis. Findings indicate that most 83.8% of the fishers believe that temperatures have increased and 76.3% state that rainfall has decreased over the past 10 years and the perceived changes of the climatic variables have led to a decline in fish productivity and fish catches. To cope with declining fish stocks and catches, fishers have adopted several adaptation strategies including, changing fishing gear, targeting new fish species, and increasing fishing efforts. The study findings help to set a path towards local-specific climate change adaptation strategies for small-scale fishers. This study provided relevant information for policymakers and fisheries stewards to formulate appropriate policies and programmes aimed at enhancing fisher's adaptation to climate change and promoting sustainable fisheries

Keywords: Fisher's perceptions of climate change

47. Improving irrigation scheduling in smallholder irrigation systems through adoption of moisture sensor technologies: A case study of Musikavanhu and Rupangwana Smallholder Irrigation Schemes in Zimbabwe

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Abstract

In Southern Africa agriculture is the backbone of most economies and irrigated agriculture is key in terms of enhancing food security especially in marginal areas. Food security can be achieved by either increasing more area under irrigation or by increasing productivity whilst using similar or even reduced water resources. In Zimbabwe the predominant irrigation practices are pumped systems that require energy. Therefore, efficient use of water and energy nexus in irrigated agriculture is paramount for optimal crop production. The study investigated the efficacy of the "*colour coded*" soil moisture sensor technology (the "chameleon") in smallholder irrigation systems at Musikavanhu and Rupangwana Irrigation schemes in Chipinge and Chiredzi Districts, Zimbabwe. Soil moisture content (at soil profile 20 cm, 40 cm and 60 cm) was measured gravimetrically, and soil moisture tension measured by the tensiometer and the "chameleon". The efficacy of the "chameleon", was compared to other technologies (gravimetric and tensiometer), for the purpose of predicting irrigation application (irrigation scheduling). "Chameleon" soil moisture sensor readings were compared with tensiometer readings and soil moisture content at same (20, 40 and 60 cm) depths. Results were comparable and there was a similar trend. Strong negative correlations (r^2) of 0.7, 0.9, and 0.7 at 20 cm; 0.8, 0.9 and 0.9 at 40 cm, 0.98, 0.99 and 0.76 at 60 cm were observed against the readings of the "chameleon" and soil moisture content. The tensiometer and "chameleon" relationship showed a similar pattern to soil moisture before and after an irrigation event. The study enhanced insights on the use of smart irrigation technologies such as the "chameleon" on efficient water accounting in smallholder irrigation systems.

Key words: *colour coded, proxy, soil moisture sensor, tension*

48. The governance-institutional nexus in water management for climate change adaptation in smallholder irrigation schemes in Zimbabwe.

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Abstract

Smallholder irrigation schemes (SISs) are crucial for improving food and income security in rural communities in a changing climate. However, despite huge investments and substantial development, most of the SISs in southern Africa, especially in Zimbabwe have been performing below expectations. The performance of the SISs is affected by numerous intricately linked variables. Nonetheless, accurate information on factors affecting the schemes is lacking in Zimbabwe. This study seeks to assess and compare vulnerability to climate change in the Exchange, Insukamini, and Ruchanyu SISs in the Midlands Province of Zimbabwe using the Livelihood Vulnerability Index (LVI) within the Intergovernmental Panel on Climate Change (LVI-IPCC) vulnerability framework. A questionnaire was used to collect data from a sample of 317 randomly selected households in the three schemes. Data was analyzed using the LVI-IPCC model developed by Hahn. The findings of this study show that farmers in the three SISs are vulnerable to climate change and variability. Perceived high exposure and sensitivity to climate change was observed in Insukamini irrigation scheme despite high adaptive capacity. Thus, policy interventions should prioritize strengthening social networks, improving water security, and strengthening weather early warning systems to address vulnerability to climate change in SISs.

Keywords: exposure; adaptive capacity; sensitivity; livelihood vulnerability index; adaptation.

