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Inside this issue:

ARC-Vegetable, Industrial and Medicinal Plants Newsletter

Newsletter of the Vegetable, Industrial and Medicinal Plants, campus in the Crop Sciences Programme of the Agricultural Research Council (ARC)

Food and nutrition security at the banks of the Mbashe River, Mveso Komkhulu

Compiled by Phomolo Maphothoma, Erika Van Den Heever, Musa Mtileni, Sidwell Tjale, Buhlebelive Mndzebele, Happy Moteleng, Mpho Makhanya and Lerato Matsaunyane

Mvezo Komkhulu (The Great Place) is a village found on the banks of the Mbashe River, approximately 80 km south-west of Mthatha, in the King Sabata Dalindyebo municipality of the OR Tambo district of the Eastern Cape Province of South Africa. This village is known as being the birthplace of Nelson Mandela. The Agricultural Research Council-Vegetable, Industrial and Medicinal plants (ARC-VIMP) was appointed as an implementing agent for a training project titled “Mvezo Komkhulu Enterprise Development Programme”, and the project was funded by Agricultural Sector Education Training Authority (AgriSETA). The aim of the project was to capacitate the Mvezo Komkhulu community in agricultural initiatives through skills and technology transfer to enable the establishment of vegetable gardens, and subsequently contribute towards improving food and nutrition security, as well as adequate access to food for households. This project was essential given that the Eastern Cape is one of the poorest South African provinces with an unemployment rate around 50%, particularly in rural Eastern Cape. The OR Tambo district ranks second in terms of the highest rate of poverty at 53.9% after Alfred Nzo district (57.7%). The project comprised 120 community members from six villages in Mvezo Komkhulu and these are Mayigele, Mayoli, Mazikhanye, Mcakathini, Msila and Ngaphezulu. The 120 participants represented 89 households. The literacy level varies from no schooling to grade 12, which is in the minority. Thirty two percent of the participants were aged <35 years, 29% were between 36-45 years, and 39% were above 46 up to late 60s with 55% of all participants

Mbashe River in Mveso Komkhulu

Communal vegetable garden established by the Mvezo Komkhulu Enterprise Development Programme participants.

Skills development programme where participants were being taught on correct use of agricultural tools.

being female. The training took place from June 2022 to August 2023 where the ARC offered accredited training in a skills programme comprising of different unit standards. The training learning outcomes were Select, Use and Care for Hand Tools and Basic Equipment and Infrastructure (US 116167); Recognize Pests, Diseases and Weeds on Crops (US 116204); Fertilize Soil & Attend to Basic Plant Nutrition (US 116206); Collect Agricultural Data (US 116156); Apply basic food safety practices (US 116166); Propagate plants (US 116205); Working with numbers on various contexts (US 7447) and Demonstrate an understanding of the various concepts of sustainable farming (US 116157).The participants also established a communal garden where they planted onion, beetroot, cabbage and spinach seedlings. Through the skills programme, as well as through a collaboration between ARC-VIMP and the directorate of Value Chain Support of the Department of Small Business Development (DSBD), the participants developed a model where

Distribution of vegetable seeds to the skills development programme participants. The seeds were donated by the Department of Agriculture, Land Reform and Rural Development. The seeds included spinach, onion, cabbage, pumpkin, butternut, carrots and beetroot.

Practical's during the skills development programme where participants were preparing soil and transplanting of seedlings.

harvest from the communal garden was sold to secure supplies for the next planting To ensure sustainable livelihoods, each household received vegetable seeds to establish household vegetable gardens. The inclusion of other vegetables together with the dominant maize plantings, will diversify the food basket of households. Given the positive outcomes from the skills development programme, the introduction of more similar activities is expected to yield positive contributions towards mitigating food and nutrition insecurity in Mvezo Komkhulu.

Acknowledgements: The Chief of Mvezo Komkhulu, Mvezo Komkhulu Chief of Staff, Mvezo Komkhulu tribal council, Mvezo Komkhulu participants, AgriSETA, Department of Small Business Development (DSBD), ARC-VIMP: Farmer support, Commercialisation and Enterprise Development (FSCED) team.

