APP - 005961

IRRIGATION BASED AGRICULTURAL ACTIVITIES AND THE ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE ON FARM EMILIENHOF, OSHIKOTO REGION

ENVIRONMENTAL ASSESSMENT SCOPING REPORT

Assessed by:

GEO Pollution Technologies Namibia

Assessed for:

Van Druten Family Trust

March 2025

Project:	**IRRIGATION BASED AGRICULTURAL ACTIVITIES AND THE ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE ON FARM EMILIENHOF OSHIKOTO REGION: ENVIRONMENTAL ASSESSMENT SCOPING REPORT**
	Final March 2025
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Report Approval	**Quzette Bosman** **Environmental & Social Practitioner**

I ELIZABETH VAN DRUTEN, acting as representative of (The van Druten Family Trust), hereby confirm that the project description contained in this report is a true reflection of the information which the Proponent provided to Geo Pollution Technologies. All material information in the possession of the Proponent that reasonably has or may have the potential of influencing any decision or the objectivity of this assessment is fairly represented in this report and the report is hereby approved.

Signed at TSUMEB on the 13th day of JUNE 2025.

The van Druten Family Trust

T64/2001
Trust Registration Number

EXECUTIVE SUMMARY

Geo Pollution Technologies (Pty) Ltd was appointed by The van Druten Family Trust (the Proponent) to undertake an environmental assessment for irrigation activities and cultivation of genetically modified maize on farm Emilienhof FMB/00588, Oshikoto Region. Existing activities on the farm are focussed on irrigated and dryland crop cultivation as well as livestock farming. The Proponent currently utilizes an area of approximately 115 ha for cultivation, of which 61 ha is irrigated by means of drippers, sprinklers and centre pivot systems utilising abstracted groundwater, and the remaining 54 ha is used for dryland crop production. In order to optimize cultivation of maize, the Proponent would like to apply for the necessary permits to cultivate genetically modified maize. The genetically modified maize events (strains) earmarked for cultivation are insect resistant, herbicide tolerant and a combination of insect resistant and herbicide tolerant maize.

The main operational activities related to agriculture include:

- land preparation,
- planting,
- water abstraction and irrigation,
- fertilizer application and pest control,
- harvesting, and transporting activities specific to each crop,
- cattle, sheep and potentially other livestock farming, and
- bush clearing and charcoal production (only as part of rangeland management).

All historically cleared areas for crop cultivation and rangeland improvement across the farm, including the existing and potential irrigation areas amount to approximately 646 ha. Pending the outcome of a hydrogeological specialist study, the total hectares of land to be irrigated simultaneously, may be increased. For irrigation, water is abstracted from three registered production boreholes on the farm. The boreholes are registered with the Ministry of Agriculture, Water and Land Reform and the Proponent has a valid water permit and has applied for a valid water licence for water abstraction as required by the new Water Act. The main produce cultivated are vegetables and maize for local and international markets.

The environmental assessment determines all environmental, safety, health and socio-economic impacts associated with the continued and planned agricultural activities on the farm. Relevant environmental data was compiled by making use of primary data from a reconnaissance site visit and secondary data from a (hydrogeological specialist study). Potential environmental impacts and associated social impacts were identified and are addressed in this report.

The project area is located amidst other farms and due to the nature and location of the Proponent’s agricultural activities, some impacts can be expected on the surrounding environment. Therefore, preventative and/or mitigation measures must be implemented to address prevent or minimize such impacts.

Regular environmental performance monitoring is recommended to ensure regulatory compliance and the implementation of corrective measures when necessary, especially with regards to water abstraction and the planting of genetically modified maize. The Proponent’s operations play a role in contributing to the Namibian agricultural sectors and provide valuable employment opportunities in the region.

The main concerns related to the operations are potential groundwater, surface water and soil contamination, decreased groundwater availability, ecological and social impacts. The addition of genetically modified maize on the farm, if not implemented responsibly, has the potential of aggravating existing impacts or causing additional impacts, while also being contentious issue for some people. A safety, health, environmental and quality policy coupled to an environmental management plan, will contribute to effective management procedures, to prevent and mitigate impacts. All regulations relating to agriculture, genetically modified organisms, labour, and health and safety legislation should be adhered to. Groundwater and soil pollution must be prevented at all times. Restrictions and prescriptions pertaining to the environmental release and handling of genetically modified maize should be strictly adhered to. This include, but is not limited to, planting of refuges, maintaining adequate isolation zones and/or buffers between genetically modified and traditional maize fields, correct pesticide application

and vigilance and reporting of any signs of insect or weed resistance onset. All staff must be made aware of the importance of biodiversity and poaching or illegal harvesting of animal and plant products prohibited. The groundwater abstraction licence must be strictly adhered to. Any waste produced must be burned or removed from site and disposed of at an appropriate facility or re-used or recycled where possible. Hazardous waste must be disposed of at an approved hazardous waste disposal site. By appointing local employees and by implementing monitoring and training programs, the positive socio-economic impacts can be maximised while preventing mitigating negative impacts.

The environmental management plan included in Section 9 of this document should be used as an on-site reference document during all phases (planning, operations (including maintenance) and decommissioning) of the development. All monitoring and records kept should be included in six monthly reports to ensure compliance with the environmental management plan and the Ministry of Environment, Forestry and Tourism’s requirements. Parties responsible for transgression of the environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. A safety, health, environmental and quality policy should be used in conjunction with the environmental management plan. Operators and responsible personnel must be taught the contents of these documents. Local or national regulations and guidelines must be adhered to and monitored regularly as outlined in the environmental management plan.

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
Bt	*Bacillus thuringiensis*
CHIRPS-2	Climate Hazards Group Infra-Red Precipitation with Station data
DWA	Department of Water Affairs
EB	Existing Borehole
EIA	Environmental Impact Assessment
EMA	Environmental Management Act No 7 of 2007
EMP	Environmental Management Plan
EMS	Environmental Management System
EPL	Exclusive Prospecting License
GM	Genetically Modified
GMO	Genetically Modified Organism
IAPs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
MAWLR	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
MERRA-2	Modern-Era Retrospective analysis for Research and Applications v2
MSDS	Material Safety Data Sheet
NCRST	National Commission on Research, Science and Technology
NDP	National Development Plan
PPE	Personal Protective Equipment
SANS	South African National Standards
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

LIST OF MEASURMENTS

°C	Degrees Celsius
cmol/kg	Centimoles per kilogram
g/L	Grams per Litre
ha	Hectare
km	Kilometre
km^2	Square kilometres
kV	Kilovolt
kWh	Kilowatt-hour
$kWh/m^2/day$	Kilowatt-hours per square meter
L	Litres
m	Metre
m/s	Metre per second
m^2/d	Square metre per day
m^3	Cubic metres
mamsl	Metres Above Mean Sea Level
mbs	Metres below surface
mg/cm^3	Milligrams per cubic centimetre
mm	Millimetres
mm/a	Millimetres per annum
mm/a	Millimetres per annum
ppm	Parts per million

GLOSSARY OF TERMS

Alternatives - A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Assessment - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

Competent Authority - A body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Construction - The building, erection or modification of a facility, structure or infrastructure that is necessary for the undertaking of an activity, including the modification, alteration, upgrading or decommissioning of such facility, structure or infrastructure.

Cumulative Impacts - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Environment - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

Environmental Impact Assessment (EIA) – The process of assessment of the effects of a development on the environment.

Environmental Management Plan (EMP) - A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.

Environmental Management System (EMS) - An Environment Management System, or EMS, is a comprehensive approach to managing environmental issues, integrating environment-oriented thinking into every aspect of business management. An EMS ensures environmental considerations are a priority, along with other concerns such as costs, product quality, investments, PR productivity and strategic planning. An EMS generally makes a positive impact on a company's bottom line. It increases efficiency and focuses on customer needs and marketplace conditions, improving both the company's financial and environmental performance. By using an EMS to convert environmental problems into commercial opportunities, companies usually become more competitive.

Evaluation –The process of ascertaining the relative importance or significance of information, the light of people's values, preference and judgements in order to make a decision.

Green Scheme - The Green Scheme is an initiative conducted by the Ministry of Agriculture, Water and Forestry to encourage the development of irrigation based agronomic production in Namibia with the aim of increasing the contribution of agriculture to the country's Gross Domestic Product. Its aim is also to simultaneously achieve the social development and upliftment of communities located within suitable irrigation areas and to also promote the human resources and skills development within the irrigation sub-sector. Such initiative could possibly enhance cross-border investment and facilitate the exchange of relevant and limited resources with neighbouring countries in this regard.

Hazard - Anything that has the potential to cause damage to life, property and/or the environment. The hazard of a particular material or installation is constant; that is, it would present the same hazard wherever it was present.

Interested and Affected Party (IAP) - A person, group of persons or organisation interested in, or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.

Mitigate - The implementation of practical measures to reduce adverse impacts.

Proponent (Applicant) - Any person who has submitted or intends to submit an application for an authorisation, as legislated by the Environmental Management Act no. 7 of 2007, to undertake an activity or activities identified as a listed activity or listed activities; or in any other notice published by the Minister or Ministry of Environment & Tourism.

Public - Citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

Scoping Process – The process of identifying: issues that will be relevant for consideration of the application; the potential environmental impacts of the proposed activity; and alternatives to the proposed activity that are feasible and reasonable.

Significant Effect/Impact - An impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Stakeholder Engagement - The process of engagement between stakeholders (the proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term "public participation".

Stakeholders - A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (IAPs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

Sustainable Development - "Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations" – the definition of the World Commission on Environment and Development (1987). "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" – the definition given in a publication called "Caring for the Earth: A Strategy for Sustainable Living" by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

1 BACKGROUND AND INTRODUCTION

Geo Pollution Technologies (Pty) Ltd was appointed by The van Druten Family Trust (the Proponent) to undertake an environmental assessment for the existing agricultural activities and the environmental release of genetically modified maize on farm Emilienhof FMB/00588, Oshikoto Region (Figure 1-1). The main commercial activities of the Proponent on the farm includes crop cultivation and livestock farming. An additional planned activity by the Proponent is the cultivation of genetically modified (GM) maize. For purposes of crop cultivation, the Proponent utilizes approximately 115 ha of which 61 ha is purposed for irrigation. Pending the outcome of a hydrogeological specialist study, the total hectares of land to be irrigated simultaneously, may be increased. Irrigation are from four production boreholes by means of centre pivot irrigation systems. The main operational activities include:

- land preparation,
- planting (including proposed planting GM maize),
- water abstraction and irrigation,
- fertilizer application and pest control,
- harvesting,
- packaging and transporting activities specific to each crop,
- cattle, sheep and potentially other livestock farming, and
- bush clearing and charcoal production (only as part of rangeland management).

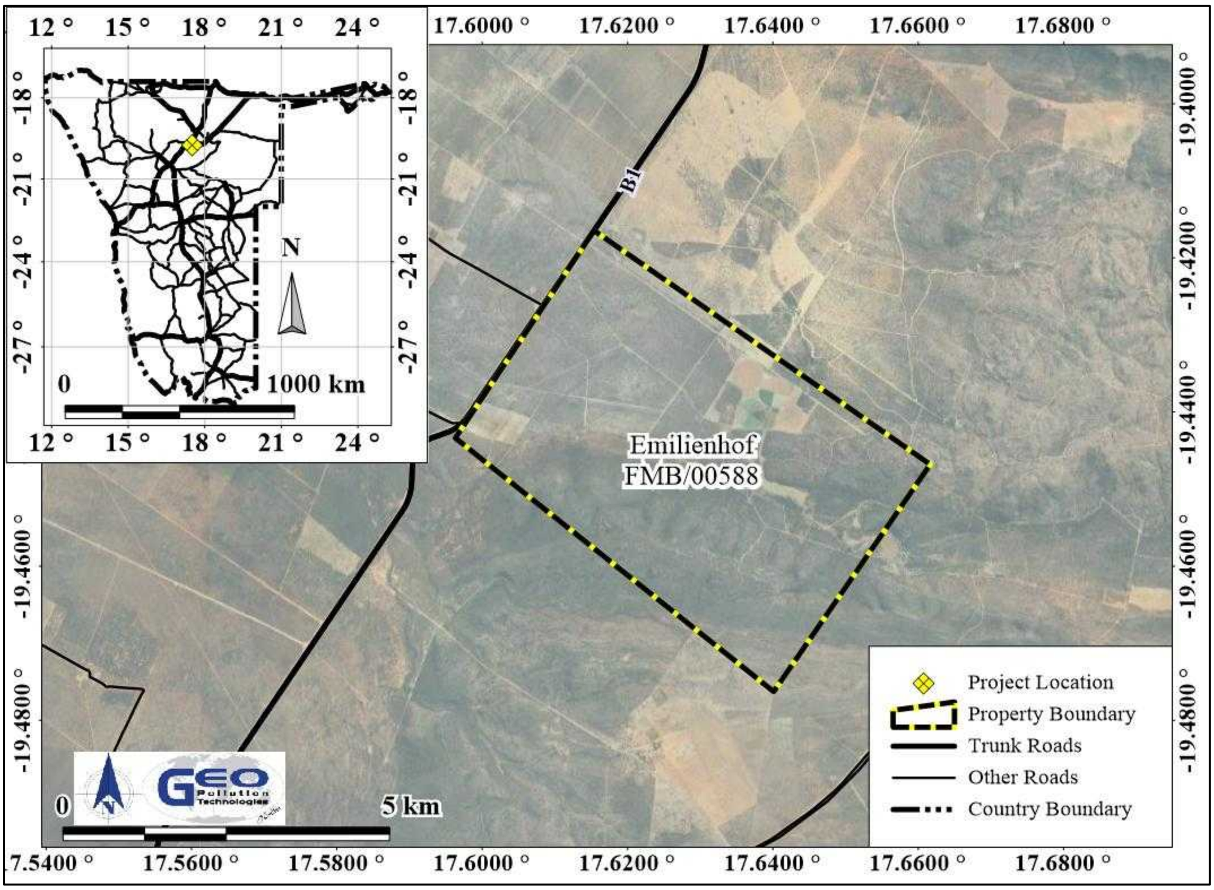


Figure 1-1 Project location

A detailed project description is provided in Section 4. The potential impacts of the project on the environment, resulting from various operational, maintenance and construction, and possible decommissioning activities, were determined through the risk assessment as presented in this report.