49. An overview of collaboration between CIMMYT and DR&SS

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Abstract

The International Maize and Wheat Improvement Center (CIMMYT) and the Department of Research and Specialist Services (DR&SS) have a long history of successful collaboration in developing and disseminating tools and technologies to sustainably improve the productivity of Zimbabwean maize farmers. Key historical examples include the Soil Fertility Consortium for Southern Africa (SOFECSA) which was established in 2005 between the University of Zimbabwe, DR&SS, CIMMYT and partners. The aim of SOFESCA was to develop and promote technical and institutional innovations that enhance contributions of integrated soil fertility management (ISFM) research and development to sustainable food security and livelihood options in Southern Africa. Protocols for managed abiotic stress screening, which are used worldwide to develop improved varieties for stress prone environments, were developed by scientists from both institutes. Recent collaborations including improving the efficiency of maize breeding pipelines, development and commercialization of provitamin A maize, rapid responses to emerging threats (including maize lethal necrosis and fall army worm) and diversifying maize production.

HIGHLIGHTS FROM SPEECHES

MESSAGE FROM THE PERMANENT SECRETARY OF THE MINISTRY OF LANDS, AGRICULTURE, FISHERIES, WATER AND RURAL DEVELOPMENT.

THE Government of Zimbabwe is committed to improving research and development (R&D), which is a key enabler in driving the country's industrialisation and development agenda, Ministry of Lands, Agriculture, Fisheries, Water and Rural Development Permanent Secretary Dr John Basera said.

Economic transformation and industrialisation being championed by the Government through the National Development Strategy1 provides meaningful investment in research and development. The Government has allocated $16 billion out of $363 billion towards research and development and innovation in the ministry for 2023.

Speaking during the inaugural Research and Extension Symposium, Dr Basera said Vision 2030 accelerator can be achieved when all the necessary conditions for successful agricultural research are in place.

Dr John Basera. Permanent Secretary in the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development

He said research results should closely mirror what subsists when the technologies are adopted on farms, or at any value chain point. Now more than ever, the new growth node should come from closing the gap between research yields and actual farmer yields. A robust and seamless Agricultural Research and Extension nexus is of paramount importance to close this gap.

Our traditional grains productivity levels are around 0.5 tonnes per hectare and like I always say, the research yield are telling a different story. The researchers are talking about 5 tonnes per hectare which fundamentally means that the country is tapping only 10% of the genetic gains of the massive and concerted investment in terms of research, so we need to close the gap," said Dr Basera. He said success in closing the yield gap will not be an easy achievement but there was need to begin the process.

"Colleagues, the agricultural research-extension nexus is a catalyst for agricultural transformation, industrialisation and development. As such, the role of extension is crucial for the users to derive maximum benefits from research," he said.

He said reports on performance of the various sub-sectors are testament of the direction the sector is taking and research-extension offers huge opportunities on how to do things differently and amplify current successes.

"Our agricultural economy grew by 36% and we are now self-sufficient in terms of food security. Wheat production has increased to 375 000 tonnes— a record wheat production since 1966. Productivity levels in maize and milk has also increased," he said. "Research will present us with a chance to consolidate and expand on these successes, more so, if our research and extension efforts are collaboratively and seamlessly linked and coordinated."

This Research and Extension Symposium provides a platform for all stakeholders to converge for purposes of sharing research results. It also provides a feedback platform on adoption of new technologies and challenges faced by farmers. This symposium also provided a critical perspective on improving the country's agricultural and food systems transformation.

Zimbabwe's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. To do so, a productive, competitive, diversified, and sustainable agricultural sector will need to emerge at an accelerated pace.

OVERVIEW AND GEOGRAPHICAL REPRESENTATION OF THE AGRICULTURAL RESEARCH, INNOVATION AND DEVELOPMENT DIRECTORATE: CHIEF DIRECTOR, DR DUMISANI KUTYWAYO

Dr D. Kutywayo Chief Director for Agricultural Research, Innovation and Development Directorate

The Vision of the Directorate is to be the leading agricultural research, innovation and development institution in Zimbabwe by 2030. With a mission of providing research-based technologies, knowledge and information for a transformed and viable agricultural sector.

The Directorate is made up of Five Sub programmes (Crop Research, Biodiversity and Variety Development, Livestock and Pastures Research, Regulatory Compliance and Quality Assurance, Analytical and Advisory Services, Migratory Pest Control and Surveillance) and is present all over the country as shown below.