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Ethnoveterinary science: Current research and future prospects

Compiled by Ebrahiema Arendse, Nqobile Masondo and Stephen Amoo

Ethnoveterinary medicine (EVM) in South Africa is a fascinating field that encompasses the traditional knowledge and practices of indigenous and local communities in animal health management. With a rich diversity of cultures and an extensive history of human-animal interaction, South Africa has a wealth of traditional knowledge related to the use of medicinal plants and other natural remedies for treating animal ailments. This traditional knowledge has been handed down through generations and continues to play a crucial role in supporting animal health and the well-being in various rural and peri-urban communities (McGaw et al., 2020). Ethnoveterinary practices in South Africa have a deep-rooted history, dating back centuries. Indigenous tribes and communities have relied on their intimate understanding of the local ecosystem and animal behaviour to develop effective remedies for their livestock and working animals. These practices are deeply ingrained in the cultural heritage of the different ethnic groups across the country. The indigenous knowledge holders have played a pivotal role in ethnoveterinary science. These highly respected individuals possess knowledge of medicinal plants and other natural remedies used to treat both human and animal health issues. Their expertise is built on observation, experimentation, and an intimate connection with nature.

South Africa is home to an extraordinarily wide range of plant species as well as cultural groups, providing a fertile ground and limitless opportunities for research on the traditional use of plants for human and animal health. As a result, several studies have been conducted over the last decade on the use of indigenous medicinal plants in EVM. For instance, Moichwanetse et al. (2020) found that 25 plants from 18 families were used as medicines by the Dinokana communities in the North West Province to treat retained placentas in cattle. The most often cited plants were the African potato (*Hypoxis hemerocallidea*), weeping wattle (*Peltophorum africanum*), Red squill (*Drimia sanguinea*), and elephant's root (*Elephantorrhiza elephantina*) (Fig. 1). In another study, a total of 64 medicinal plants from 32 families (dominated by plants from the Compositae, Fabaceae, and Asparagaceae families) were used to treat 27 cattle diseases in two communities of the Ramotshere Moiloa local municipality, Limpopo Province, South Africa (Chakale et al., 2022). Some of the diseases that were treated include dysentery, blackquarter, anthrax, aphosphorisis, abscess, lumpy skin disease, lung diseases, and parasites (ticks and worms).

Once ethnoveterinary plants are surveyed, the valorisation

African potato (*Hypoxis hemerocallidea*) | Weeping wattle (*Peltophorum africanum*) | Elephant's root (*Elephantorrhiza elephantina*)

Figure 1. Some of the medicinal plants used in Ethnoveterinary medicine.

of the surveyed plants become critical in order to harness the associated benefits. It is essential for researchers to conduct *in vitro* and *in vivo* studies to determine the efficacy and safety of medicinal plants in animals. The recent work by Chakale et al. (2021) reported that 310 medicinal plants across 81 families were used to treat 10 categories of cattle diseases in South Africa. However, only an estimated 21% of these 310 plants were further studied *in vitro* (biological activity) using cow disease-related bioassays. Research has shown that ethnoveterinary plants have the ability to also improve animal meat quality. For instance, feeding lambs with Chinese bush-clover (*Sericea lespedeza*) provided a sustainable means of controlling gastrointestinal nematodes and enhanced meat production and shelf life of lamb (Mahachi et al., 2020). In a more recent study, Mahachi et al. (2023) found that Chinese bush-clover diets reduced meat spoilage on lamb carcasses, compared to those fed with a control diet (lucerne).

Although surveys and literature reviews are highly relevant and provide insight into the usage of EVM and the treatment of diseases, limited *in vitro* and *in vivo* studies have been reported on the safety and efficacy of ethnoveterinary plants Thus, further research evaluating the efficacy and safety, as well as the chemical profiles of medicinal plants used in EVM remains crucial. The use of medicinal plants is proven to be safe and efficacious in animal health care and has become a more affordable and readily accessible option, especially to resource-poor farmers (Fig. 2). The implementation of the above would help to improve EVM's acceptability and standing in Western veterinary practices, as well as assist in the adoption of EVM into traditional animal healthcare systems and the curriculum in higher education.