The environment being defined in the Environmental Management Act as “land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, paleontological or social values". The environmental assessment was conducted to apply for an environmental clearance certificate in compliance with Namibia's Environmental Management Act (Act No 7 of 2007) (EMA).

Project Justification – Traditionally farms in the region were used for cattle ranching with limited dryland crop cultivation. However, in the area, including on the Proponent's farm, farming activities were diversified to include irrigation based crop cultivation. The Proponent has a well-established irrigation and agriculture development, which sees an optimisation of crop production by means of irrigation, augmented by rainwater. It is now the Proponent's intention to further diversify farming activities by cultivating GM maize. This addition is proposed in an effort to increase resilience in food production for Namibia. Namibia aims at increasing sustainable food production and ensuring food security in the country. In addition, agriculture is an important employment sector for Namibia, adding to roughly a third of the workforce. Existing and planned agricultural activities require employment, which is required to be maintained for continued operations. Pivot irrigation systems also require significant investment costs and therefore the development of the irrigation areas, has ensured a sizeable investment into the area and the Tsumeb district.

Benefits of the agricultural activities conducted by the Proponent include.

- Food production and enhanced food security.
- Employment and supporting of livelihoods of both unskilled and skilled labourers.
- Technological development and investment in agricultural practices.
- Generation of income that contributes to the national treasury and a positive trade balance through the export of produce to international markets.
- Support for economic resilience in the area through diversified business activities and opportunities.

2 SCOPE

The scope of this report is to, in compliance with the requirements of EMA:

1. Present a detailed project and environmental description related to the Proponent's activities.
2. Determine the potential environmental impacts emanating from the Proponent's activities and potential future decommissioning of such activities.
3. Identify a range of management actions to mitigate the potential adverse impacts to acceptable levels.
4. Provide sufficient information to the relevant competent authority and the Ministry of Environment, Forestry and Tourism (MEFT) and related authorities to make an informed decision regarding the project and the issuing of an environmental clearance certificate.

3 METHODOLOGY

Methods employed to investigate and report on potential impacts of the Proponent's activities on the social and natural environment include:

1. Detailed infrastructure and operational procedures received from the client are presented in this report.
2. Baseline information about the site and its surroundings were obtained from existing secondary information as well as from a reconnaissance site visit.
3. A specialist report related to the benefits, impacts and concerns of environmental release of GM crops was compiled and the findings of this report was considered in the environmental assessment.
4. As part of the scoping process to determine potential environmental impacts, interested and affected parties (IAPs) were consulted about their views, comments and opinions, all of which are presented in this report.
5. As per the findings of this environmental assessment, a scoping report with an environmental management plan (EMP) were prepared and this will be submitted to the MEFT.

4 OPERATIONS AND RELATED ACTIVITIES

Agricultural activities, focussing on local food production, have constituted the core of the Proponent's operations for the last nine years. The earliest documentation of cultivated areas are visible on the topographic sheets, which were generated in the 1970's. Irrigation based crop cultivation is a more recent development to augment the traditional dryland cropping and cattle ranching. The Proponent gradually expanded precision agriculture for the past 9 years to ultimately include pivot based irrigation systems. Currently, commercial produce is cultivated on a rotation basis for irrigation-based fields. In an attempt to increase resilience of maize and thereby increasing local maize yields, the Proponent would like to, in the future, cultivate GM maize. Livestock farming involves mainly cattle and goats, while there is also some game on the farm. However, game farming and related fencing is not an active pursuit of the Proponent. Existing and planned operations are reliant on support infrastructure and resources, all of which are described below.

4.1 LAND CLEARING

The farm is a known agricultural unit for, more than 50 years. Initial land clearing was conducted to accommodate dry land cropping. Land clearing for crop cultivation includes removal of boulders and vegetation. More recent agricultural activities have seen an expansion of the cleared areas for irrigation-based crop cultivation on the farm.

Bush clearing is also conducted around crop fields to allow for implements to manoeuvre and to reduce competition for groundwater. In addition to the clearing of land for crops, parts of the faming unit (apart from isolated outcrops) has undergone rangeland improvement in the past by a third party, which involved bush-thinning activities. However, renewed efforts related to rangeland management efforts by the Proponent have focussed on the western portions of the farm. These rangeland measures include an aftercare program continually being implemented.

Approximately 115 ha across the farm has been cleared for irrigation and dryland crop production, while approximately 523 ha is actively rangeland managed. Vegetation was also cleared, and is maintained so, next to all fences as to accommodate firefighting initiatives (firebreaks).

Photo 4-1 Large trees retained in initial rangeland improvement

Photo 4-2 Cleared areas along vegetation

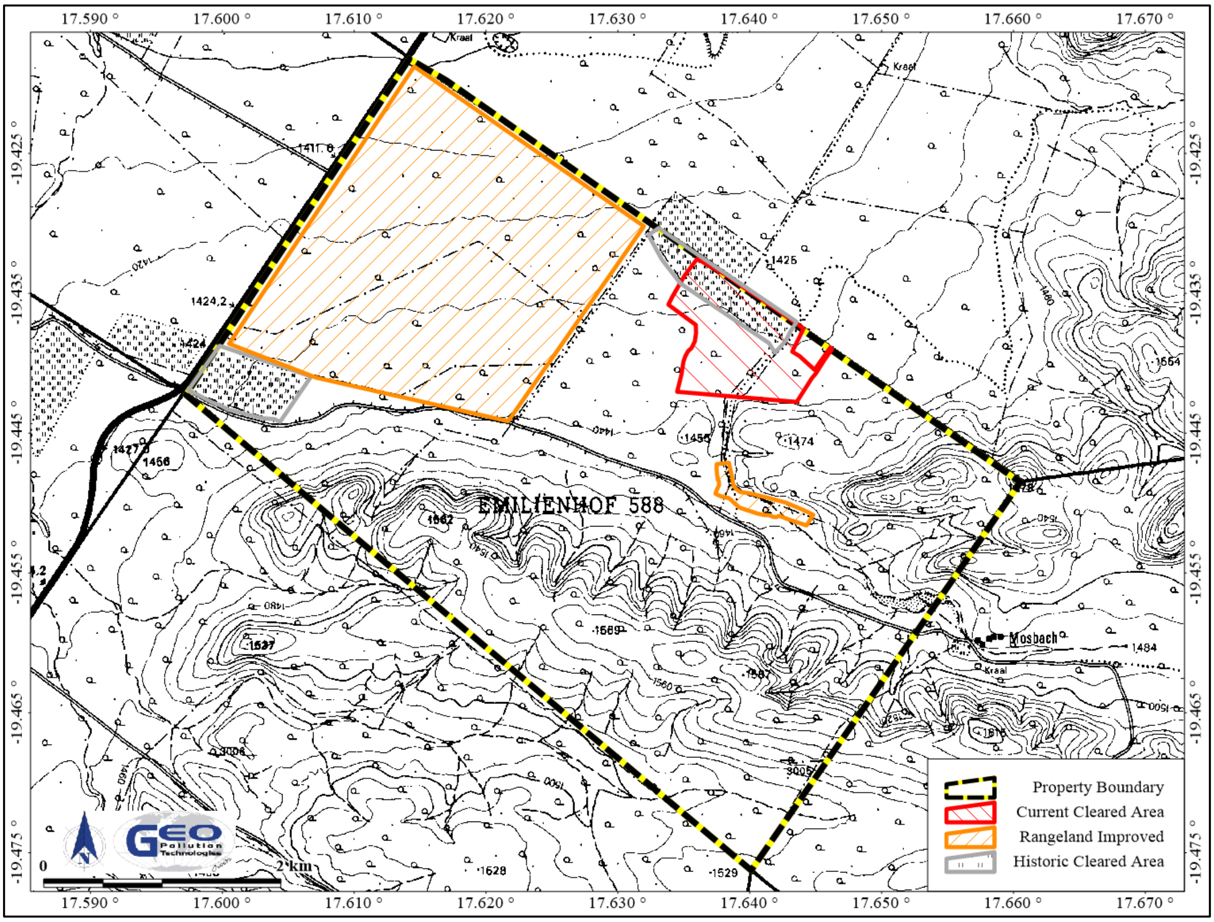


Figure 4-1 Cleared areas in relation to the 1975 topographical map

4.1 Arable Farming

Crops are planted on a rotational basis across the farm. Besides maize, potatoes, onions, butternuts, and pumpkins, which are the main commercial crops, radish and wheat are grown to improve soil health. Drip irrigation is employed across 1 ha for vegetable cultivation while stationary sprinkler systems are used on another 4 ha. The rest, and bulk of the irrigated areas are by means of centre pivot systems. Figure 4-2 depicts the cultivated fields in relation to cleared areas.

The Proponent conducts a combination of standard and semi-conservation agricultural practices. Pivot fields will be irrigated and dry land fields will need about 80 mm of rain to achieve optimal soil moisture before ploughing commences. Ploughing and tilling techniques are used for dry land and pivot fields to prepare seedbeds. Due to compaction, the fields must be tilled before planting can commence. After planting and before complete germination, all of the planted sections need to be treated with herbicides to prevent invasive species from overwhelming the future seedlings. Cultivation of maize and vegetables follows the same planting program, once the maize plants have broken the soil surface, herbicides can no longer be used. Various combinations of chemicals and herbicides are then employed to try and stem weed growth among the maize. The farm faces sever challenges with weeds such as Itch-grass / tarentaalgras (*Rottboellia cochinchinensis*) and Crowfoot / hoenderspoor (*Cynosurus aegyptius L.*) Apart from weed control, pesticides area also employed to protect the crop field from insects such as the fall-army worm. Pesticides are administered as per the specified application procedures for the corresponding pest by means of tractor spraying. To ensure correct and safe application of pesticides, a pesticide plan is implemented and regularly updated. The Proponent requires a minimum amount of pesticides as compared to conventional agricultural production. The Proponent does not use round-up on their irrigated fields and has the same grass and weed challenges as on dryland fields. In fact, additional pests can be associated with irrigation-based land such as Red spider mite (*Tetranychus urticae*).

Fertilizers are applied as required and according to the specifications for application. For irrigated fields, fertilisers are mixed with water in a large mixing tank. Once the desired mixing ratio is achieved, the fertiliser is fed into the irrigation system for administration onto the crops. Harvesting of all commercial produce comprise conventional methods which employ conventional harvesting machines. Most of these vegetables are hand harvested and are therefore labour intensive .Only during droughts cattle are allowed to graze on harvested fields.

Photo 4-3 Fertilizer sprayer

Photo 4-4 Row Rake for gathering hay

Photo 4-5 Hay field

Photo 4-6 Harvested hay bail

Photo 4-7 Butternut field under sprinkler irrigation

Photo 4-8 Harvested Butternuts

The majority of produce are annual crops, which require one or two seasons to complete their life cycle. Mammals, such as warthog, porcupine and baboons, can cause considerable damage to maize fields. Cultivated areas are therefore surrounded by game fencing to restrict wildlife entrance.