Distribution of DR&SS stations across the country

"HE WHO DOES NOT RESEARCH HAS NOTHING TO TEACH"

AN OVERVIEW AND MANDATE OF THE AGRICULTURAL AND RURAL DEVELOPMENT ADVISORY SERVICES (ARDAS)

Prof O. Jiri. Chief Director for Agricultural Advisory Services

The vision of ARDAS is for clients to have access to pluralistic, demand-driven, decentralized and farmer-lead extension system. ARDAS exists to transform Zimbabwean agriculture from traditional subsistence to market-oriented systems in order to achieve food security, eliminate hunger and enhance agricultural and rural development. ARDAS(AGRITEX) at sub-provincial levels] is perhaps the most decentralized department of the ministry - with cadres at district and down to ward level. This ensures that no farmer and no place is left behind in the delivery of agricultural extension and advisory services.

Agricultural Extension and Advisory services play an important part of the agricultural innovation system, contributing to economic growth, poverty reduction and environmental well-being. Is an essential tool in dealing with serious agricultural challenges of climate change, high food prices and degradation of natural resources while simultaneously helping to increase productivity and reducing poverty. Extension and advisory services provide information on phyto-sanitary and epidemiological information and also market information including access to credit.

The strategic objective of Extension and Advisory services is to ensure that all actors in the agricultural value chain enjoy equitable and optimum access to knowledge & skills and have the capacity to explore opportunities for the advancement of their enterprises and livelihoods. This is achieved through 1.

Ensure effective linkages & exchange of information among research, education, and extension [the triangle of development] and producers, [Agricultural development is a function of Knowledge Generation [research], Capacity Generation [education and training] and Knowledge Dissemination [Extension and Advisory Services].

RCZ OVER-ARCHING ROLE IN RESEARCH

Dr N. Maseko. CEO for Research Council of Zimbabwe

The Research Council of Zimbabwe is a Statutory Body established in terms of the Research Act [Chapter 10:22] to promote, direct, supervise and co-ordinate research. It has control over research conducted in terms of any Act and lies under the Office of the President and Cabinet

Zimbabwe has a National Science, Technology and Innovation System which is a web of interconnected institutions involved in the organisation and steering of the production of scientific knowledge and the generation and uptake of innovations. RCZ sits between researchers, industry and government thus plays an important role in the research ecosystem in Zimbabwe.

Section 16 (2) states that RCZ exercises the powers and functions conferred upon it by or under this Act over research conducted by any person or body in terms of any Act. The Research Act establish the supremacy of the RCZ over all research activities which empowers the RCZ to develop contemporary requirements for administering the highly dynamic field of research. Establishing Research Councils and Institutes such as the MRCZ, Agricultural Research Council, SIRDC and NBA.

The mandate of the council is thus, to exercise the power of control conferred upon it by or under this Act over Research Councils and Institutes and make donations or grants and award fellowships or any other similar awards for specific research. RCZ coordinates research with individuals, organisations and institutes world over and ensures that people, animals, plants and the environment generally are protected from the effects of potentially harmful research or undertakings. Overall, the Research Council of Zimbabwe, tender advice to Government on the overall management of research programmes and the allocation of funds/resources for research as well as securing full use in the public interest of the results of research.

National Research Priority Areas of Research include Social Sciences and Humanities, Sustainable Environmental and Resource Management, Promoting and Maintaining Good Health and National Security of Zimbabwe. There are ongoing efforts by the Research council of Zimbabwe to create a national research database of Zimbabwe which will create collaboration opportunities within the research community, allowing the free flow of public domain research information in Zimbabwe and globally. Initiated in 2010, Import Export started in 2015 harvesting metadata only and is currently inked to seven institutions to date, has potential for foreign direct investment in the global competition context.

RCZ will be hosting a Zimbabwe International Research Symposia on the 13th of October 2023 which will celebrate research excellence and acknowledge hard work, dedication, and achievement by researchers. This symposium aims to stimulate/encourage use of research results for socio-economic transformation and also motivate young researchers to take up careers in research

RESEARCH AND EXTENSION: ANCHORING ZIMBABWE'S AGRO INDUSTRIAL INNOVATION SYSTEM

Prof M. Rukuni

Research and extension should be seamless and referred to more as Agro-Industrial Innovation System. Good technology, good innovation needs to be dynamic. Currently, research has many scientists and very few innovators.
Institutional innovation is as crucial as technological innovation.
The technological challenge can be summed up as follows: There is growing prerequisite to increase productivity while using: less land, less water, less chemicals, and producing less GHGs.