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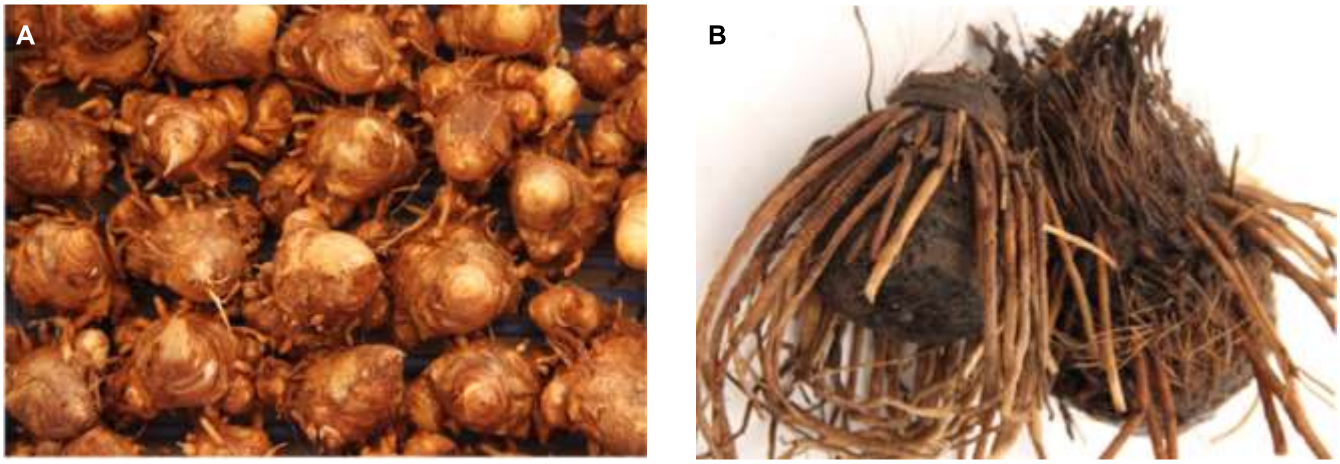

Figure 2. Medicinal plants and their potential application to treat animal diseases. 2a. African ginger (*Serokolo medicinal*) bulbs, used as an anti-inflammatory treatment of colds and influenza; 2b. African potato (*Hypoxis hemerocallidea*) bulbs, used for tuberculosis, urinary tract infections, gastric ulcers and internal cancer tumours.

Figure 2 (continue). Medicinal plants and their potential application to treat animal diseases. 2c. Pineapple flower (*Eucomis autumnalis*), used for urinary diseases and fevers. 2d. Bushman poison bulb (*Boophone disticha*), used for skin disorders and eye conditions.

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Medicinal plants in ethnoveterinary science - The importance of documenting indigenous knowledge

Compiled by Nqobile Masondo[1], Ebrahiema Arendse[1], Adeyemi Aremu[2], and Stephen Amoo[1]

Traditional knowledge, indigenous technical knowledge, people's science, and ethno-science are common terms associated with knowledge and practices held by ethnic or cultural groups located within a defined geographical area. As an essential part of survival and adaptation, ethnoscience has contributed a wealth of resources to current advancements in the agricultural, ecological, and medical sectors. Essentially, ethnoveterinary medicine remains a common alternative practice used in diagnostics, disease prevention, and treatment of livestock in rural communities (Fig. 1). Ethnoveterinary medicine entails the holistic management of animal health and diseases through the use of traditional knowledge, beliefs, skills, methods, plants, metaphysics, surgical methods, and traditional veterinary model technologies (McCorkle and Mathias-Mundy, 1992). The reason why ethnoveterinary medicine is still relevant even in a Western science-driven society is its practical value, which is linked to cost-effective, sustainable, and environmentally friendly systems capable of improving animal wellbeing while contributing to income generation in several communities (McCorkle and Mathias-Mundy, 1992).

In South Africa, the documentation of plants with ethnoveterinary relevance, including the diagnostics, prevention, and control of diseases affecting livestock is significantly neglected (McGaw et al., 2020; Viljoen et al., 2019). The research conducted is limited to a number of districts in a few Provinces, and such knowledge is largely influenced by the plant species availability or natural distribution. Fig. 2, which forms part of a review published by McGaw et al. (2020), shows the distribution at Provincial levels of survey studies reported up to 2008, as well as 2019. The review revealed only a marginal increase in the number of South African Provinces surveyed between 2008 and 2019, in relation to documenting plants used for livestock health management. The authors identified Mpumalanga as the only additional Province that was surveyed in comparison to the three previously studied Provinces (North West, Eastern Cape, and Limpopo). The slow rate of documenting such valuable information on readily available indigenous plants with traditionally “proven efficacies” (based on the long-term use by communities) is alarming as this valuable knowledge might be lost over time. This becomes worrisome as it is generally known that such indigenous knowledge is held by the community’s elders, many of whom are advanced in age, and the younger generations are often not very keen on preserving such systems. In the near future, the possibility of the immense knowledge, skills, and experience accumulated over generations could become extinct due to urbanisation and technological development is a real threat. Even worse, some of the technological developments could originate from biopiracy of undocumented indigenous knowledge, which are then re-packaged and developed as products that are later sold back to the communities who are the original custodians of such knowledge. It is advocated that prior consent of indigenous knowledge holders and their agreement on access to benefits be concluded before any commercialisation, in compliance with good ethics, IKS legislation, and the