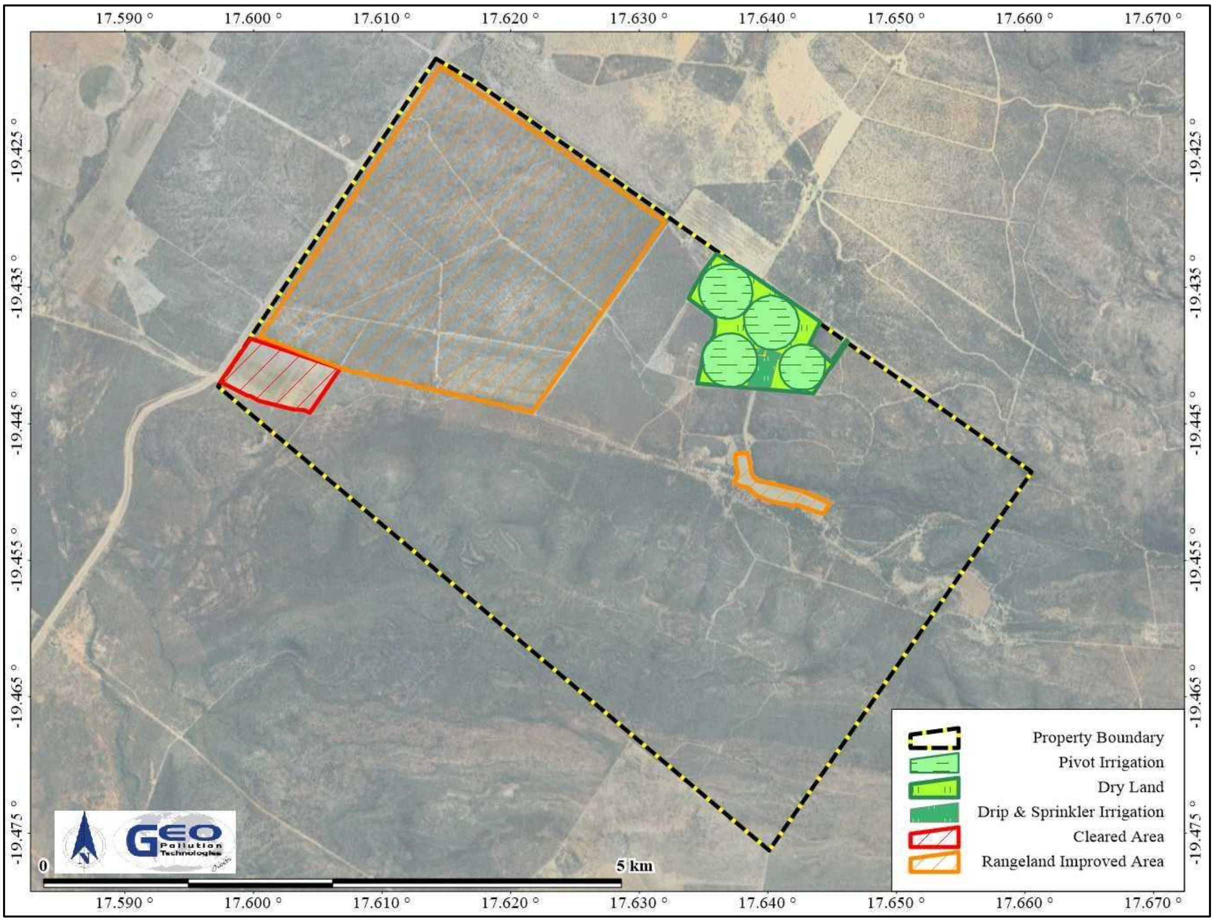


Figure 4-2 Cultivated and cleared areas

Photo 4-9 Fertiliser mixing tank inside shed

Photo 4-10 Crop sprayer

	
Photo 4-11 Plough	**Photo 4-12 Seed planter**

4.2 CULTIVATION OF GENETICALLY MODIFIED MAIZE

The Proponent plans to cultivate GM maize. Applications for the environmental release of GM maize for cultivation, based on existing procedures, policies and plans, will be submitted to the National Commission on Research Science and Technology (NCRST) under the Ministry of Higher Education, Technology and Innovation for approval. Such applications must be accompanied by a completed application form, this environmental assessment and its accompanying EMP, the related ECC, and emergency response plans for its cultivation and transport. The GM maize events earmarked for cultivation are listed in Table 4-1. Each type of maize is referred to as an "event".

Table 4-1 GM maize events earmarked for cultivation by the Proponent

Event	Commonly Referred/Trade Name	Trait
MON 810	Bt Maize/ YieldGard™	Resistant to lepidopteran* larvae like African maize stalk borer and fall armyworm
MON 89034	Bt Maize/ YieldGard™ VT Pro™	Resistant to lepidopteran larvae African maize stalk borer and fall armyworm
NK 603	Roundup Ready™ 2 Maize	Resistant (tolerant) to glyphosate herbicide (RoundUp™)
MON 89034 × NK 603	Roundup Ready® Maize 2	Resistant (tolerant) to glyphosate herbicide (RoundUp™) and resistant to lepidopteran larvae like African maize stalk borer and fall armyworm
NK 603 × MON 810	YieldGard™ CB + RR	Resistant (tolerant) to glyphosate herbicide (RoundUp™) and resistant to lepidopteran larvae like African maize stalk borer and fall armyworm

*Lepidopterans are the order Lepidoptera comprising moths and butterflies

The insect resistant events are protected during an outbreak of pests like the African maize stalk borer and fall armyworm. These are the larvae (caterpillars) of moths. Due to a specific protein the plant produce as a result of the genetic modification, the larvae of the moths die when eating the maize plants, thus minimizing crop loss without the need for applying pesticides. Herbicide resistant events have been modified to be tolerant to RoundUp™, which is a broad-spectrum herbicide with the active ingredient glyphosate. Post-emergent Roundup Ready™ maize can thus be sprayed with RoundUp™ to kill weeds without harming the maize plant itself. This eliminates the need for pre-planting weed control regimes and manual weed removal post-emergence. Stacked events have more than one trait, as is the case for, for example Roundup Ready® Maize 2, which is both resistant to glyphosate and lepidopteran larvae

The specialist report in Appendix C provides a detailed description and assessment of GMOs in general and then specifically also the GM maize events to be planted by the Proponent. Note that the report also includes GM cotton events. The report addresses myths, truths and concerns regarding GMOs and provides prevention and mitigation measures required for GM maize cultivation. The cultivation of GM maize has received conditional approval by MEFT for its cultivation in Namibia. This approval was based on a strategic environmental assessment conducted in 2019/2020 (Faul et al. 2020). The conditional approval requires that individual assessments must be undertaken for each farm, as is being done in this report.

In the interim, until GM maize cultivation is approved, conventional maize cultivation continues. Once GM maize is cultivated, harvested GM and conventional maize will be kept separate, should both be planted on the farm. If not kept separate, all maize will be considered as GM maize.

4.3 LIVESTOCK

The less suitable areas for crop cultivation are used for livestock rearing. Cattle, sheep, and goats are herded and managed as part of the integrated business unit. A dedicated workforce manage all operations related to livestock farming, which includes predator protection, watering equipment, lambing or calving support, herd vaccinations, hoof care, pasture management and meat marketing. At times, such as during nights or during calving season, some of the livestock are kept in holding pens closer to the Proponent's main operations. A feedlot is employed at times to provide for additional support during droughts.

Photo 4-13 Cattle at a feeding through

Photo 4-14 Cattle at a water hole

4.4 SUPPORT INFRASTRUCTURE

Operations as outlined above, require support infrastructure or resources. The most crucial of these relate to water required for irrigation and potable use. Related support infrastructure are detailed below. Water and related irrigation systems are discussed in Section 4.5 while labour and related aspects are detailed in Section 4.6.

The majority of operations on the farm are provided with **electricity** from a 32 kVA photovoltaic solar system. The main system (22 kVA) is employed at the irrigation boreholes while household electricity is augmented by smaller (10 kVA) solar systems. An additional a 50 kVA installation is planned for future operations. Employee houses are serviced with outside lights. **Fuel** is stored in one above ground tank of 5000 *l* for the use by mainly tractors and farming related operations.

Water is pumped from various boreholes for irrigation, stock watering and domestic use. Storage of water is determined by its use. Irrigation boreholes has a balancing dam before water is pumped to the pivots, stock watering rely on reservoirs and water holes while domestic use employ water storage tanks. All offices are provided with septic tank and french drain systems to accommodate waste water. Employees' houses are provided with pit latrines and septic tanks that are pumped out. **Waste disposal** mainly comprise an excavated pit where waste is regularly burned. Due to a lack of any recyclers in the area, recycling of certain wastes are not possible. However, where possible waste items are taken to the municipal landfill waste items are not discarded, but rather re-used for alternative purposes. This includes the re-use of old oil when not collected by oil recycling companies. Any hazardous waste is stored in suitable bunded areas while empty pesticides containers are burned.

 **Photo 4-15 Solar installation used at boreholes**	 **Photo 4-16 Fuel storage tank**
 Photo 4-17 Domestic water storage tank	 Photo 4-18 Water reservoir

A **storage and maintenance area** is located on the farm and comprise of a shed and storerooms where implements and other maintenance material are stored under roof and on impermeable surfaces. Any maintenance and or minor repairs are conducted on site and within these areas. Unused equipment and related materials are stored in an access controlled area. Offices and employee houses are all located on the farm as well. All pesticides and herbicides are stored in a dedicated **chemical store**. The chemical store is access controlled. Fertilisers are stored, separate from all other chemicals or materials, on an impermeable layer. Operational areas have firefighting equipment and safety signs where required. A summary of the support infrastructure components are presented in Table 4-2. Old borrow pits are located on the farm. These were developed by the Roads Authority during road maintenance and construction activities.

	
Photo 4-19 Chemical storage	**Photo 4-20 Chemical storage room entrance**

Table 4-2 Summary of infrastructure components related to agricultural operations

Project Component	Current Provision	Future Provision
Electricity Provision	No electricity provision	No future provision is planned
Photovoltaic Solar System	32 kVA	50 kVA
Water Provision	Groundwater abstraction from various boreholes	An increase in water allocation may be applied for
Water Storage	Various stock watering reservoirs and water tanks	No storage reservoirs planned for irrigation related activities
Equipment and General Storage	One existing storage complex	No additional storage proposed
Sanitation	Current septic tank and french drain systems catering for existing staff compliment	Additional septic tank and french drains may be required for planned expansions
Landfill	One landfill site	No additional sites planed
Fuel Storage	One diesel tank with a combined capacity of 5,000 *l*	No additional tanks will be erected for the foreseeable future
Chemical Storage Area	One chemical storage unit	No additional chemical storage unit planned

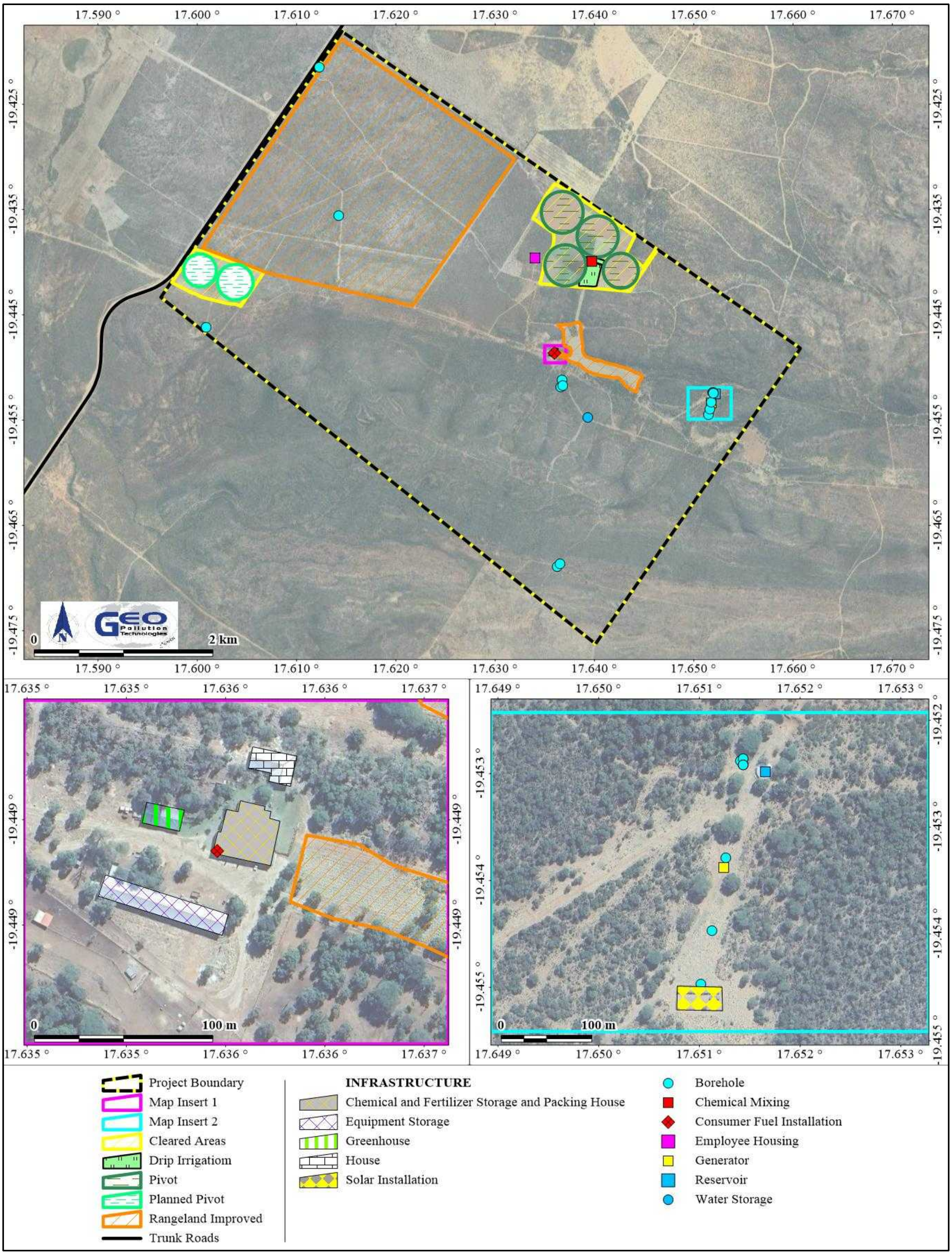


Figure 4-3 Map with infrastructure components

4.5 IRRIGATION AND WATER SUPPLY

All water requirements of the Proponent are met through the abstraction of groundwater. Existing and proposed irrigation of crops, make up the bulk of the water use, and is the determining factor in terms of water use and related licensing. The irrigation system employed on the farm is centre pivots. The Proponent has four fixed centre pivots irrigation fields.

