

AGRICULTURE IN SUSTAINABLE DEVELOPMENT

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The Sustainable Development Goals are a set of 17 interconnected global goals that, by 2030, aim to eradicate poverty, safeguard the environment, and ensure that everyone lives in peace and prosperity. They were formulated by the United Nations General Assembly as part of the Post-2015 Development Agenda. Like Elkington's accounting framework called the "Triple Bottom Line", whose performance dimensions are referred to as the three Ps: people, planet and profits, they place special emphasis on the interdependence of environmental, social, and economic factors.

Most of SDGs such as no poverty (#1), zero hunger (#2), high-quality education (#4), gender equality (#5), climate action (#13), and life on the land (#15), have directly or indirect effects on agriculture. Consequently, more than 50% of the SDGs have some connection to agriculture, proving its significance and the fact that several SDGs cannot be achieved without a successful and sustainable agricultural sector. Due to the continuous increase in world population, agriculture will continue to play a crucial role in the achievement of the SDGs.

This lecture will demonstrate how agriculture is contributing to the SDGs to ensure that most of its goals are achieved through collaboration, student supervision and research publications.

NO POVERTY: SDG 1

Even though South Africa is often seen as having a potential emerging economy in the African continent, poverty is still rife as this country has the highest inequality in income distribution with approximately 80% of the country's total wealth owned by 10% while the remaining 20% is in the hands of 90% of the population. Most of the rural residents are severely poor, approximately three-quarters of them rely on agriculture for their livelihoods and food security. Fighting poverty is far from ending for women who earn on average 30% less than

their male workers according to StatSA 2020, kids living in rural areas, and people with little to no formal education. Agriculture is essential to reducing poverty, even though the fight against it has made only little progress. The research publications are how my collaborators and I have contributed to SDG 1.

ARTICLES

a. **The potential of replacing soyabean oil cake with macadamia oil cake in broiler diets.** Published in the Tropical Animal Health and Production Journal in 2016.

A study was conducted to evaluate the potential of macadamia oil cake (MOC) as a replacement of soyabean oil cake (SOC) in Ross broiler diets.

Findings: The threshold of 25 % MOC can replace soybean oil cake meal in the diets of broiler provided that this alternative feed ingredient is readily available at an affordable cost.

b. **Indigenous knowledge and food security in harvesting of *Adansonia digitata* (baobab tree) products in the South-east Lowveld of Zimbabwe.** Published in Indilinga – African Journal of Indigenous Knowledge Systems

This article sought to unravel the application of indigenous knowledge for food security thereof attained by the harvesting of baobab tree products by households in the study area.

Findings: Consumption of baobab tree products was done by 96% of the households while 86% use the baobab tree for medicinal purposes. Also, indigenous knowledge forms the basis in the baobab products harvesting.

c. **Household perceptions on commercial cultivation of baobab tree (*Adansonia digitata*) in the South-east Lowveld of Zimbabwe.** Journal of Consumer Sciences in 2021

The need to investigate household perspectives arisen due to poor baobab tree regeneration

Findings: The study recommended that the communities should be trained on the application of modern technologies to shorten the maturity period of the trees through propagation.

ZERO HUNGER: SDG 2

To put an end to hunger, establish food security, and guarantee that everyone has access to nutritious food. This SDG also aims to ensure advanced sustainable food production systems through resilient agricultural practices, that is, increase productivity while maintaining the implementation of healthy environmental practices. According to this SDG, some countries like Central and East Asia, Latin America and the Caribbean have witnessed a significant decrease in undernourishment in the past two decades due to economic growth that is attributed mostly to increased agricultural productivity. In South Africa, however, the FAOSTATS (2021) revealed an increase in the prevalence of undernourishment from 3.3% in 2008/2010 to 6.5% in 2018/2020 year, this is a concerning factor. The production increase in the previously mentioned countries was mostly achieved in the small-scale farming sector, that is, in rural areas where extreme poverty is rife. Also, unlike other African countries where almost 80% of agricultural contribution to GDP is from the small-scale farming sector, in South African, this sector contributes less than 20%. Having said so, I also fully comprehend the difficulties the small-scale farming sector in this country faces, such as land and emigration to industrial cities, but as agricultural scientists in South Africa, we also need to devise ways to maximize the potential of this sector to ensure that there is no hunger, especially for those who are still in rural areas, or perhaps to also reduce urbanization.

We can support the entire world's population and ensure that no one goes hungry ever again by supporting sustainable agriculture, especially with modern technologies and equitable distribution of resources. Agriculture may reduce hunger by generating jobs and relying on sustainable food production, biodiversity, and a variety of stakeholders. This gives people a chance to feed their families and live a decent life. Due to unequal access to resources, hunger is the largest cause of death worldwide, and it is rising rather than decreasing globally.