Figure 1. Representative traditional medicine at *muthi* markets.
https://www.herbology.co.za/taq/khoisan-medicinal-plants

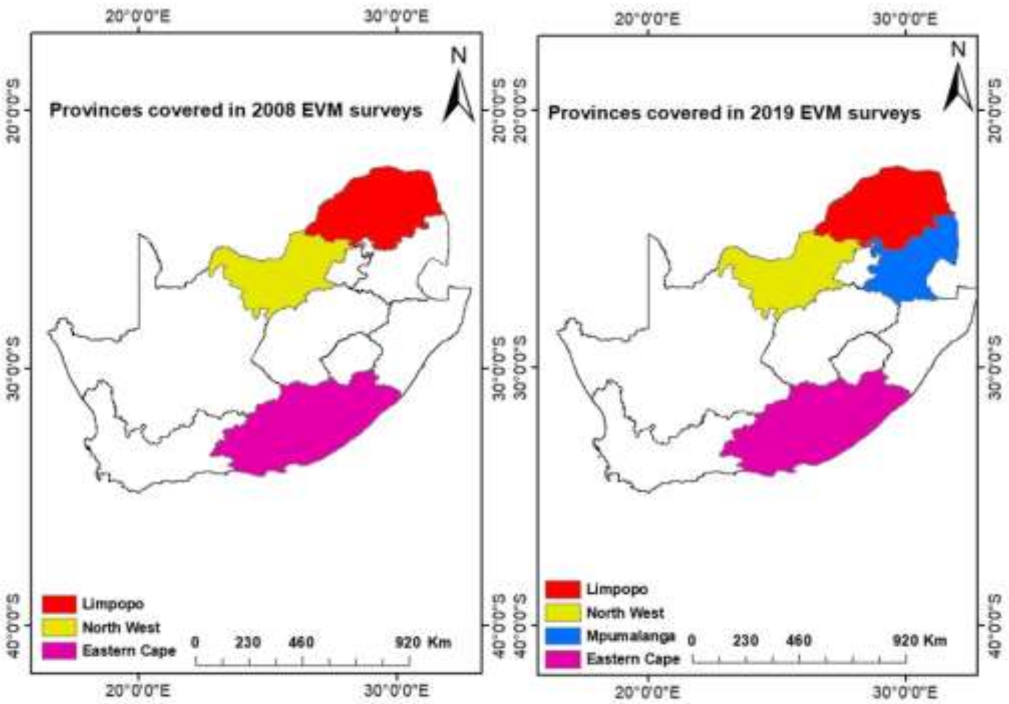

Figure 2. Provinces in South Africa with evidence of ethnoveterinary surveys (McGaw et al., 2020).

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Characterization of plant growth promoting bacterial isolates

Compiled by René Sutherland

Plant growth promoting rhizobacteria (PGPRs) are symbiotic, free-living bacteria that have beneficial effects on plants. PGPRs can enhance plant growth, productivity and the nutrient status of plants, protect them against invading pathogens and enhance their tolerance against abiotic stresses. As chemicals have a negative impact on the environment, PGPRs can be applied as biofertilizers or as biocontrol agents. To identify bacteria with growth promoting activity, bacterial isolates obtained from the potato rhizosphere and potato roots were further characterized. Mondial tubers were planted in sterilized soil and inoculated with 27 different PGPR isolates after 4 weeks. Water was used as the control treatment. Five isolates (PGPR052, PGPR134, PGPR170, PGPR065 and PGPR008 (green bars in Fig. 1)) showed significant increase in stem length after 12 weeks, whereas 13 isolates showed significant increase in root length (PGPR145, PGPR135, PGPR050, PGPR126, PGPR007, PGPR149, PGPR120, PGPR014, PGPR036, PGPR004, PGPR051, PGPR025 and PGPR009 (green bars in Fig. 2)).

Researchers further intend to develop awareness among smallholder potato farmers on PGPRs. PGPRs can be used in an integrated disease management strategy. Increase in potato growth may enable farmers to produce high yielding crops of good quality, which will enhance their competitiveness in the local markets, as well as contribute to improved nutrition, food security, as well as poverty alleviation.

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Testing the effect of PGPRs on potato plantlets in pots in a greenhouse.