Phocaides (2007) provides a description of the centre pivot, being a low to medium pressure, fully mechanised, automated irrigation of permanent assemble. It basically comprise a sprinkler pipeline (usually of high tensile galvanized light steel or aluminium pipes) supported above ground by mobile A-frame towers, long spans, steel trusses and/or cables (Photo 4-21). The pipeline is connected to a central tower with the "pivot mechanism" and main control panel. Moveable systems are mounted on wheels which allows it to be dragged from one field and fixed water supply point, to the next. The entire active irrigation system remains self-propelled to slowly rotate around the central tower while dispensing water through sprinklers (emitters) connected to the pipeline (Photo 4-22). An automatic alignment systems ensures the irrigation pipeline remains straight while a drive system enables the system movement. Small variations to the emitter sequence may be done when moving between different crops which may have different irrigation requirements. The Proponent has approximately 65 ha of pivot related irrigation fields on the farm and would like to further develop another 20 ha.

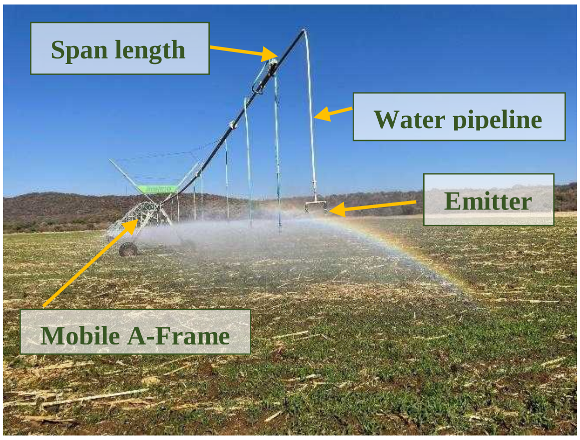


Photo 4-21 Centre pivot system

Photo 4-22 Centre pivot irrigating

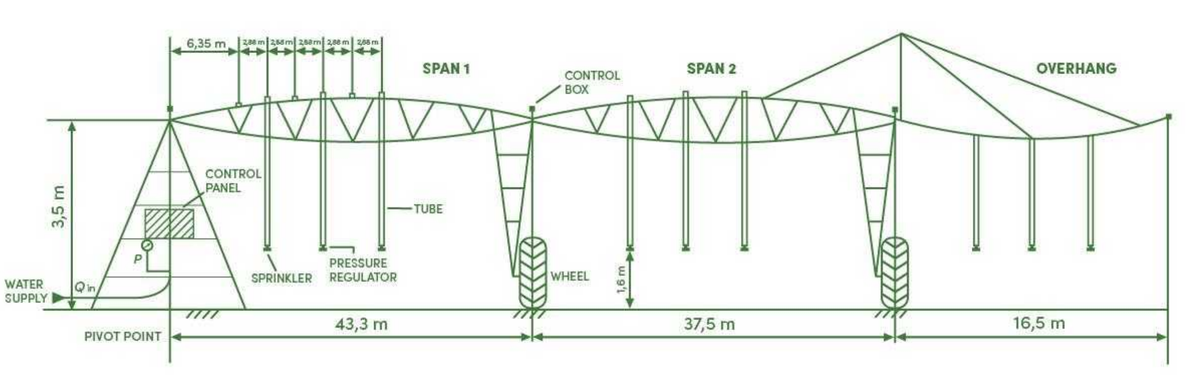


Figure 4-4 Diagram of a typical centre pivot irrigation system (AGRIVI, 2022)

During the recognisance site visit, al known boreholes on the farm were documented. Twelve boreholes were visited and data gathered about their status, use and physical description. Coordinates of all boreholes were recorded and mapped, as presented in Figure 4-5. Of the boreholes surveyed, four are used for irrigation purposes.

The Proponent has a water abstraction permit for 120,000 m³ per year and has, as required by the new Water Act, applied to the have the permit be replaced by a water license.

Table 4-3 Summary of borehole information obtained from the Proponent

Map Ref.	Farm Name	Borehole Name(s)	Use	Borehole Depth (m)	Yield (m³/h)	Water Level (mbs)
BH1	Emilienhoff FMB/00588	SAS Gat	Irrigation	79	90	
BH2	Emilienhoff FMB/00588	WW200925	Irrigation	120	90	19

Map Ref.	Farm Name	Borehole Name(s)	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
BH3	Emilienhoff FMB/00588	WW200926	Irrigation	120	90	26
BH4	Emilienhoff FMB/00588	WW200927	Irrigation	120	60	37
BH5	Emilienhoff FMB/00588	Berg Gat 1	Not used	60	2	25
BH6	Emilienhoff FMB/00588	Berg Gat 2	Not used	60	2	29
BH7	Emilienhoff FMB/00588	WW39401	Domestic/ Stock		5	22
BH8	Emilienhoff FMB/00588	Bobbejaan Flop Gat	Not used			
BH9	Emilienhoff FMB/00588	Bobbejaan Pos Gat	Not used			
BH10	Emilienhoff FMB/00588	Teerpad Land	Not used	148	245	36
BH11	Emilienhoff FMB/00588	WW39337	Stock		2.5	
BH12	Emilienhoff FMB/00588	Kalkbank Gat	Not used	60		

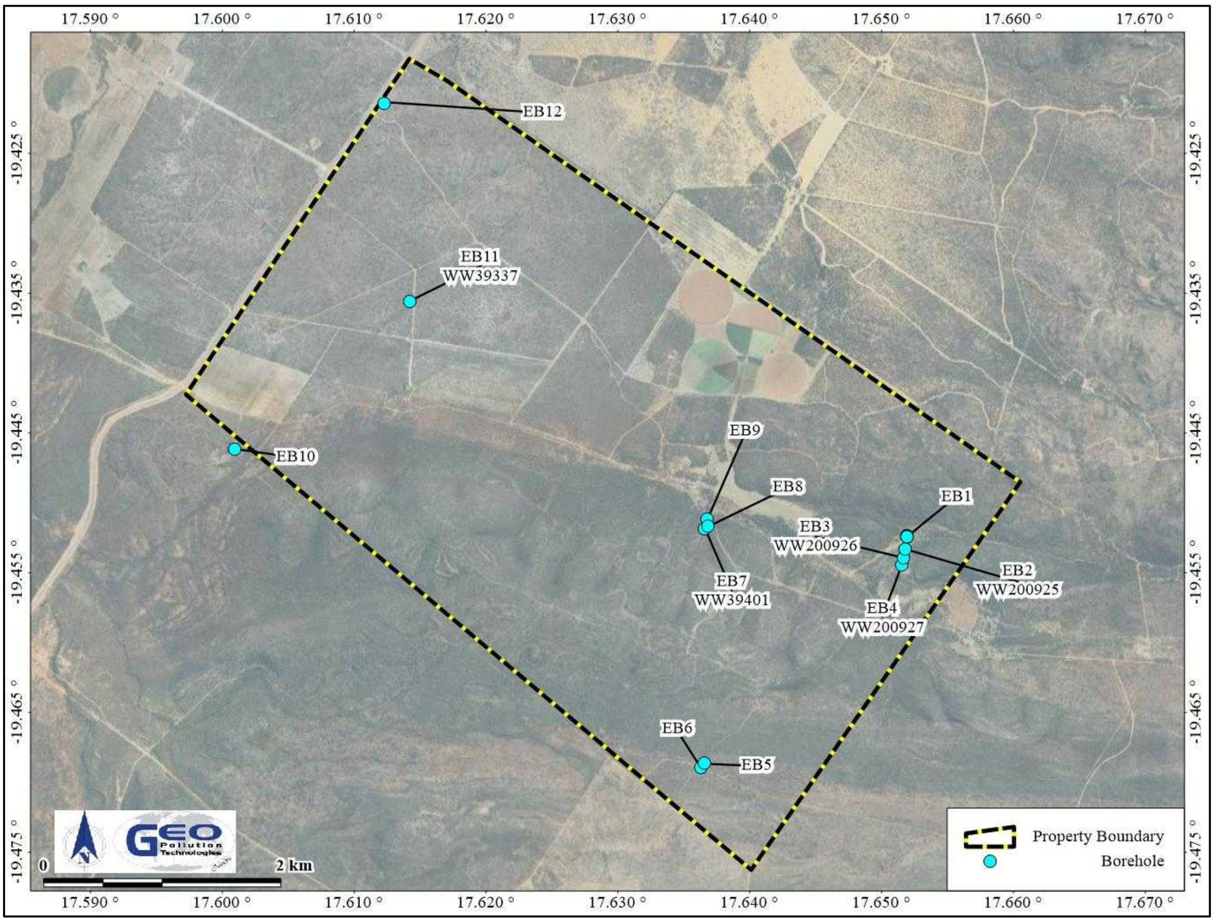


Figure 4-5 Locations of boreholes

Photo 4-23 BH1 Irrigation borehole

Photo 4-24 BH2 Irrigation borehole WW200925

Photo 4-25 BH4 Irrigation borehole WW200927

Photo 4-26 BH7 Domestic/stock borehole WW39401

4.6 EMPLOYMENT

All operations on the farm are reliant on labour. Operations currently require 43 permanent employees and approximately 80 seasonal employees. All permanent employees are provided with housing, and running warm water. There are dedicated permanent housing units to accommodate permanent staff. All employees are further provided with personal protective equipment when appropriate, while support is provided in terms of education, etc.

Photo 4-27 Employee housing

Photo 4-28 Seasonal employees being registered

5 ALTERNATIVES

The Proponent has incorporated various possible revenue generating activities on the property to ensure a robust and sustainable operational unit. A combination of agriculture and related activities are implemented, thereby significantly reducing possible feasible alternatives. Alternatives considered and described below, relate mostly to the implementation of the various project components but also include:

- Location alternatives;
- Project implementation and design alternatives;
- No-go alternative.

5.1 LOCATION ALTERNATIVES

The location of the irrigation areas area well suited for crop production due to the availability of water and suitability of soils. Boreholes are already in place and land clearing and field establishment have already been completed for existing operations. Cultivation areas have been informed by soil sampling and analysis to ensure the most suited placement of recent developed fields and proposed expansion areas. No location alternatives are therefore considered feasible, as the Proponent owns the property on which operations are conducted and proposed.

5.2 PROJECT IMPLEMENTATION AND DESIGN ALTERNATIVES

Various alternatives are continually considered to optimise crop production an irrigation. Boreholes are already in place and no surface water is available. Therefore, there are no alternative water sources for the irrigation operations. However, there are a number of alternatives with regards to the application of the water used. The most pertinent relates to crop irrigation methods. Furthermore, the type and variation of crops cultivated are also considered as alternatives.

5.2.1 Irrigation Methods

When considering alternative irrigations systems, the most viable irrigation option is not only based on the irrigation system's design efficiency, but should include environmental constrains and operating costs. Some systems are simply not viable due to climatic and topographical features as well as cost implications. For example, flood irrigation is not viable on steeper gradients and are more expensive due to water pumping costs.

The type of produce cultivated also plays a determining role. It will not be feasible to install highly efficient yet expensive irrigation systems (such as drip irrigation) for crops with lower economic yields. In turn, some crops will not produce such high yields when cultivated under less efficient systems. Table 5-1 depicts different types of irrigation systems as per the South African Irrigation Institute's suggested efficiencies (IWRM Plan Joint Venture Namibia, 2010). The estimated average costs are based on 35 ha units and although outdated estimates are still useful for comparisons purposes. Although flood systems are not viable irrigation methods, these have been included for comparison with regards to capital cost and design efficiency.

Table 5-1 Irrigation system efficiency (IWRM Plan Joint Venture Namibia, 2010)

Irrigation System	Design Efficiency	Capital Costs (R /ha)
Flood: Furrow	65%	13,000
Flood: Border	60%	17,600
Flood: Basin	75%	18,800
Sprinkler: Dragline	75%	24,800
Sprinkler: Quick-coupling	75%	22,500
Sprinkler: Permanent	85%	34,500
Sprinkler: Travelling boom	80%	23,200

Irrigation System	Design Efficiency	Capital Costs (R /ha)
Sprinkler: Centre pivot	85%	43,300
Sprinkler: Linear	85%	69,400
Sprinkler: Micro sprinkler	85%	36,300
Micro: Spray	90%	53,200
Micro: Drip	95%	46,300

In the Tsumeb district, climatic and soil conditions necessitate an irrigation system with a high rate of water deposition (due to evaporation). For purposes of irrigation, centre pivot and sprinkler systems are suitable. All irrigation is adjusted and implemented according to rainfall. During higher rainfall periods, less water is irrigated.

5.2.2 Soil Preparation

Traditionally, soil is prepared for planting by tilling and ploughing. These processes break the top layer of soil at varying depths and mix residual plant material into the soil. It also uproots weeds and provide for loose soil. There is nowadays however a shift in the approach to soil preparation that has some advantageous over traditional tilling. Conservation tillage practises aim at less disturbance of the soil and have advantages of less erosion, less evaporation and save on time and costs of traditional tilling. Conservation tillage can either be just partial tillage as is the case with strip-tilling or no tilling at all. With strip-tillage, only narrow strips are tilled in the area where planting will take place. The areas, between planted rows, are left untilled and with residual plant material from the previous harvest. With no-tillage, seeds are planted on the field with no soil preparation at all. The Proponent can investigate conservation tillage practices but due compacted fields (on the pivots), no-tillage may not be feasible.