PUBLICATIONS

Effects of different dietary inclusion levels of macadamia oil cake on growth performance and carcass characteristics in South African mutton merino lambs

Published in Tropical Animal Health and Production published in 2016

Growth performance and carcass characteristics of South African mutton merino fed graded levels of macadamia oil cake were assessed

Findings: 5% of Macadamia oil cake provided the best results in terms of carcass characteristic in sheep.

Dietary Crude Fiber Levels for Optimal Productivity of Male Ross 308 Broiler and Venda Chickens Aged 1 to 42 Days

Animal-MDPI in 2022

The study determined the effects of dietary crude fiber (CF) levels on the production performance of male Ross 308 broiler and indigenous Venda chickens.

Findings: The indigenous Venda chickens performed better with higher dietary CF than the Ross 308 broiler chickens.

Effects of dietary fibre level on rumen pH, total microbial count and methanogenic archaea in Bonsmara and Nguni steers

South African Journal of Animal Science 2021,

A study was conducted to evaluate the effect of the level of dietary fibre on rumen pH, total microbial count and methanogenic archaeacount of Bonsmara (225 ± 10.0 kg live weight) and Nguni (215 ± 10.0 kg live weight) steers

Findings: A low-fibre diet can be applied as a viable strategy to enhance rumen total microbial count in exotic beef breeds and crossbred cattle such as Bonsmara. Nguni steers fed a high NDF diet had higher rumen total microbial count than Nguni steers fed a low-fibre diet. The high NDF diet can be used efficiently by feeding it to indigenous breeds and purebred cattle such as Nguni.

GOOD HEALTH AND WELL-BEING: SDG 3

One of the main determinants of health is food security, defined by The World Food Programme as “access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life”.

Food security, therefore, implies that the food, whether homegrown or imported must be available in sufficient quantities, people need to have access to adequate quantities whether through purchase or home production, and food needs to have a positive nutritional impact on people by providing the essential nutrients such as protein, energy, vitamins, micro and

macro-minerals that are required for human health. Food gives the stimulus necessary to study and think resulting in better futures. A major contributor to illness prevention and health improvement is a nutritious food. The famous quote by Hippocrates, the ancient Greek physician “let food be thy medicine, thy medicine shall be thy food” strongly supports the major contribution of food to human health. Who then can better provide that nutritious food than agriculture?

The use of agricultural and livestock practices that are supported by the results of research and reasonable consumption, as well as, better redistribution of the resources are encouraged. SDG 3 stating GOOD HEALTH AND WELL BEING goes beyond human health. How can human health be achieved if the environment where plants are consumed by humans and animals is not healthy? And taking into consideration that some of the animals are consumed by humans. Hence, ONE HEALTH is essential for the environment, plants, animals, and people.

PUBLICATIONS

The effects of graded levels of dietary tannin on the epithelial tissue of the gastro-intestinal tract and liver and kidney masses of Boer goats. Published in. *Animal Science* © 2002 British Society of Animal Science

This study was conducted to determine the effects of different levels of dietary tannin on gastrointestinal tract (GIT) histology and on liver and kidney masses

Findings: Increased dietary tannin levels induced thickening of epithelial tissue in the reticulum, rumen, omasum and abomasum and a loss of epithelial cells, erosion of microvilli and shortened villi height in the duodenum, which could impair the absorption of nutrients. Consequently, condensed tannins had negative effects on the histopathology of the Boer goats.

Preliminary evaluation of selected minerals in liver samples from springbok (*Antidorcas marsupialis*) from the National Zoological Gardens of South Africa. Published in *Journal of the South African Veterinary Association* in 2012

The study investigated the presence of myopathy in antelope at the National Zoological Gardens of South Africa (NZG), stored liver samples from six springbok (*Antidorcas marsupialis*) and seven other antelopes, as well as selected food items, were analysed for selenium, copper, manganese and zinc content by spectrophotometry.

Findings: The study highlighted the need to establish baseline mineral nutrition data for captive and free-ranging antelope under South African conditions.

Immune and Growth Response of Indigenous Pedi Goats Vaccinated with Blanthrax to an Inclusion of *Moringa oleifera* (Drumstick Tree) in *Cenchrus ciliaris* (Buffel Grass) Hay-Based Diet Published in Advances in Animal and Veterinary Sciences in 2022

The study ascertained the immunomodulatory effects of *Moringa oleifera* leaves supplemented to the diets of wether BaPedi goats following vaccination with blanthrax vaccine.

Findings: Results of the present study suggest that *M. oleifera* leaves can be used as a feed supplement at 20% and 50% inclusion levels without having any adverse effects on blood parameters and growth performance.