Researchers are reluctant revolutionaries who drive structural transformation ensuring transition within African food systems since urban population now defines food systems. The Agro-industrial political power base in shifting. 40 years ago when agriculture sneezed, the whole economy caught a cold. But with the new shift, food systems transformation is now the mother of light and heavy industries whilst rural development provides power over rural industrialization. Institutional innovation is what has now made the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development a powerhouse.

Rural development is essential for structural transformation and hinges on agriculture. Rural transformation does not happen in isolation, but as part of a broader process of structural transformation which is shaped by the interlinkages between agriculture, the rural non-farm economy, manufacturing and services. Inclusive rural transformation requires concerted effort as it will not happen automatically. Rural industrialization starts with proto-industry. The secret to fast industrialization is the rural middle class. However, Africa is the only continent with no HIC as all 55 MIC resulting in the Middle Income Trap. This due to dual economy, unorthodox structural transformation and rapid urbanisation with NO manufacturing. Rural middle income status is average $4 to $20 per day income, or $1,500 to $7,000 per annum. Once a rural resident attains $4/day, they start consuming more locally manufactured goods and services, more meat, fruits and vegetables. this is the secret to industrialisation and urbanisation with jobs which creates demand for domestic goods. Industry will happen everywhere including rural areas, small towns, growth points, in high density suburbs and peri-urban spaces.

What is agricultural innovation system? An **"INVENTION"** is a solution to a problem, largely the outputs of research whereas an **"INNOVATION"** is a social and economically successful invention, innovation systems involve collaborative arrangement and technological, managerial, organizational, institutional and service delivery. R&D does not end with producing new knowledge or technology. Success is only claimed when inventions are disseminated, adapted, adopted and used. Institutional Innovation and technological innovation both important strategies of agricultural innovation systems grounded in the integration of research, extension, education, training (innovation platforms) which connect farmers, producers, entrepreneurs, consumers and organise/massify production, aggregation, agro-logistics, proto-industries, mass-processing, distribution, consumption, There is thus a great need to strengthen the entire system to deliver the above taking into cognizance challenges and constraints of Agrarian food system transformation.

In conclusion Zimbabwe need not wish to be bread-basket of region again. Today every country including Malawi and Zambia can produce own grain surpluses. Hence Zimbabwe has to aspire to be supermarket to the region supplying top quality finished products. 29 value-chains are no longer sufficient for a diversified industrialized Zimbabwe - These have to be more than 100 by 2025 and 300 by 2030

KEYNOTE ADDRESS

Transition from R&D to research and innovation development – critical issues to be addressed

Paramu. L. Mafongoya, Busisiwe Vilakazi and Mungandani Raymond

Prof P.L Mafongoya. University of KwaZulu Natal, School of Agriculture, Earth and Environmental Sciences

Agriculture is backbone of many African economies, employing vast majority of the population and providing a means of subsistence and source of revenue for more than 60% of the population living in rural areas. Strengthening the sector through investment and policies is therefore critical for growth and development in the continent. African agricultural systems contend with two overarching issues of low food security and low productivity. Well compacting hunger remain an important concern in Africa that conducive policy environment for ensuring a proper balanced nutrition is required.

There are numerous national and regional policies and strategies to boost agricultural growth and development. These include: Promotion of research through increased investment; Technology and information dissemination; Capacity building of stakeholders through training and cooperation; Water control, management and sustainable use of natural resources; Better access to inputs (fertilizers, improved seeds, financial and technical services); Mechanization and modernization of the agricultural sector; Improved infrastructure (storage, conservation, rural and urban market linkages); Promoting agro-processing activities and adding value along the agricultural value chains; Broadening markets, increasing competitiveness and ensuring quality of agricultural products.

There are also PAN African initiatives meant to harmonize policies and scale up best practices e.g. CAADP, 203 Maputo declaration which focus on integrated agriculture for poverty reduction and increasing food security through agriculture science agenda for agriculture in Africa. There are also other initiatives in Africa which include Malabo declaration on accelerated agricultural growth and transformation for shared prosperity and improved livelihoods; Abuja declaration on fertilizer for African green revolution for scaling up nutrition movement.

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Agricultural development models are there to accelerate progress within the agricultural sector. Agricultural development can be characterized by 6 models that is: The Frontier model; Conservation model; Urban industrial impact model; Diffusion model; High-payoff input model; and Induced innovation model.