5.2.3 Crop Selection (Maize)

The main challenges faced by the Proponent in maize cultivation, relates to the removal of weeds and extermination of pest such as Red Spider Mite (*Tetranychus urticae*) and the fall armyworm. Use of the Namibian approved herbicides are limiting, not only due to its effectiveness, but also due to the time requirements for spraying the various combinations. Some conventional maize variants are further sensitive to some of the available pesticides making its cultivation more challenging.

Conventional crop cultivation in Namibia excludes GM maize. Major advantages and disadvantages of traditional non-GM maize and various strains of GM maize are presented in Table 5-2.

Table 5-2 Alternative comparison of maize types for cultivation

Alternative	Advantages	Disadvantages	Preferred Option
Maize type			
Traditional non-GM maize	♦ Long established crops of which the positive and negative properties are well known ♦ Cheaper seeds ♦ Seeds easily available ♦ Can keep some harvested maize seed for next planting season	♦ Highly susceptible to crop damage by insects ♦ Reduced crop yields when significant pest outbreaks occur ♦ Maize is only broad leaf herbicide tolerant ♦ More labour intensive ♦ More spraying result in more fuel use and thus greenhouse gasses ♦ Increased water use due to need for dilution of insecticides	♦ Cultivation of GM maize with traditional maize as refuges. Planting a combination of GM maize events, or varying GM maize events between planting seasons, will contribute to delaying the
MON 810	♦ Resistant to main pests like fall armyworm	♦ Only one BT toxin can potentially lead to	

Alternative	Advantages	Disadvantages	Preferred Option
	and African stalk borer • Increased actual yields • Reduced insecticide use • Less labour intensive • Less greenhouse gas emissions due to reduced fuel use for spraying • Reduced water use due to less need for dilution of insecticides	more rapid insect resistance to *Bacillus thuringiensis* • Seed is more expensive • Seed is less easily obtainable • Requires special knowledge and proper management to prevent potential negative impacts	onset of insect resistance
MON 89034 (Maize)	• Resistant to main pests like fall armyworm and African stalk borer • Two *Bacillus thuringiensis* toxins has high efficiency and delay insect resistance • Increased actual yields • Reduced insecticide use • Less labour intensive • Less greenhouse gas emissions due to reduced fuel use for spraying • Reduced water use due to less need for dilution of insecticides	• Seed is more expensive • Seed is less easily obtainable • Requires special knowledge and proper management to prevent potential negative impacts	
NK 603 (Maize)	• Easier weed control • Increased actual yields	• Weeds can become resistant to glyphosate • Requires special knowledge and proper management to prevent potential negative impacts	
Stacked events	• Both insect resistance and easier weed control • Increased actual yields • Reduced insecticide use • Less labour intensive • Less greenhouse gas emissions due to reduced fuel use for spraying • Reduced water use due to less need for dilution of insecticides	• Pests and weeds can become resistant to Bt proteins and glyphosate • Requires special knowledge and proper management to prevent potential negative impacts	

5.3 No Go Alternative

Agriculture has been a core activity in the region for decades. Maize is supplied to Namibian mills and the stover used for fodder. Currently, within the restriction of pesticides available in Namibia and the significant infestation of invader grass species, the production of maize is almost not feasible. If maize is for example harvested along with the grass seeds, the entire harvest is downgraded, becoming not economically feasible when considering "input costs". This could be disastrous to Namibia who already is a nett importer of maize.

Should the project not receive an environmental clearance certificate, there would be a loss in capital investment and a significant loss in employment. This will lead to a decrease in the spending power of the local community. Finally, less revenue will be generated for Namibia and more money will be required for importing of feed and food. However, the most important aspect of the no go alternatives will be the lack of staple food production for the local market resulting in the need to import maize from other countries.

6 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

All projects, plans, programmes and policies with potential adverse impacts on the environment require an environmental assessment, as per the Namibian legislation. This promotes protection of the environment as well as sustainable development. The legislation and standards provided in Table 6-1 to Table 6-3 govern the environmental assessment process in Namibia, and are relevant to the assessed development.

Table 6-1 Namibian law applicable to the development

Law	Key Aspects
The Namibian Constitution	• Promotes the welfare of people • Incorporates a high level of environmental protection • Incorporates international agreements as part of Namibian law
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	• Defines the environment • Promotes sustainable management of the environment and the use of natural resources • Provides a process of assessment and control of activities with possible significant effects on the environment
Environmental Management Act Regulations Act No. 7 of 2007, Government Notice No. 28-30 of 2012	• Commencement of the Environmental Management Act • List activities that requires an environmental clearance certificate • Provides Environmental Impact Assessment Regulations
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act Act No. 36 of 1947; Government Notice No. 1239 of 1947	• Governs the registration, importation, sale and use of fertilizers, farm feeds, agricultural remedies and stock remedies • Various amendments and regulations
Seed and Seed Varieties Act 23 of 2018 Act No. 23 of 2018, Government Notice No. 368 of 2018	• Provides for restrictions on the importation of seed • Not in force yet
Water Resources Management Act Act No. 11 of 2013, Government Notice No. 269 of 2023	• Provides for management, protection, development, use and conservation of water resources • Prevention of water pollution and assignment of liability

Law	Key Aspects
Forest Act Act 12 of 2001, Government Notice No. 248 of 2001	• Makes provision for the protection of the environment and the control and management of forest fires • Provides for the licencing and permit conditions for the removal of woody and other vegetation as well as the disturbance and removal of soil from forested areas
Forest Regulations: Forest Act, 2001 Act 12 of 2001, Government Notice No. 170 of 2015	• Declares protected trees or plants • Issuing of permits to remove protected tree and plant species • Issuing of permits for harvesting of trees for wood and charcoal production and transport
Soil Conservation Act Act No. 76 of 1969, Government Notice No. 494 of 1970	• Laws relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources in Namibia
Biosafety Act Act No. 7 of 2006, Government Notice No. 210 of 2016	• Regulates activities involving the research, development, production, marketing, transport, application and other uses of genetically modified organisms and specified products derived from genetically modified organisms • Prohibits planting of genetically modified organisms without registration
Petroleum Products and Energy Act Act No. 13 of 1990, Government Notice No. 45 of 1990	• Regulates petroleum industry • Makes provision for impact assessment • Petroleum Products Regulations (Government Notice No. 155 of 2000) • Prescribes South African National Standards (SANS) or equivalents for construction, operation and decommissioning of petroleum facilities (refer to Government Notice No. 21 of 2002)
Local Authorities Act Act No. 23 of 1992, Government Notice No. 116 of 1992	• Defines the powers, duties and functions of local authority councils
Public and Environmental Health Act Act No. 1 of 2015, Government Notice No. 86 of 2015	• Provides a framework for a structured more uniform public and environmental health system, and for incidental matters • Deals with Integrated Waste Management including waste collection disposal and recycling, waste generation and storage, and sanitation
Labour Act Act No 11 of 2007, Government Notice No. 236 of 2007	• Provides for Labour Law and the protection and safety of employees • Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997)
Hazardous Substances Ordinance Ordinance No. 14 of 1974, Government Notice No. 2429 of 1972	• Applies to the manufacture, sale, use, disposal and dumping of hazardous substances as well as their import and export • Aims to prevent hazardous substances from causing injury, ill-health or the death of human beings

Law	Key Aspects
Pollution Control and Waste Management Bill (draft document)	♦ Not in force yet ♦ Provides for prevention and control of pollution and waste ♦ Provides for procedures to be followed for licence applications

Table 6-2 Guiding documents, directives and standards

Standard or Code	Key Aspects
South African National Standards (SANS)	♦ The Petroleum Products and Energy Act prescribes SANS standards for the construction, operations and demolition of petroleum facilities ♦ SANS 10089-3:2010 is specifically aimed at storage and distribution of petroleum products at fuel retail facilities and consumer installations ♦ SANS 10131 (2004) is aimed at above-ground storage tanks for petroleum products ♦ Provide requirements for spill control infrastructure
Department of Water Affairs and Forestry Code of Practice: Volume 1 Septic Tank Guidelines (General Guidelines July 2008)	♦ It defines french drains and septic tanks ♦ Gives location consideration and tank design guidance ♦ Septic tanks are- not allowed between two and five meters from a building and or a boundary ♦ It specifically states that in rocky areas secondary treatment must be provided for soak-aways

Table 6-3 Relevant multilateral environmental agreements

Agreement	Key Aspects
Stockholm Declaration on the Human Environment, Stockholm 1972	♦ Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment
United Nations Framework Convention on Climate Change (UNFCCC)	♦ The Convention recognises that developing countries should be accorded appropriate assistance to enable them to fulfil the terms of the Convention
Convention on Biological Diversity, Rio de Janeiro, 1992	♦ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity
International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	♦ Promotes conservation, exploration, collection, characterization, evaluation and documentation of plant genetic resources for food and agriculture ♦ Promote the sustainable use of plant genetic resources for food and agriculture

Listed activities, which require an ECC application (Government Regulation No 29 of 2012) related to this project, include the following:

Section 4: Forestry Activities

- <u>4 The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorisation in terms of the Forest Act, 2001 (Act No 12 of 2001) or any other law.</u> Various portions of the farm have previously been cleared (spanning a timeframe of 50 years).

Section 7: Agriculture and Aquaculture Activities

- <u>7.4 The import, processing and transit of genetically modified organisms:</u> The Proponent plans to plant GM maize.

- 7.5 Pest control: The Proponent uses conventional pest control products as approved by the Namibian government. These may include herbicides and pesticides and will vary according to season and pests encountered during a year.

Section 8 of Government Notice No. 29 of 2012: Water Resource Developments

- 8.1. The abstraction of ground or surface water for industrial or commercial purposes: Groundwater is abstracted for current and proposed commercial operations.
- 8.7 Irrigation schemes for agriculture excluding domestic irrigation: No *irrigation scheme* was developed, however, *irrigation systems* are used on the farm. Irrigation on the farm does not contribute to, or is part of any irrigation scheme, as proclaimed by the Namibian Government.

Section 9 of Government Notice No. 29 of 2012: Hazardous Substance Treatment, Handling and Storage

- 9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974." Fuel is stored on site for daily operations.
- 9.2 Any process or activity which requires a permit, licence or other form of authorisation, or the modification of or changes to existing facilities for any process or activity which requires an amendment of an existing permit, licence or authorisation or which requires a new permit, licence or authorisation in terms of a law governing the generation or release of emissions, pollution, effluent or waste. The Proponent has the infrastructure to store more than 5,000 *l* in aboveground storage tanks.
- 9.5 Construction of filling stations or any other facility for the underground and aboveground storage of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin. Fuel is stored on site, in an aboveground storage tank for daily operations.

Additional national planning legislation considered include:

- National Development Plans (NDPs).
- Ministry of Agriculture, Water & Forestry Strategic Plan 2017/18-2021/22.
- Namibia's Climate Change Adaptation.

The rationale behind the NDPs is to introduce an element of flexibility within the Ministry planning system by fast tracking development in areas where progress is insufficient. It also incorporates new development opportunities and aims to address challenges that have emerged after the formulation of various NDPs. In the NDPs Strategic Plan, the amount of hectares developed for irrigation, is a key performance indicator for the plan's second pillar's strategic objectives, which are aimed:

"*to increase productivity during the strategic period through the implementation of appropriate technologies e.g. Comprehensive Conservation Agriculture (CCA) and mechanization in order to ensure food security at both household and national level."*

Additional strategies included for the Agriculture Sector and Food Security include:

- Increase agricultural production for cereals, horticulture and livestock
- Promote the planting of drought resistance varieties

The above ties in with NDPs which purposes to set out a roadmap for achieving envisioned rapid industrialization while adhering to the four integrated pillars of sustainable development as identified in the plan. Irrigation activities contribute primary to the "Economic Progression" pillar by increasing the volumes of locally produced goods. One of the focus areas of the economic progression pillar of NDPs is agriculture and food security. The NDPs aims to decrease the amount of food insecure individuals, increase food production and increase the share of value addition in crop and livestock farming. Development and operations of irrigation activities on the farm are in line with all of these strategies as identified in the NDPs as well as for the Strategic Plans. The operation contributes to the amount of productive, irrigated land in Namibia, provides employment, and most crucially, produces crops for local markets.

Namibia's Climate Change Adaptation Communication to the United Nations Framework Convention on Climate Change, identifiers adaptation actions (amongst others) for the agriculture and water sectors. The Proponent has specifically considered the following actions:

- Develop improved crop varieties that adapt to climate change (Climate-Resilient Agriculture);
- Promote the diversification of crops to hedge against erratic rainfall and shorter seasons (Climate-Smart Agriculture); and
- Improve water demand management, particularly at the local level and in the agricultural sectors.

7 ENVIRONMENTAL CHARACTERISTICS

This section lists pertinent environmental characteristics of the study area and provides a statement on the potential environmental impacts on each.

7.1 LOCALITY AND SURROUNDING LAND USE

The project is located in Tsumeb constituency, approximately 26 km south of Tsumeb (19.447167°S and 17.630559°E). Presently there are no exclusive prospecting license (EPL) registered over the farm. However, there are three EPL *applications* registered across the farm for base and rare metals, industrials minerals, and precious metals. A reconnaissance license (RL) is further registered over the farm and pending renewal.