DECENT WORK AND ECONOMIC GROWTH: SDG 8

To promote inclusive and sustainable economic growth, employment and decent work for all

The greatest industry in the world by far is agriculture, particularly in developing countries where it accounts for a sizable portion of GDP. According to StatSA, agricultural products in South Africa contributed 2.47 % to the country's GDP in the 2021 financial year, a significant increase from the 2% contribution between 2015 to 2019 years. As an Animal Scientist, I have to mention that animal products had the highest gross value, contributing approximately 48% to the country's gross agricultural produce. Nonetheless, most of workers—especially young people—hold dangerous and low-paid positions in rural areas, which frequently drives them to migrate to urban areas with oversaturated labor markets. As a result, there is a call for better working conditions and labour standards, especially for farm workers. Because most of us eat at least once or more per day, food and agriculture can and will contribute to the solution of the employment problem and better livelihoods. This is thanks to the efforts of various agricultural stakeholders, including farm workers, students studying various agricultural fields, agricultural scientists, and many others. The majority of agricultural-related jobs are categorized as scarce skills in South Africa.

CLIMATE ACTION: SDG 13

To combat climate change and its detrimental effects

The lives of people and the biodiversity of our world are negatively impacted by climate change. Agriculture is very sensitive to climate change and as a result it (climate change) will continue to have an impact on the availability of food by decreasing the productivity of plants, animals, and crops, which will impede access to food by threatening attempts to feed a growing global population and their livelihoods. In nations and regions that are already highly food insecure, the changing climate will seriously threaten food production if nothing is done. South Africa is considered not immune to the impacts of climate change as it (climate change) was seen as the critical element in explaining the 2015 drought that resulted in damage to crops and livestock deaths. President Ramaphosa, in his speech during his visit to the flooded areas of eThekweni metropolitan area in April 2022 also stated that the disaster was part of telling us that climate change is serious and we therefore no longer need to postpone but to take measures to deal with climate change. Furthermore, in the 27th Conference of the Parties (COP 27) in November 2022, the President reaffirmed the need for strategies to reduce greenhouse gas emissions to keep the rise in global warming temperatures to not more than the 1.5° C target agreed upon in COP 26.

Thus, improving grazing practices on rangeland and lowering ruminant greenhouse gas emissions should be done through climate-smart agriculture. With climate-smart agriculture and research-based projects to promote sustainable lives, agriculture may significantly contribute to the mitigation of climate change. Although it is known that ruminant production could become one of the casualties of climate change, practicing climate-smart agriculture can help, e. g. improving production as this will lower the amount of greenhouse gas produced per product. This indicates that by lowering greenhouse production you are also improving food availability.

Others are promoting switching to a plant-based diet since livestock is a significant contributor to climate change, accounting for about 14.5% of all greenhouse gas (GHG) emissions worldwide. Some people have already said, "I won't survive without eating meat," in the phrase *Mina nenyama angeke sihlukane*. Moderate meat consumption is not a severe issue, but excessive consumption can cause rich man's disease commonly known as (GOUT). Some of us are descended from the hunter-gatherer civilization, which was based on gathering food by hunting and gathering, but also caring for the environment and conserving both plants and animals so that we still have them now. Animal Science is here to improve

animal production while controlling its negative impacts and promoting sustainable agriculture. Researchers studying ruminants are working to develop ways to lower greenhouse gas emissions globally.

PUBLICATIONS

Impacts of graded dietary fiber levels on feed efficiency and carbon footprint of two beef breeds Published in Livestock Science in 2022

An experiment was conducted to evaluate the impacts of graded dietary fiber levels on feed efficiency and carbon footprint in 9 Bonsmara

Finding: Feeding a low fiber diet can be used to reduce carbon footprint while improving feed efficiency of beef steers.

Enteric Methane Emission, Rumen Fermentation and Microbial Profiles of Meat-Master Lambs Supplemented with Barley Fodder Sprouts

Published in Fermentation – MDPI in 2022

This study evaluated the effects of barley sprout on the ruminal fermentation characteristics, enteric methane emission and microbiome profiles of meat-master lambs

Finding: The sprout supplementation improves feed utilization efficiency by the animals. In conclusion, barley sprouts may be strategically used as a climate-smart feed resource for ruminants.

LIFE ON LAND: SDG 15

To prevent and reverse land degradation, preserve biodiversity, manage rangelands, forests, and deserts sustainably.