Food systems are currently responsible for 20 - 23% GHG emissions and also account for 70% of fresh water withdrawals and 70% biodiversity loss. 500 million farmers provide 80% of food consumed in developing countries. 1.3 billion tons of food produced is wasted along agricultural supply chain. There is need to minimise these losses. Transforming Food system is very important for sustainable development with the aim to feed 10 billion people by 2050 while meeting SDG by 2030 food system. Food systems should be sustainable, efficient, nutritious and healthy and they require substantial innovation and departure from the status quo.

SYMPOSIUM PROGRAMME

MINISTRY OF LANDS, AGRICULTURE, FISHERIES, WATER AND RURAL DEVELOPMENT

INAUGURAL RESEARCH AND EXTENSION SYMPOSIUM

HARARE EXHIBITION PARK, ROBBIE MUPAWOSE HALL & ANDY MILLAR HALL, ZAS, HARARE

1-2 MARCH 2023

THEME: **"TRANSFORMATIVE AGRICULTURAL TECHNOLOGIES TO ACHIEVE VISION 2030"**

Dress Code: Formal on Day 1, Smart Casual Day 2

TIMETABLE OF ACTIVITIES

DAY 1: WEDNESDAY, 1 MARCH 2023			
TIME	**ACTIVITY**	**RESOURCE PERSON**	**Session 1** Chair: E. Mtetwa
0830	Registration	Ms A. Chimupisi, Ms E.Jack	
0900	National Anthem	Protocol Team	
0905	Prayer	TBA	
0910	Welcome Remarks, DRSS Overview and Geographical Representation	Chief Director: Dr D. Kutywayo	
0925	Remarks, ARDAS Overview and Mandate	Chief Director: Prof O. Jiri	
0940	RCZ Over-arching Role in Research	CEO Dr N. Maseko	
0950	Research& Extension: Anchoring Zimbabwe's Agro-Industrial Innovation System	Prof M. Rukuni	
1005	Official Opening Speech: Guest of Honour, Permanent Secretary MLAFWRD	PS Dr J. Basera	
1030-1100	**H E A L T H B R E A K**		
PLENARY SESSION			
Session Chair/Moderator: Dr I. Mharapara			
1100	**KEYNOTE PAPER** Prof P.L. Mafongoya, University of KwaZulu Natal, School of Agriculture, Earth and Environmental Sciences. "Transition from R&D to Research and Innovation Development - Critical issues to be addressed".		
1130	**Plenary Speaker 1:** Anthony Mapaura- Genetic Resource Conservation and Taxonomy Climate Change and predicted changes in distribution of invasive *Nassella* species in Southern Africa		
1145	**Plenary Speaker 2** : Armwell Shumba, Soil fertility management Long-term tillage, residue management and crop rotation impacts on N_2O and CH_4 emissions from two contrasting soils in sub-humid Zimbabwe		
1200	**Plenary Speaker 3**: B.P Karigeni, E.S .Zimunga, T. Pfupa, R. Dube- Plant pests and diseases surveillance and management Use of computer vision and remote sensing in detecting armyworm		
1215	**Plenary Speaker 4** :Dr S. Sibanda –Animal health, breeding and productivity The prevalence and epidemiological features of infection with *Aphanomyces invadans*/epizootic ulcerative syndrome (eus) in finfish, on dams and rivers on the Zimbabwean side of the Kavango-Zambezi (kaza) tfca and the great Limpopo Trans-Frontier drainage: implications on human livelihoods and the environment.		
1230	**DISCUSSION**		
1300	**L U N C H**		
	Break Away Day 1/ 1:1 - Andy Millar **Thematic area/s- Animal Health, Breeding and Productivity** **Session Chair/Moderator- Dr Makaya**		**Break Away Day1/ 2:1 – Robbie Mupawose** **Thematic Area/s- Farming Systems, Extension and Feedback Mechanisms, Plant pests and disease surveillance and management** **Session Chair/ Moderator- Dr X. Mhike (Cimmyt)**
Presentations of Selected Research and Extension Papers			
1400-1415	Presenter/s : Tsikire David Optimising targets for Tsetse : Taking a fly's eye view to improve the colour of synthetic fabrics.	1400-1415	Presenter/s: S. Nyamutukwa The first evidence of *Quelea* economic damage on maize, its breeding and roosting sites: Implications for management in Zimbabwe
1415-1430	Presenter/s: Nyakupinda Learnmore	1415-1430	Presenter/s: Juliet Gwenzi, Paramu, L, Mafongoya B and Emmanuel Mashonjowaa Improving extension methods through agrometeorological advisories using the