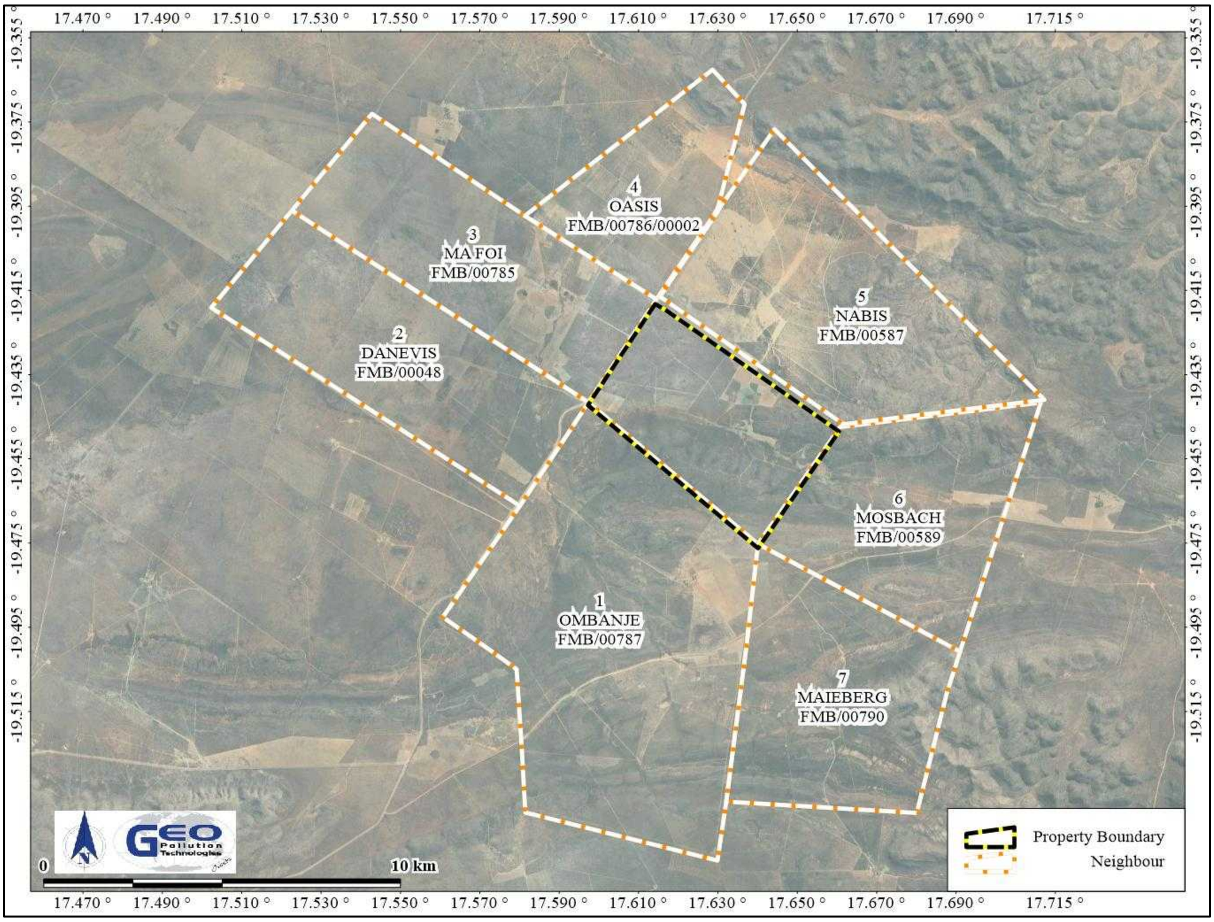


Figure 7-1 Properties adjacent to the project area

Surrounding properties are all similar in nature and used for crop cultivation and livestock rearing (commercial farming). No national or proclaimed conservation areas, protected areas or communal conservancies, are located close to the project. The adjacent properties are listed in the table below and their locations are depicted in Figure 7 1.

Table 7-1 Adjacent properties

Number on Map	Farm Name and/or Number
1	Ombanje FMB/00787
2	Danevis FMB/00048
3	Mafoi FMB/00785
4	Oasis FMB/00786/000002
5	Nabis FMB/00587
6	Mosbach FMB/00589
7	Maieberg FMB/00790

Implications and Impacts

The location is well suited for the agricultural activities. It is already zoned for agricultural use and is located in an area suitable for irrigation. All buffer zones, as required for the cultivation of GM maize should be maintained between the Proponent and neighbours cultivation traditional maize. Consideration should be provided toward prospecting activities proposed across plantations or areas under cultivation which are not allowed as per the Section 1 of the Minerals (Prospecting and Mining) Act 33 of 1992 as amended by the Minerals (Prospecting and Mining) Amendment Act 8 of 2008.

7.2 CLIMATE

The lack of functioning weather stations in Namibia, in especially rural areas, limits the availability of long term, true weather data. In the absence of weather station in the area, the best possible workaround is to use long term climate data obtained from the Atlas of Namibia Project (2002), the CHIRPS-2 database for precipitation (Funk et al., 2015), and temperature data from Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) (Ronald Gelaro, et al., 2017). Long term precipitation data was obtained from the CHIRPS-2 database (Funk et al., 2015). The CHIRPS-2 dataset (Climate Hazards Group Infra-Red Precipitation with Station data version 2) consist of long term precipitation data (1981 to near-present) obtained from satellite imagery and in-situ station data and therefore represents more recent data. Data is averaged over an area of roughly 5 km by 5 km (25 km^2). This averaging effect should be kept in mind during data analyses as high precipitation from single thunder storm cells would be averaged out, thereby providing a reduced daily maximum precipitation value.

According to the Köppen-Geiger Climate Classification system the project is located in a hot semi-arid climate (BSh) (http://koeppen-geiger.vu-wien.ac.at/present.htm). This means that the area receives precipitation below potential evapotranspiration, but not as low as a desert climate and has a mean annual temperature of at least 18 °C.

The Atlas of Namibia average rainfall for the area is 450 to 550 mm/a with a variation of 30 to 40% (Atlas of Namibia, 2022). The CHIRPS-2 dataset correlates well with the Atlas of Namibia with a calculated average rainfall of 468.34 mm/a for the area. However the coefficient of variance is slightly lower at 26.98 %. Both datasets indicate monthly rainfall peaking in January to March. CHIRPS-2 also indicates heavier precipitation (single day events) occurring between December to April, with a single day 25 km^2 maximum of 62.24 mm in March being the highest. Maximum precipitation received over a 3-day period is 85.62 mm indicating that heavy rainfall over long periods is not a common occurrence. The potential evapotranspiration is 2,400 – 2500 mm/a. By dividing the mean annual potential evapotranspiration into the mean annual precipitation, an aridity index value for the area was indicated as 0.22, which suggests the area to be Semi-Arid. The Atlas of Namibia and CHIRPS-2 datasets do not correlate well with the data received from the farmer, who receives an average of 850 mm over a 40-year period.

CHIRPS-2 daily and seasonal precipitation data is presented in Table 7-2 and in Figure 7-2 (Funk et al., 2015). Seasonal (July to June) total precipitation, centered on the average line for the last 43 years, is presented, with the daily total precipitation and the seasonal cumulative precipitation. From the figure it is clear that the rainfall for 7 out of the last 10 seasons were all below average.

Table 7-2 Rainfall statistics (Funk et al., 2015)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (mm/m)	20.24	27.10	27.91	0.00	0.00	0.00	0.00	0.00	0.00	5.33	9.80	15.82
Maximum (mm/m)	293.44	209.96	172.54	98.10	6.10	0.51	0.03	0.00	8.95	57.83	118.88	175.56
Average (mm/m)	121.34	110.21	77.06	27.47	0.98	0.03	0.00	0.00	1.06	17.59	37.99	70.90
Variability (%)	55.14	48.69	40.78	83.30	196.48	359.27	458.13	0.00	205.84	71.40	54.05	52.05
Daily Maximum (mm)	45.19	62.24	61.68	51.41	6.10	0.23	0.01	0.00	8.29	20.70	33.40	44.87
Average Rain Days	12.93	11.16	7.93	2.93	0.33	0.26	0.16	0.00	0.60	3.70	7.53	10.47

Season July - June average 468.34 | Season coefficient of variation: 26.98 | 3 Day return period: 85.62

Date range: 1981-Jan-01 to 2024-Jun-30 | Lat: 19.447°S | Long: 17.631°E

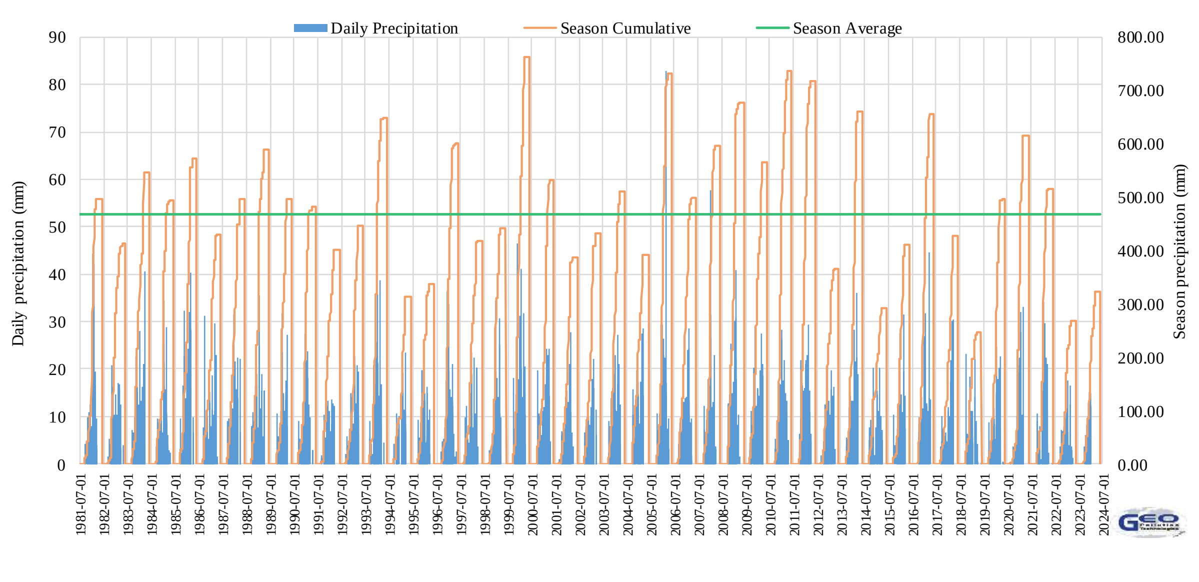


Figure 7-2 Daily and seasonal rainfall (Funk et al., 2015)

Similar to precipitation data, temperature data is also lacking for the project area, with the Atlas of Namibia presenting only crude, large scale averages. To have an idea of temperatures in the area, monthly temperature data was retrieved from the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) data set for a height of 2 m above surface (Ronald Gelaro, et al., 2017). This data set is a NASA atmospheric reanalysis, incorporating satellite data integration and aims at historical climate analyses at 0.5° x 0.625° spatial resolution. This translates to roughly 3,640 km², which still is a large area, but is somewhat less crude than the Atlas data.

Table 7-3 presents statistics of daily modelled temperature data abstracted from the MERRA-2 data set for the last 41 years. The modelled lowest temperature of -1.86°C was recorded in June. Temperatures of -3°C to -4°C have been recorded by the farmer, leading to frost over the farm, including pivot fields, necessitating frost measurements. The average annual minimum temperature is 5.1°C. A maximum temperature of 40.6°C was measured in January, while the average annual maximum temperature is 36.8°C. The average annual temperature range is 22°C while the average diurnal temperature (difference between daily minimum and maximum temperature) for this area is around 23°C. Direct normal solar irradiance for the area is 5.559 kWh/m²/day.

Figure 7-3 indicates modelled wind data that has been generated via satellite data for the project area and has not been generated on site. Localised conditions may see wind patterns being slightly altered by localised topography. Wind is generally blowing from east (E) and from the east-north-east (ENE).