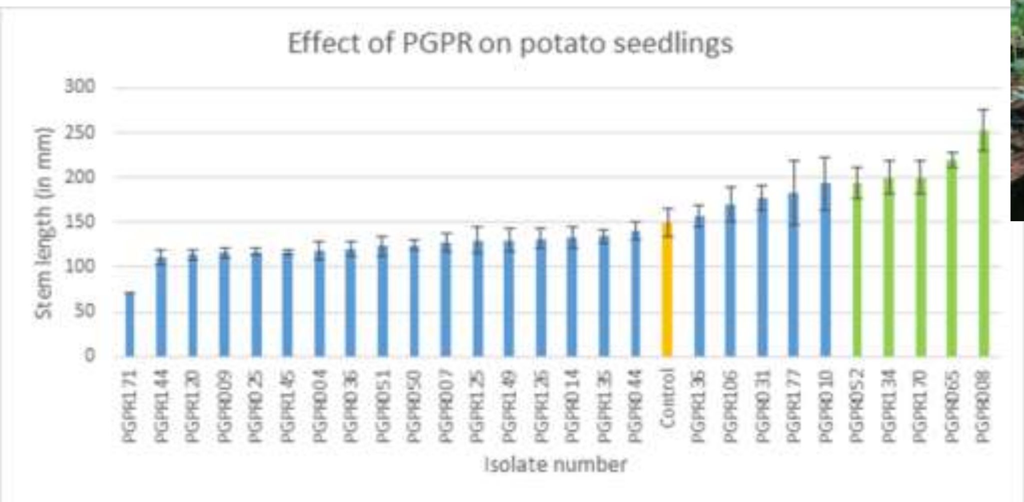

Figure 1. Effect of PGPRs on the stem length of potato seedlings in the greenhouse after 12 weeks.

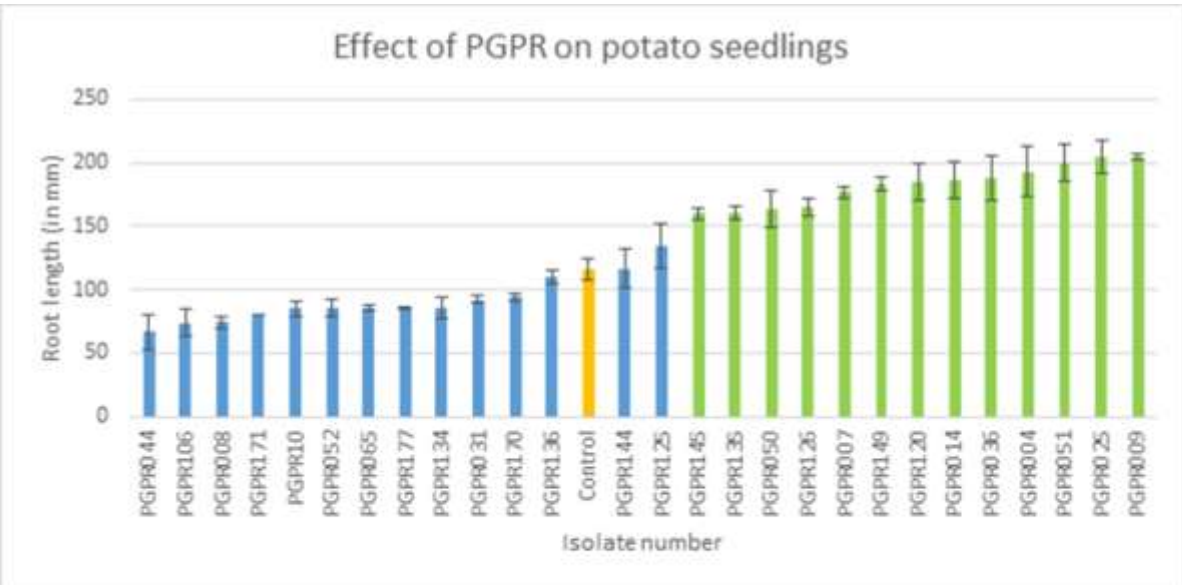

Figure 2. Effect of PGPRs on the root length of potato seedlings in the greenhouse after 12 weeks.

A perspective on the potential use of hybrid true potato seed in the South African industry: challenges and opportunities

Compiled by Ntombokulunga W. Mbuma and Sunette M. Laurie

Potato (*Solanum tuberosum* L.) is one of the world's most important food crops, providing food security and nutrition for millions of people around the world. Potato is an important economic crop in South Africa. With an annual production of 2.6 million metric tonnes, it is the largest vegetable crop produced in South Africa (Abstracts of Agricultural Statistics, 2022). The contribution of the potato industry to the gross value of agricultural production in South Africa was R8 billion during 2018, which accounted for 2.6% of the total of agricultural products. However, potato production sustainability is threatened by biotic and abiotic stresses, requiring high input farming systems such as irrigation systems, fertilizers, and herbicides and pesticides, which results in lower profit margins for farmers.