	An atlas of Tsetse and animal African *Trypanosomiasis* in Zimbabwe.		Climate Field School concept: A case of Uzumba Maramba Pfungwe District, Zimbabwe.
1430-1445	Presenter/s: C. Zvavahera : Fisheries and Acquaculture Resources Modification of the *Oreochromis* spp. Aquaculture production environment using greenhouses	1430-1445	Presenter/s: B. Neurashe, A. Muzira, M. Chiduwa Evaluation of the effects of crop variety and fertilizer rates performance of cereals under Pfumvudza through on-farm Triadic Comparison of Technologies (Tricot)
1445-1500	Presenter/s: Makumbe Milton Potential of fisheries and aquaculture resources on rural livelihoods and food Security in Zimbabwe.	1445-1500	Presenter/s: S. Nyamasoka Effectiveness of different management strategies On Fall armyworm (*Spodoptera frugiperda*) in white and yellow maize in Zimbabwe.
1500-1515	**DISCUSSION**		
1515-1530	**H E A L T H B R E A K**		

Presentations of Selected Research and Extension Papers			
Break Away Day 1: 1:2 - Andy Millar **Thematic area/s- Animal Health, breeding and Productivity** **Session Chair/Moderator- Dr Makaya**		**Break Away 1/ 2:2 – Robbie Mupawose** **Thematic Area/s- Soil fertility management/ Crop breeding, Agronomy and seed systems** **Session Chair/ Moderator- Dr. X. Mhike (Cimmyt)**	
1530-1545	Presenter/s: Dr T Kadungure Research Knowledge and Perceptions of abattoir operators and meat handlers about hygiene and food safety	1530-1545	Presenter/s: T. Gwandu., L. Blake, H. Nezomba, J. Rurinda, S. Chivasa, F. Mtambanengwe, P. Mapfumo and K. Johnson Water treatment residual for rebuilding soil health in urban agroecosystems in Zimbabwe
1545-1600	Presenter/s: Dr S. Swiswa Establishment, Importance and Implementation of NAREC in the Regulation of Research in Animal Health and Production	1545-1600	Presenter/s: Mafaune Grace, Matuvhunye Shepherd T, Chikwari Emmanuel & Chiduwa Mazvita Multistrain inoculant for improved cowpea response to rhizobia inoculation under variable soil and rainfall conditions of Zimbabwe
1600-1615	Presenter/s: Dr E.Waniwa Acaricide resistance and dip concentration monitoring as part of integrated tick and tick-borne disease Control Strategy implementation	1600-1615	Presenter/s: S. Nyagura, Dr C. Mujaju, Dr M. Zikhali and Dr P. Manjeru Molecular characterization of Soya bean varieties grown in Zimbabwe using Single Nucleotide Polymorphism (SNP).
1615-1630	**DISCUSSION**	1615-1630	**DISCUSSION**
END OF DAY 1			

DAY 2: THURSDAY, 2 MARCH 2023			
Presentations of Selected Research and Extension Papers Continuation			
Break Away Day 2/ 1:1 - Andy Millar Hall **Thematic area/s- Animal Health, breeding and Productivity** **Session Chair/Moderator- Mr K. Nhongo (WHH ZAKIS)**		**Break Away Day 2/ 2:1– Robbie Mupawose hall** **Thematic Area/s-Genetic Resources conservation and Taxonomy / Plant pests and disease surveillance and management** **Session Chair/ Moderator- Prof E. Gasura (UZ)**	
0830-0845	Presenter/s: Dr Hodobo Resuscitation of BOLVAC *Theileria* Vaccine Production, Laboratory and Field Trails	0830-0845	Presenter/s: Presenter/s: K. B. Mutasa and A. Mapaura Predicting the spatial extent of the potentially invasive species Giant Milkweed (*Calotropis Procera* L. Aiton) in Zimbabwe
0845-0900	Presenter/s: Dr T.Gadaga Rolling out of the National Artificial insemination Program for Cattle Genetic Improvement	0845-0900	Presenter/s: D. Seka, C. Karavina, O. Chipfunde, C. Machokoto, T. Rungwe Effects of seed storage period on the viability of Genebank conserved Fingermillet (*Eleusine coracana* (L.) Gaertn) accessions