Table 7-3 Temperature statistics based on Merra-2 data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (°C)	8.73	8.22	8.49	6.95	2.98	-1.86	-0.45	2.84	5.51	5.13	5.42	9.43
Maximum (°C)	40.63	38.87	38.97	36.14	33.84	30.27	30.50	33.75	37.68	40.26	40.53	40.26
Average (°C)	25.49	24.20	23.39	21.32	19.12	16.24	16.12	19.05	22.62	25.16	25.94	25.64
Diurnal (°C)	21.22	19.40	19.86	20.82	22.43	23.47	24.01	25.55	26.06	24.61	24.16	22.31
Season July - June			Seasonal average Temperature: 22.02									
Date range:	1980-Jan-01	to	2021-Sep-30			Lat: 19.447°S				Long: 17.631°E		

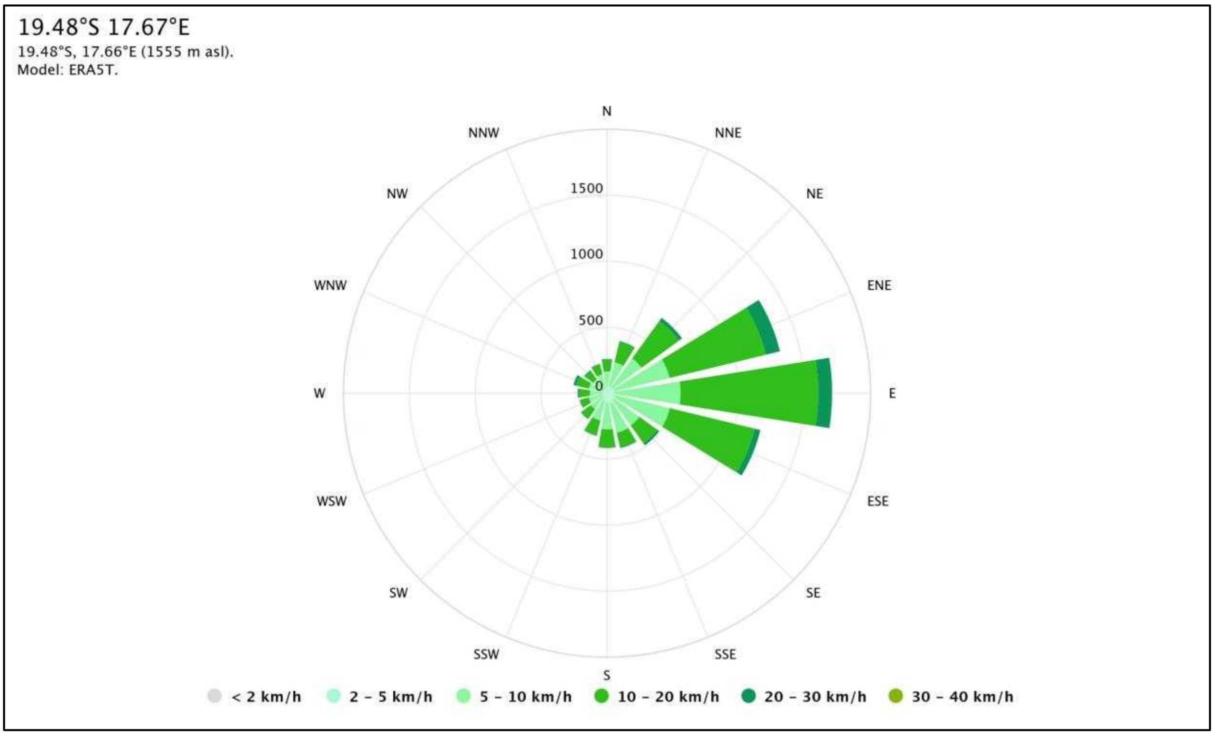


Figure 7-3 Average wind speed direction (https://www.meteoblue.com)

Photo 7-1 Potato field damaged by frost

Photo 7-2 Frost damaged potatoes

Implications and Impacts

Rainfall events are often thunderstorms with heavy rainfall that can occur in short periods of time ("cloud bursts"). Rainfall in the area is above the Namibian average, but varies significantly year on year. Hail is known to occur in the area and has, in the past contributed to crop damage on the farm. Heavy rainfall can lead to soil erosion when improper agricultural practises are employed while dry seasons will necessitate greater reliance on groundwater resources. Recurring drought conditions may impact on groundwater availability due to reduced aquifer recharge.

Hot dry winds increase the risk of crop damages as well as fire risks and related severity. General winds may carry chemicals and pollen of crops in mainly a western direction. Solar radiation values are high enough to reliably support photovoltaic solar panels. Electricity output from solar panels is affected by smoke caused by field fires in the northern parts of the country. Occasional frost necessitate frost management measures. Climate change contributors are largely related to the mechanised systems and synthetic fertilisers used as part of operations. Effects of climate change to consider during the proposed operations over the next 30 years include increased frequency of droughts (changing rainfall patterns) and higher temperatures (World Bank, 2021).

7.3 TOPOGRAPHY, DRAINAGE

The farm is part of the Karstveld landscape (Medeleson, 2022), an area dominated by limestone with little or no surface run-off and a strong development of sinkholes, dolines and caves. The general description of little to no run-off relates to the fact that most of the rainfall in the area rapidly drains into the ground and underground cavities. Drainage and soils of the Karstveld landscape are influenced by its topography. For the Proponent's farm, the topography can be described as largely an open valley within the northern reaches of the Otavi Mountainlands. Contrary to the overall low surface runoff in the Karstveld landscape, the steeper mountains on the southern boundary of the farm, do ensure more run-off on site. The local drainage is towards the east, ultimately draining towards the Etosha Pan, as part of the Etosha Catchment.

The southern hills, of the farm rises to an elevation of 1,429, the lowest elevation of the farm therefore being on its western border Although this area has an average slope of 3.3%, it is misleading since this portion of the farm is distinctly more hilly, having steep slopes of up to 24%, while the central portions are more undulating having a gentler slope of approximately 1% overall.

Photo 7-3 Part of the Otavi Mountainland on the southern part of the farm

Photo 7-4 Northern view from the farm

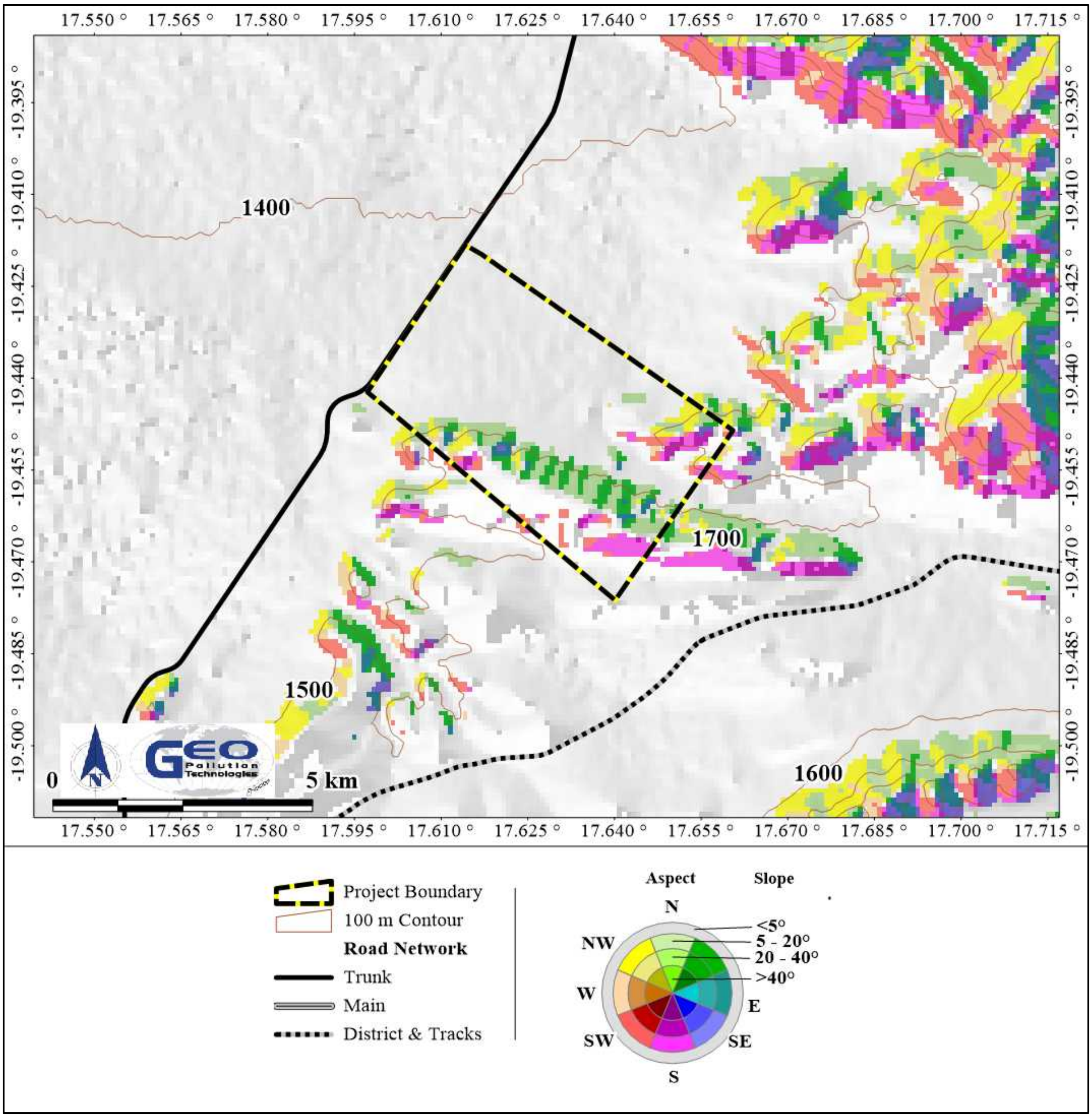


Figure 7-4 Aspect slope

Implications and Impacts

The project area is generally flat to the northern parts and well suited for pivot-based irrigation. Topographical features to the south restrict the availability of areas suitable for commercial crop production. In addition, drainage of the area influences crop field orientation, taking into consideration slope gradient and erosion. Steeper gradient areas are also more difficult to manage, especially in terms of rangeland management with bush encroachment clearly evident.

7.4 GEOLOGY AND HYDROGEOLOGY

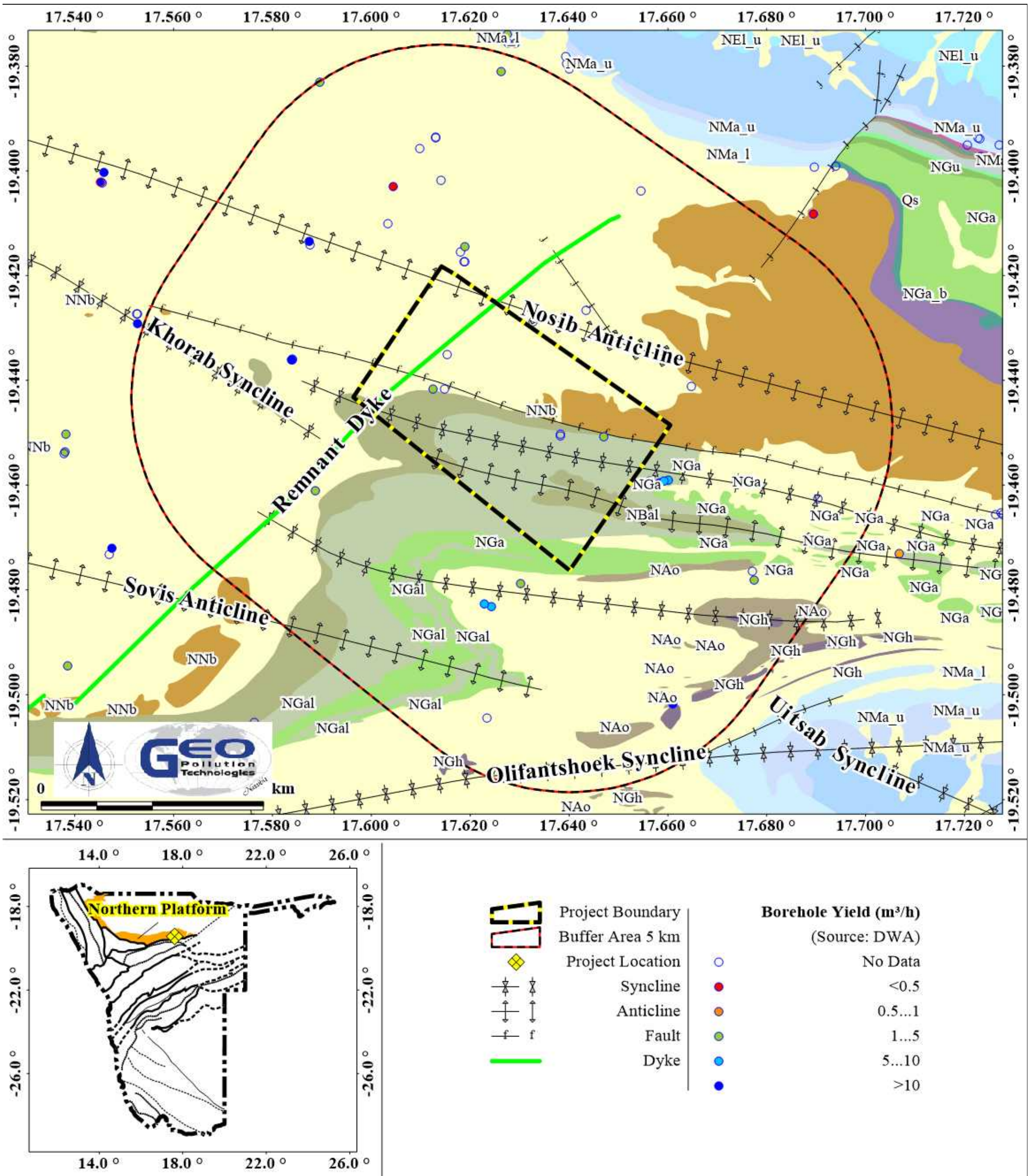
The geology underlaying the project area was formed during the Quaternary, Namibian, and Mokolian ages. Forming a complex stratigraphic succession of geological layers with periods of intense weathering and deposition events recorded. Currently the geology underlaying the flat portions of the project area is entirely from the Quaternary and Tertiary Age comprises of the Kalahari Group deposits which consists of sand, calcrete and gravel (). While the mountainous areas forms part of the Namibian aged Otavi Group, consisting of Limestone (NGal and NBal) and dolostone (NGa).