Hybrid true potato seed (HTPS) is a relatively new technology in the global potato industry, offering many benefits to farmers and the environment. Hybrid true potato seeds are a new type of potato seed created through DNA technology that allows for the growth of stable potatoes from seed (Figure 1A) instead of tubers (Figure 1B). The HTPS are produced from a hybrid cross between two inbred varieties of potatoes. The HTPS are more resilient and resistant to diseases compared to the traditional potato tuber seeds (Jansky et al. 2016).

For farmers, potato true seeds are typically bred for enhanced disease resistance, making them more resistant to common potato diseases such as late blight and potato viruses. In contrast, potato tubers may carry diseases and can spread them to new plants when used for propagation. This also means that farmers can use fewer chemicals to control pests and diseases, reducing their environmental impact. Potato true seeds are much lighter and smaller than potato tubers, which makes them easier to transport and distribute to different regions. This can be particularly advantageous for farmers in remote areas or regions with limited access to seed tubers. Potato true seeds are generally less expensive than seed tubers, especially for farmers who can produce their own seeds through controlled pollination. Additionally, true seeds require less storage space and can be stored for longer periods without losing viability compared to tubers, resulting in lower storage costs. When using true seeds, farmers have better control over the quality and health of their potato crop since they are starting from a known source. This can lead to improved crop performance and decreased risk of disease outbreaks in the field.

Despite the numerous benefits of HTPS, there are still some challenges that need to be addressed. One of the main challenges is the difficulty in producing high-quality HTPS. To produce high-quality HTPS, farmers need to be able to identify the best parent plants for producing hybrid seeds. Additionally, the process of producing HTPS is labour-intensive and requires careful management of the parent plants. This can be a challenge for many farmers in developing countries who may not have access to the resources or knowledge to produce high-quality HTPS. Another challenge is the lack of acceptance of HTPS in the potato industry. Many farmers are reluctant to switch from traditional seed potatoes to HTPS due to concerns over yield and quality. Additionally, there is a lack of awareness of the benefits of HTPS among farmers, making it difficult to persuade them to switch. Finally, there is a need for more research into HTPS. Despite its potential benefits, there is still a lack of data on the performance of HTPS in different environments and climates. This lack of data makes it difficult to determine the optimal conditions for HTPS production and to assess whether or not it is suitable for different farming systems.

Figure 1. Showing A) potato berry with true seed and B) traditional seed potatoes (tuber seeds). Photo A: https://www.potatopro.com/about/seed-potatoes, and B: https://www.istockphoto.com/photo/seed-potato-gm147334914-9437761

Even with these challenges, there is also great potential for HTPS to revolutionize potato production in South Africa and other countries. HTPS offers various advantages over traditional seed potato production, including clean seed material, improved disease resistance and less reliance on purchased seed potatoes. The potential of HTPS in South Africa is significant, as it can provide a more reliable, efficient and sustainable alternative to traditional seed potato production. The main competition that HTPS is likely to face in the South African market is from traditional seed potato production. Traditional seed potato production is still the dominant form of seed potato production in South Africa and in the world and is likely to remain so for the foreseeable future. However, HTPS has the potential to become a viable alternative for farmers, especially those who are looking for a more reliable, cost-effective and sustainable source of seed potatoes. The adoption of HTPS in the South African market will also depend on the level of awareness among farmers. Many farmers are still unfamiliar with the technology, so there is a need for more information and education on the benefits of HTPS. Furthermore, there is a need for more research and development into HTPS in order to ensure that it is adapted to the local conditions in South Africa.

With the right investments in research and technology, HTPS could become a viable option for potato farmers around the world. By improving potato yields, increasing resistance and tolerance to biotic and abiotic stresses, reducing environmental impacts, and reducing labour, HTPS could be instrumental in helping to reduce poverty, improve food security, and promote sustainable agriculture.

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ARC Researchers attend the Potatoes South Africa's Research Symposium

Compiled by Rene Sutherland

Potatoes South Africa (PSA) organized their annual Research Symposium at Khaya Ibubesi, Parys, Free State from 18-20 July 2023. The theme of this year's symposium was 'Roots in the ground with the future in mind'. Approximately 250 potato producers, researchers, students, representatives of input suppliers, personnel of Potatoes South Africa, Potato Certification Service and Potato Laboratory Service and others attended the symposium to learn what progress has been made with research funded by the potato industry. Several researchers and technicians from the ARC-VIMP, ARC-PHP, ARC-TSC, ARC-GC, ARC INV-NVB and ARC-NRE attended.