0900-0915	Presenter/s: Dr M. Jubenkanda Communication medium in Theileriosis control: the factors that determine disease knowledge among smallholder farmers in Zimbabwe	0900-0915	Presenter/s: Mudada N., Banana J, Tauya C, Sengwe T., Nyaruwata K.P., Runyanga T.J. Louisa D.M. Makumbe. Zimbabwe is free from Maize Chlorotic Mottle Virus (MCMV): The chief virus for maize lethal necrosis.
0915-0930	Presenter/s: Mpofu M, R.Ndlovu , G. Sisito, T. Rukuni, M. Mare Effect of mealworm larva (Tenebrio molitor) meal in pre-starter diets on broiler performance and carcass yield	0915-0930	Presenters: Louisa D.M. Makumbe, Tinashe J Runyanga, Clemence Tauya, Mudada Nhamo, Wayne Kirkman Surveillance for the early detection and early warning of the *Candidatus Liberibacter asiaticus* and its vector, *Diaphorina citri* in Zimbabwe.
0930-0945	Presenter/s: Daga O, Sisito. G, Musasira M. Ndlovu .N and Matshazi The potential of Marula tree fruit pulp and skin as a palatability/flavour enhancer to improve intake of late cut hay fed indigenous goats.	0930-0945	Presenter/s: Chikwari A. and Chachoka S. Management and suppression of tomato late blight disease (*Phytophthora infestans*) using plant extracts in Zimbabwe
0945-1000	**QUESTION AND ANSWER**	0945-1000	**QUESTION AND ANSWER**
1000	H E A L T H B R E A K		
Break Away Day 2/ 1:2 - Andy Millar **Thematic area/s- Animal Health, breeding and Productivity** **Session Chair/Moderator- Dr X. Poshiwa (GZU)**		**Break Away : Day 2/ 2:2 – Robbie Mupawose** **Thematic Area/s- Crop breeding, Agronomy and Seed systems** **Session Chair/ Moderator- Dr G. Mabuyaye (SeedCo)**	
1030-1045	Presenter/s: Primrose Nkomboni Impacts of land-use changes on livelihood and ecological dynamics in Matobo District, Zimbabwe.	1030-1045	Presenter/s: Jackson Nyamupfukudza, Tendai Madanzi , Ronald Mandumbu & Olivia Mukondwa Effects of different rates of Colophospermum Mopane mulch on the emergence, days to 50% emergence and growth of sorghum.
1045-1100	Presenter/s: Rukuni, T, Mbanga J ,Sisito, G Isolation and identification of lactic acid bacteria for goat milk yoghurt starter culture development.	1045-1100	Presenter/s: Winnie Ndebele Effects of different organic manures on sprouting of cassava cuttings
1100-1115	Presenter/s: T. Shumba, J. Mukwena, P. Makiwa1, J. Madzimure, and B. Foto Effects of partially substituting Soya bean meal with Cowpea in Broiler rations on broiler performance	1100-1115	Presenter/s: M. Mare, B. Chapepa and W. Mubvekeri Evaluating the performance of Advanced Medium Staple *Gossypium Hirsutum* L. Genotyp2es under Diverse Agro-Ecological Conditions of Zimbabwe
1115-1130	Presenter/s: G. M. Hore, M. T. Makumbe, M. Dumba and H. B. Munyaradzi Developing Dairy Climate Smart Business Model by Calculating the Carbon Footprint of Dairy Farms in Zimbabwe	1115-1130	Presenter/s: Jonathan Hodzi Evaluation of the effect of Trichoderma on common bean (*Phaseolus vulgaris*) productivity
1130-1145	Presenter/s: C. Gwatirisa, T. Bonyongwe, A. Chamisa and G. Fatini Development of manually operated scissors small ruminants feed block-making machine	1130-1145	Presenter/s: R. Mukaro, M. Sithole , B.O. Mavankeni, Victor Chingwara Variation in grain yield, protein and oil content among Soybean genotypes and their relationship to other agronomic traits.
1145-1200	Presenter/s: S. Machenesa, C. Gwatirisa Production and performance of mealworm (Tenebrio molitor) fed on sorghum in Matabeleland South, Zimbabwe	1145-1200	Presenter/s: F. Jimu and W. Mubvekeri Efficacy of Emamectin Benzoate + Acetamiprid 112 EC on Lepidopteran pests of cotton in Zimbabwe.
1200-1215	Presenter/s: Mukondwa O, Dube M and Mashinya R, Rukuni T, Sisito G and Nyamupfukudza Multi-locational evaluation of Sorghum for grain and fodder yield: A step towards dual purpose varieties	1200-1215	Presenter/s: Chipere K; Muhera S, Msamala D Pesticide Knowledge, Attitude and Practices by farmers in Zimbabwe
1215-1230	Presenter/s: Maredza Tafadzwa, Chigede Ngavaite, Manyanga Amosi Misi, Hungwe Tinoziva, Muvhuringi Prosper Bright Chisumbanje Vertisols Potential as a Feed Additive in Beef Feedlot Rations: A Systematic Review.	1215-1230	Presenter/s: Memory Pilime , Busiso Olga Mavankeni and Victor Chingwara Preliminary evaluation of iron and zinc rich Irish potato (*Solanum tuberosum*) genotypes in Zimbabwe