Effective rangeland management can prevent and reverse the land deterioration. For instance, with a good stocking rate, taking into consideration the carrying capacity of the veld, overgrazing that can lead to poor vegetative cover and soil erosion can be prevented. Provision of extension or advisory service to communal farmers who have no private ownership of land may be beneficial in maintaining rangelands in a productive and sustainable condition. Rangelands support a variety of enterprises, generate employment and revenue, and provide many people with food, medicine, and healthy livestock. They are also a habitat

for our wildlife, and a source of tourist attraction (creating breathtaking landscapes of our beautiful land). Living conditions are being threatened by the depletion of natural resources, the stress on ecosystems, and the loss of biological variety, which results in land degradation, soil erosion, the loss of grazing pastures, and the release of additional carbon into the atmosphere. These may be also the results associated with climate change.

Improving grazing management can contribute to grassland restoration and carbon sequestration in soils, and it can also reduce deforestation. For example, the association of trees, herbaceous material and some grasses – can prevent soil erosion, facilitate water infiltration and decrease damage to production from extreme weather conditions. An example of an association is that of *Acacia karoo* and grass production. The grass is often reported to grow well where there are few *Acacia* trees than where there are none but production declines as tree density increases above a threshold level. Hence, bush encroachment is a threat and is being controlled in our country. Such actions also help diversify income sources and provide energy and fodder for livestock. In addition, the use of nitrogen-fixing leguminous trees can increase soil fertility and yields. Agricultural biodiversity and well-adapted livestock are essential, particularly in harsh environments where crop farming is difficult or impossible. The capacity of agro-ecosystems to maintain and increase their productivity, and to adapt to changing circumstances, constitutes a vital element in global food security. All these areas provide good opportunities for students, supervisors and other stakeholders to engage through the application of technologies. rediscovering effective indigenous knowledge. This will yield greater advances in the sustainable use of our natural resources in agriculture.

PUBLICATIONS

Using faecal profiling to assess the effects of different management types on diet quality in semi-arid savanna

Published in African Journal of Range & Forage Science in 2006

We used faecal profiling to assess diet quality of animals under three different management types in a semi-arid savanna, northwest of Kimberley, Northern Cape, South Africa.

Finding: The results of this study demonstrated the value of faecal profiling for management of semi-arid savanna livestock and game.

Determining spatial and temporal variability in quantity and quality of vegetation for estimating the predictable sustainable stocking rate in the semi-arid savanna

Published in African Journal of Range & Forage Science in 2007

This study assessed the importance of spatial and temporal variation in plant quality and quantity for determining sustainable stocking rates in game, commercial and communal ranches in semi-arid savanna of the Northern Cape Province, South Africa

Finding: Quality measures (CP and P) gave more conservative predictions of stocking density than biomass. In the Northern Cape, seasonally-inundated pan habitats are particularly valuable despite low-standing vegetation because they have the highest year-round quality. Contrastingly, ranchers should only lightly stock open savanna habitats, though there is high plant biomass because they have low vegetation quality and may be particularly susceptible to degradation and invasion by poisonous and unpalatable plants. It was recommended that commercial ranchers should introduce a greater variety of stock and/or game to reduce selective grazing of certain plant species.

The effects of grazing, fire, nitrogen and water availability on nutritional

quality of grass in semi-arid savanna, South Africa. Journal of Arid Environments in 2010

Examined the effects of grazing, fire, nitrogen addition, and watering treatments on the nutritional value of grass in a field experiment in the Northern Cape, South Africa

Findings: There was more CP and P mass per unit area in fenced (ungrazed) plots during the wet season. Fire interacted with addition of nitrogen and grazing to increase grass quality.

Soil nitrogen availability appears to be the most important factor affecting nutrient quality of grasses in the wet season in this semi-arid ecosystem.

Effects of herbivore exclosures on variation in quality and quantity of plants among management and habitat types in a semiarid savanna

Published in African Journal of Range & Forage Science in 2010

The effects of grazing on plant biomass, plant quality, species evenness, species diversity and species composition were determined among management types (communal, commercial and game) and among habitat types (open savanna, rocky and pan) in a semiarid savanna in South Africa.

Findings: The negative effects of grazing were more evident in the commercial ranch, although the greater abundance of poisonous plants on the communal ranch is of great concern. The exclosures are very useful tools for examining the effects of grazing on plant

quality and composition. It was recommended that ranchers use exclosures as medium- to long-term indicators of range condition in semi-arid savannas.

Browse silage as potential feed for captive wild ungulates in southern Africa: A review

Published in Animal Nutrition in 2018

The objective of the review was to assess the potential of indigenous browse trees as a sustainable feed supplement in the form of silage for captive wild ungulates, especially in zoological gardens.

Finding: Improving intake and nutrient utilisation and reducing the concentrations of anti-nutritional compounds in silage from the indigenous browse trees of southern Africa should be the focus for animal nutrition research that need further investigation.

There is a need for alternative feed sources for captive wild ungulates in zoos, game farms and game reserves in southern Africa due to insufficient supply and high prices of existing feed sources. The alternative feed source can be obtained from leaves of browse trees.

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