The conference was divided into 10 sessions, namely, a) mechanisation and irrigation, b) soil health, c) foliar diseases, d) potato tuber moth, e) innovations in crop protection, f) cultivars, g) meeting the global challenges, h) potato nutrition and impact on quality and shelf life, i) technologies to trigger innovation in potato production, and j) the gen z view. Each session started with pre-recorded presentations followed by a panel discussion. The symposium provided the opportunity to exchange knowledge, as well as an opportunity for discussions between researchers.

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Figure 1. ARC staff and students at the Potatoes South Africa Research Symposium. Back left to right: Dr Estianne Retief (ARC-PHP), Dr Mariette Marais (ARC-PHP), Dr Mieke Daneel (ARC-TSC), Dr Sonja Steenkamp (ARC-GC), Ms Kate Phetla (ARC-VIMP), Dr Rinus Knoetze (ARC INV-NVB), Dr Rene Sutherland (ARC-VIMP), Dr Chris Spies (ARC-PHP), Dr Elsie Cruywagen (ARC-VIMP), Dr Elna van der Linde (ARC-PHP), Dr Diedrich Visser (ARC-VIMP); Front left to right: Dr Mariette Truter ARC-VIMP), Ms Zama Nkosi (ARC-VIMP), Ms Abongile Nxitywa (ARC-VIMP), Ms Pinkie Mojapelo (ARC-VIMP), Dr Ntombokulunga Mbuma (ARC-VIMP), Ms Kgothatso Chauke (ARC-VIMP) and Ms Adri Laas (ARC-NRE & ARC-VIMP).

Dr Elsie Cruywagen (ARC-VIMP) gave an interesting presentation regarding the efficacy of fungicides against various *Alternaria* diseases on potatoes.

Dr Diedrich Visser (ARC-VIMP) discussed practical interventions to control the Potato tuber moth.

Dr René Sutherland (ARC-VIMP) discussed the factors involved in potato early dying (PED) in the Limpopo Province.

ARC books, factsheets and other information material that were available at the ARC exhibition.

ARC exhibition at the Potatoes South Africa Research Symposium, held at Khaya Ibubesi, Parys, Free State during 18-20 July 2023.

Dr Mariette Truter from the ARC-VIMP in a panel discussion facilitated by Ms Lindi Botha on soil health at the Potatoes South Africa's Symposium, together with Dr Freddie Denner (UPL), Prof Martin Steyn (University of Pretoria), Mr Albert de Villiers (potato producer) and Dr Miekie Human (Grain SA). One of the key messages from the panel discussion was that soil health is a critical corner stone of integrated pest and disease management and no longer a option for farmers to ignore.

WRC and partners international site visit: ARC-Vegetable, Industrial and Medicinal Plants (VIMP)

Compiled by Adri Laas, Nadia Araya, Hintsa Araya, Ian du Plooy, Mariette Truter and Nthabiseng Motete

Prof. Sylvester Mpandeli, Executive Manager at the Water Research Commission (WRC): Water Utilization in Agriculture led a delegation of international partners, including post-graduate students from the IHE Delft Institute for Water Education, to a site visit at the ARC-VIMP on 16 August 2023. The initiative forms part of the Water-Energy-Food (WEF) Nexus Winter School held in South Africa, from the 14th to the 18th of August 2023. The performance of the water-efficient circulating hydroponic systems was showcased, including the vertical nutrient film and the gravel film techniques. The crop production technologies applied in the system are climate-smart, cost-effective, user-friendly and resource-use efficient, and are considered by the WRC as one of their strategic projects for funding. In addition, several bio-based circular agricultural innovations were demonstrated. These included an artificial wetland for water purification, a biogas digester, a multipurpose biochar kiln and a self-regulating, low energy, clay-based irrigation (SLECI) system. The trade-offs and synergies between water, energy and food within the WEF nexus framework were explained through in-situ practical demonstrations. The visit was highly successful and strengthened relations between the ARC and WRC, creating possible opportunities for future funding to expand these research initiatives and conduct technology transfer to several possible end-users.

Acknowledgments
The authors would like to acknowledge the contributions of the Water Research Commission (Project N° C2019/2020 – 00229) and DIVAGRI (Grant Agreement N°: 101000348) for funding the research and the Agricultural Research Council for research implementation and project management.

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Dr. Nthabiseng Motete, ARC Group Executive: Crop Sciences, welcomed the visitors to the ARC-VIMP.

Prof. Sylvester Mpandeli, WRC Executive Manager: Water Utilization in Agriculture, explained the purpose of the visit and the background of the project.