1230-1245	Presenter/s: R. T. Muringai and P. Mafongoya The impacts of climate change and variability on inland freshwater fisheries sector of Zimbabwe.	1230-1245	Presenter/s: Nomusa Chizhande, Busiso Olga Mavankeni and V. Chingwara Evaluation of Promising Upland rice varieties for adaptability and stability in different Agro ecological zones of Zimbabwe
1245-1300	**QUESTION AND ANSWER**	1245-1300	**QUESTION AND ANSWER**
1300	**L U N C H**		
	Break Away Day 2: 1:3 - Andy Millar Thematic area/s- Soil fertility management / Irrigation development and water resource management Session Chair/Moderator – Eng B. Chitsungo		Break Away: Day 2/ 2:3 – Robbie Mupawose Thematic Area/s- Crop breeding, Agronomy and Seed systems Session Chair/ Moderator- Dr C. Mujaju
1400-1415	Presenter/s: Mukungurutse C.S., Chikwari E, Mhaka L., Manyanga M.A Effect of different watering regimes on nitrogen use efficiency, yield and water productivity of drip irrigated cabbages (*Brassica oleracea*)	1400-1415	Presenter/s: N. Mutasa Determination of the critical weeding period in soybean (*Glycine max*)
1415-1430	Presenter/s: Evelyn Tatire, Hodson Makurira, Krasposy K. Kujinga , Regis Chiwaya Improving irrigation scheduling in smallholder irrigation systems through adoption of moisture sensor technologies: A case study of Musikavanhu and Rupangwana smallholder irrigation schemes in Zimbabwe	1415-1430	Presenter/s: Sakadzo Nyasha, Makaza Kasirayi and Manashe Shingai Potency of Bitter apple fruit (*Solanum incanum* L.) and contact time against fall armyworm on maize foliage diet
1430-1445	Presenter/s: Mwadzingeni L, Mugandani R and Mafongoya P.L The governance-institutional nexus in water management for climate change adaptation in smallholder irrigation schemes in Zimbabwe.	1430-1445	Presenter/s: Presenter/s: Nyasha Sakadzo, Rabson Chadenganga, and Andrew Tapiwa Kugedera Management strategies and constraints of smallholder farmers in response to incursion by fall armyworm (FAW) (*Spodoptera frugiperda* JE Smith). A Case of Summerton Resettlement Area
1445-1500	Presenter: Freeman Gutsa Socio-economic considerations in setting Research Priorities	1445-1500	Presenter/s: Barbra Chisikaurayi, Cosmos Magorokosho, Casper Nyaradzai Kamutando, Mafongoya P.L Genetic analysis of maize streak virus disease resistance on tropical maize.
1500-1515	**QUESTION AND ANSWERS**	1500-1515	**QUESTIONS AND ANSWERS**
1515-1530	**H E A L T H B R E A K**		
Closing Ceremony (Joint Sitting): Robbie Mupawose Hall **Session Chair: Dr I. Mharapara**			
1530-1600	PRESENTATION OF PRIZES		Adjudicators/Sponsors/Directors
1600-1625	CLOSING REMARKS		Chief Director, Dr. D Kutywayo
1625-1700	**NETWORKING AND DEPARTURE**		

"Transformative Agricultural Technologies to Achieve Vision 2030"

Delegates listening attentively during the 2023 Inaugural Agriculture Research and Extension Symposium

From left, Dr J Basera, Dr D Kutywayo and Prof Rukuni during the 2023 Inaugural Agriculture Research and Extension Symposium