ARC staff and post-graduate students from the IHE Delft Institute for Water Education and WRC Managers from Water Utilization in Agriculture at the hydroponics facilities of the ARC-VIMP, Roodeplaat.

Dr. Nadia Araya, Principal Investigator of the hydroponics project, explains the bag system to one of the visitors.

Dr. Nthabiseng Motete and Dr. Hintsa Araya discussing the potential of the biochar technology and its multi-purposes to enhance agricultural productivity, food security and societal development.

Visits to the Agricultural Academy Institutes, Bulgaria

Compiled by Dr Dean Oelofse and Dr Sonja Venter

The Agricultural Research Council with the Bulgarian Institute of Plant Genetic Resources (IPGR) entered into a Memorandum of Understanding (MoU) in July 2019. In 2020, IPGR got funding for an exchange programme from the European Commission (EC) Erasmus Plus Fund. Due to COVID-19 restrictions the Bulgarian delegation was only hosted by the ARC 20-26 November 2022. The European Commission (EC) Erasmus Plus Fund also made provision for an ARC researcher, namely, Dr Dean Oelofse, to visit the IPGR in Bulgaria. The ARC made funding available for Dr Sonja Venter (Senior Manager Research: ARC-VIMP) to represent the Crop Sciences team at a management level as this is a strategic intervention to broaden the international collaboration footprint of the ARC. Dr Oelofse and Dr Venter visited the Agricultural Academy Institutes, Bulgaria, 28 May 2023 to 3 June 2023. The following Institutes of the Agricultural Academy in Bulgaria were visited:

- Institute of Plant Genetic Resources (IPGR) ("K Malkov") in Sadovo.
- Institute of Rose and Essential Oil Crops in Kazanlak and visits to private agricultural companies and greenhouses.
- Crops Research Institute in Chirpan.
- Institute of Vegetable Crops in Plovdiv.
- The Agricultural Academy in Sofia.

The purpose of the visits included engagements, discussions and workshops with the management bodies and several researchers of the Institutes as mentioned above, and to present and discuss the research and work conducted by the various institutes in Bulgaria and those of the ARC Crop Sciences Division and to identify and explore further possible areas of collaboration. Dr Oelofse presented the work done in the ARC's Crop Sciences Division at the Institute of Plant Genetic Resources (IPGR) ("K Malkov") in Sadovo. He also highlighted the visit of the Bulgarian delegation to the ARC in November 2022, as well as the areas of collaboration identified during their visit to the ARC. The Bulgarian delegation comprised of Professor Tsvetelina Stoilova, IPGR, and Associate Professor Nikolaya Velcheva, Head of Department for International Relations and Projects, IPGR. Dr Venter presented an updated version of Dr Oelofse's presentation at the Agricultural Academy in Sofia, which included additional areas of collaboration following the visits to the various institutes during the week.

The updated identified areas of collaboration between the ARC and the Agricultural Academy Institutes are:

- Crop protection and agronomy, including pre-breeding for disease resistance.
- Scientists and students exchange program.
- Conservation and use of local plant genetic resources of field crops, vegetables (including underutilised vegetables and grains/cereals) and medicinal plants, including the exchange of germplasm and information on these crops.
- Exchange on breeding technologies and testing of varieties/germplasm from the two countries in different localities and different environments in South Africa and Bulgaria and possible collective breeding/development of

From left to right: Dr Dean Oelofse, Assoc. Prof. Dr Nikolaya Velcheva, and Dr Sonja Venter

Visit to the Institute of Plant Genetic Resources, Sadovo, Bulgaria.

new germplasm that are adapted to warmer climates and drought, as well as pest and disease tolerance due to climate change. Specific crops discussed includes wheat and durum wheat, triticale, cotton, cowpeas, dry beans, essential oils crops, onion, tomato, potato.

- Genebank documentation using FAO descriptors.
- Expanding and characterising of the grain legumes collection, including nitrogen fixation research.
- Development of genomic tools for the listed crops.
- Indicator models for climate change adaptation and biodiversity (biotic and abiotic).
- Breeding and technology of wheat and other cereal crops.
- Seed production and seed systems development which includes maintenance and preservation for purity and authenticity.
- Development of environmentally friendly technologies for crop production, including organic farming and precision agriculture.

For each of the above, provisional contact points were identified for both the ARC and the Agricultural Academy Institutes of Bulgaria. There will be continued facilitation of engagements and information sharing, the project leaders and project teams will be finalised, concept notes will be developed, funding sources are to be identified, and progress reports are to be compiled every six months. This visit strengthened collaboration between the ARC and the IPGR and in the implementation of the MoU

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Visit to the Maritsa Vegetable Crops Research Institute.