The Kalahari Group sediments originate mainly from fluvial deposition with some reworking through aeolian processes. Kalahari sediments at the project location form only a surface cover. The Kalahari Group sediments commonly overlie pre-Kalahari rocks of the Damara Sequence (Namibian Age). At the project location the underlaying Damara Sequence consists of dolostones, limestone, diamicitite, phyllites, quartzites, and shales of the Tsumeb and Abenab Subgroups. These subgroups belong to the Otavi Group (Schneider, 2008). Furthermore, the Otavi Group belongs to the Northern Platform of the Damara Sequence. Inclusions of the Navachab (Khomas) Subgroup of the Swakop Group can also be found in the area. The Swakop Group originated from the Northen Zone of the Damara Sequence. These groups are relatively of the same age but originated in two different locations. See the following figure that describes the lithological succession of the Damara Supergroup.

Moderate folding of the strata occurred during the Pan African Orogeny (680-450 Ma) and resulted in the formation of synclines and anticlines, generally trending east-west. The development of joints and fractures in the rocks are associated with the folding, which have an impact on the hydrogeological characterization of the area. The project area is largely impacted by thrusted faulting that led to the development of multiple synclines and anticlines within the mapping extend (Miller, 2008).The Nosib and Sovis Anticline as well the Khorab, Uitsab, and Olifantshoek Syncline are all in and around the project area. With fault lines trending in an east-west direction parallel to the various synclines.

Various northeast striking magnetic dykes are known to be present in the subsurface, as inferred from aeromagnetic data. The dykes seem to be related to the Paresis intrusion which are situated just south of Otjiwarongo, with dykes radiating from this intrusion. These dykes are locally thought to have shattered the host rocks during its formation. Where dolomite is the host rock, it forms a zone favourable for the development of karst features and groundwater accumulation. The remnant dyke can be found northwest of the project location, just outside of the mapping extend of Figure 7-5. The main fault orientation is roughly east to west.

Geophysical-interpreted dykes occur in the area and strike towards the northeast. As mentioned, the Remnant dyke is located on the western side of the project area. This dyke is identifiable on the aeromagnetic data. The nature of these dykes tends to be mineralised faults with high hydraulic conductivity values. Both the Tsumeb and Remnant dykes represented a major exploration target for the NamWater water supply programme to Windhoek. The dykes are thought to have shattered the host rocks during its formation (Hoad, 1992).



Age	Lith Code	Supergroup	Group	Subgroup	Formation	Description
Quaternary	Qs		Kalahari			Sand, gravel, and calcrete
Namibian	NEl_u	Damara	Otavi	Tsumeb	Elandshoek	Dolostone (bedded)
	NEl_l					Dolostone (massive)
	NMa_u				Maieberg	Dolostone (bedded)
	NMa_l					Limestone/marl (bedded)
	NAo_u			Abenab	Auros	Dolostone
	NAo					Limestone, Dolostone
	NAos					Shale, and limestone
	NAo_l					Dolostone (cherty)
	NGu				Gruis	Dolostone (bedded)
	NGa				Gauss	Dolostone (massive)
	NGabd					Dolostone (bedded)
	NGa_b					Dolostone, shale
	NGal					Limestone
	NBal				Berg Aukas	Limestone
	NBa					Dolostone (laminated light/dark)
	NCh				Chuos	Diamictite, pebbly schist, quartzite, conglomerate, dolostone and shale
	NGh		Swakop	Navachab (Khomas)	Ghaub	Diamictite
	NNb		Nosib		Nabis	Quartzite, arkose, conglomerate, and shale

Figure 7-5 Regional Geology (GSN Geological Map, 1:250,000)

Several known karst features are present in the region. These include the mineralised karst chimneys of both the Tsumeb and Abenab Mines (Bäumle, 2003), as well as several sinkhole lakes (Otjikoto and Guinas) and caves. The Gross Otavi and the Kombat mines are located approximately 23 to 29 km to the south of the project area respectively. This hydrothermal deposit represents a highly mineralized zone of which metals like vanadium as well as lead, copper and zinc were mined until 1948 and 1958 respectively when the ore reserves were depleted and the mines were closed (von Bezing, Bode, & Jahn, 2014). The Tsumeb Mine is approximately 62 km to the northeast; mining ceased here in 1994.

The project area is situated in the Owambo Groundwater Basin with the southern tip of the farm located in the Kunene South Groundwater Basin. Localised groundwater flow may take place along preferred flow paths in different directions, but the larger scale groundwater flow is expected to be in a northern direction (Figure 7-6). Local flow patterns may vary due to groundwater abstraction. Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes/mineralised faults or along contact zones (secondary porosity) and other geological structures present within the underlying formations (hard rock formations). Contact zones in the area occur between permeable and impermeable formations and create favourable conditions to promote groundwater flow.

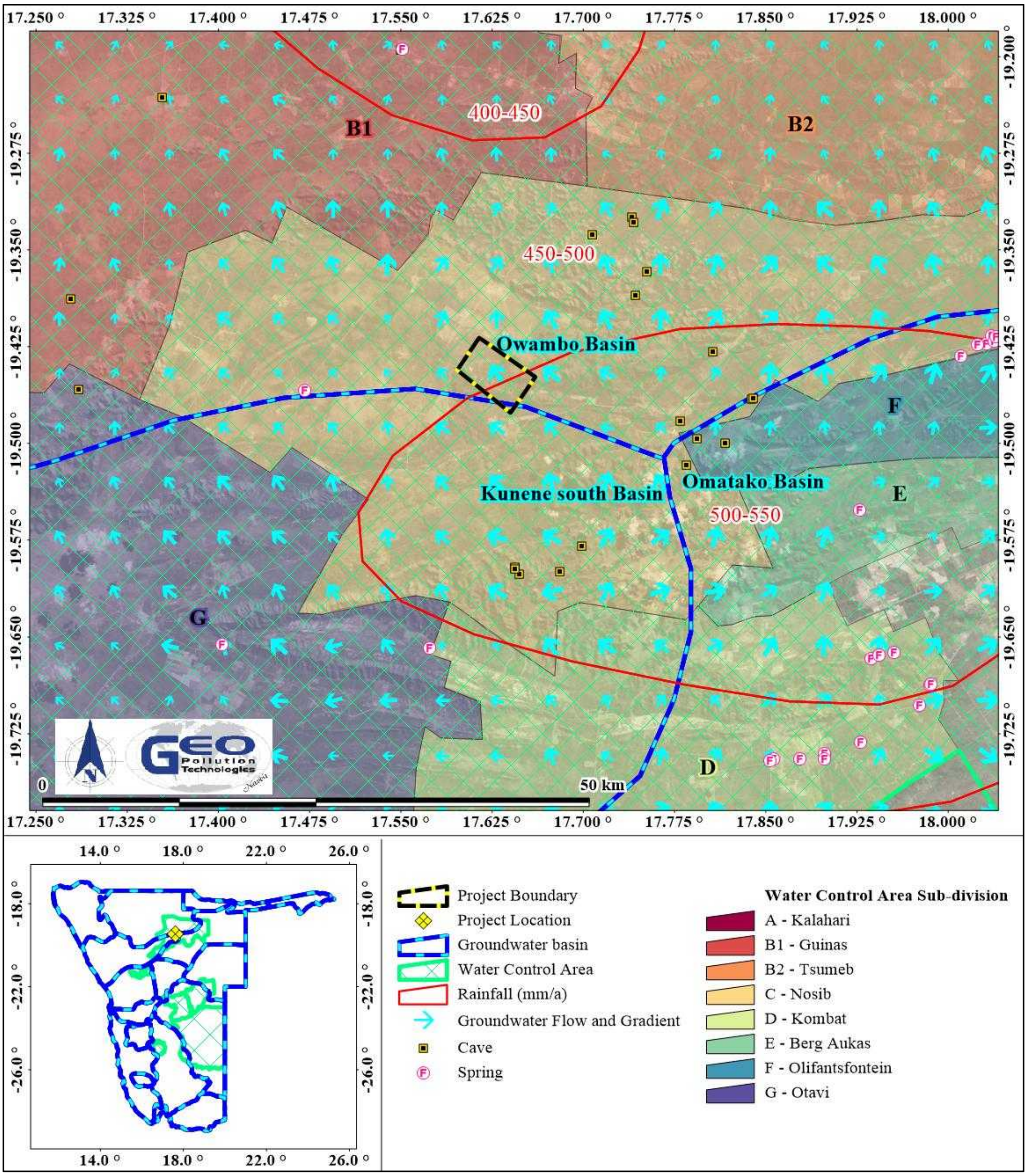


Figure 7-6 Groundwater catchments and water control areas

Please not that there is a discrepancy between Table 7-4 and Figure 7-5 as the figure indicates numerous boreholes with yields below 0.5, yet only nine data points are included in the table. The boreholes shown with yields below 0.5 have no recorded data, aligning with the table's filtering criteria, which excludes values greater than 0.01. Table 7-4 indicates the groundwater statistics for 9 boreholes in a 5 km radius around the project. The groundwater information was obtained from Department of Water Affairs (DWA) borehole database. This database is generally outdated and more boreholes might be present. The average depth of 9 of the 9 boreholes is 58 m below surface and the yield of 9 of the 9 boreholes ranges between 2.7 and 8.1 m^3/h. The average groundwater level of 5 of the 9 known boreholes is 27.6 m below surface, ranging between 9 and 60 m below surface.

Table 7-4 Groundwater statistics

	Depth (m)	Yield m^3/h)	Water level (m)	Water Strike (m)	TDS (ppm)	SO4 (ppm)	NO3 (ppm)	F (ppm)
Data Points	9	9	5	0	9	9	7	9
Minimum	29	2.7	9	0	470	15	0.8	0.5
Average	58.2	5.0	27.6	0.0	659	51	15	1
Maximum	107	8.1	60	0	858	117	30	1.1
Group A	*0-50*	*>10*	*0-10*	*0-10*	*0-1000*	*0-200*	*0-10*	*0-1.5*
%	44%	0%	40%	100%	100%	100%	43%	100%
Group B	*50-100*	*5-10*	*10-50*	*10-50*	*1000-1500*	*200-600*	*10-20*	*1.5-2.0*
%	44%	44%	40%	0%	0%	0%	14%	0%
Group C	*100-200*	*0.5-5*	*50-100*	*50-100*	*1500-2000*	*600-1200*	*20-40*	*2.0-3.0*
%	11%	56%	20%	0%	0%	0%	43%	0%
Group D	*>200*	*0-0.5*	*>100*	*>100*	*>2000*	*>1200*	*>40*	*>3*
%	0%	0%	0%	0%	0%	0%	0%	0%
9 boreholes in a 5 km radius from				**-19.447167**		**17.630559**		

Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:

Group A: Water with an excellent quality

Group B: Water with acceptable quality

Group C: Water with low health risk

Group D: Water with a high health risk, or water unsuitable for human consumption.

Implications and Impacts

A risk to groundwater pollution is expected due to the geological sensitivity of the area. Groundwater is utilized in the area and such users would be at risk if groundwater contamination occurs. Irresponsible irrigation methods like over-irrigation may result in higher demands for fertiliser and pesticide which in turn will increase nitrates and pesticide concentration in the groundwater. Over application of the herbicides is specifically a common expressed concern when planting GMO maize.

Over abstraction may also impact on other users of the aquifer. The hydrogeological specialist study however indicates that water levels, under current groundwater abstraction rates, are stable.

7.5 SOIL AND AEZ

The dominant soil type on the southern and the southwestern part of the farm is Skeletic Lithic Leptosol which refers to a soil type with a stony characteristic or very shallow depth over a continuous rock surface. These soils are typically found in hills where erosion takes place at a higher rate than soil formation or sediment deposition. Due to this and the fact that these soils form a thin layer with high drainage, leptosols are poor candidates for crop production. In addition to this, the leptosol of this particular area is known for having continuous hard rock within 10 cm of the soil surface and containing 40 to 90 % gravel or other coarse fragments by weight up to a depth of 100 cm. The soil in this area is made up of approximately 65-70% sand, 10-15% silt, and 25-30% clay, giving it the texture of Sandy Clay Loam. It typically extends to a depth of 140-150 cm, with a pH between 5.5 and 6 and a cation exchange capacity of 7-10 cmol/kg. Additionally, the soil can hold 40-60 mm of water at root depth (De Pauw, et al, 1998).

The dominant soil type on the northern and northeastern part of the farm is Leptic Regosol which refers to a young, undeveloped soil type lacking in diagnostic horizons and revealing very little evidence of its exact formation. These soils are common in areas where arid conditions have severely restricted the erosive processes and deposition of sediments. This also has the effect of making regosols on slopes highly erosive and not suitable for the cultivation of rain-fed crops shifting the Proponents focus to pivot irrigation. In addition to this, the regosol of this particular area is known for having continuous hard rock within 10 cm of the soil surface and containing 60-65 %, 10% silt and 25-30 % clay, giving it the texture of Silt loamy soil. It typically extends to a depth of 150-160 cm, with a pH between 5.5 and 6 and a cation exchange capacity of 10-13 cmol/kg. Additionally, the soil can hold 60-80 mm at root depth (De Pauw, et al, 1998).

The farm is situated within the CPL16-2 Agro-Ecological Zone (AEZ) with an average growing period 91-120 days. The CPL16-2 AEZ is ranked 2nd in Namibia in terms of agricultural potential and is deemed most suitable for short-maturing crops and large stock grazing. The CPL16-2 area is characterized mainly by sandy and loamy soils that are often underlain by calcrete. The area can be adequate for crop growing, providing soils are deep enough for good moisture retention capacity. The areas under irrigation around the farm are located in patches where sufficiently deep, quality soil is present for irrigation of crops (De Pauw, et al, 1998).

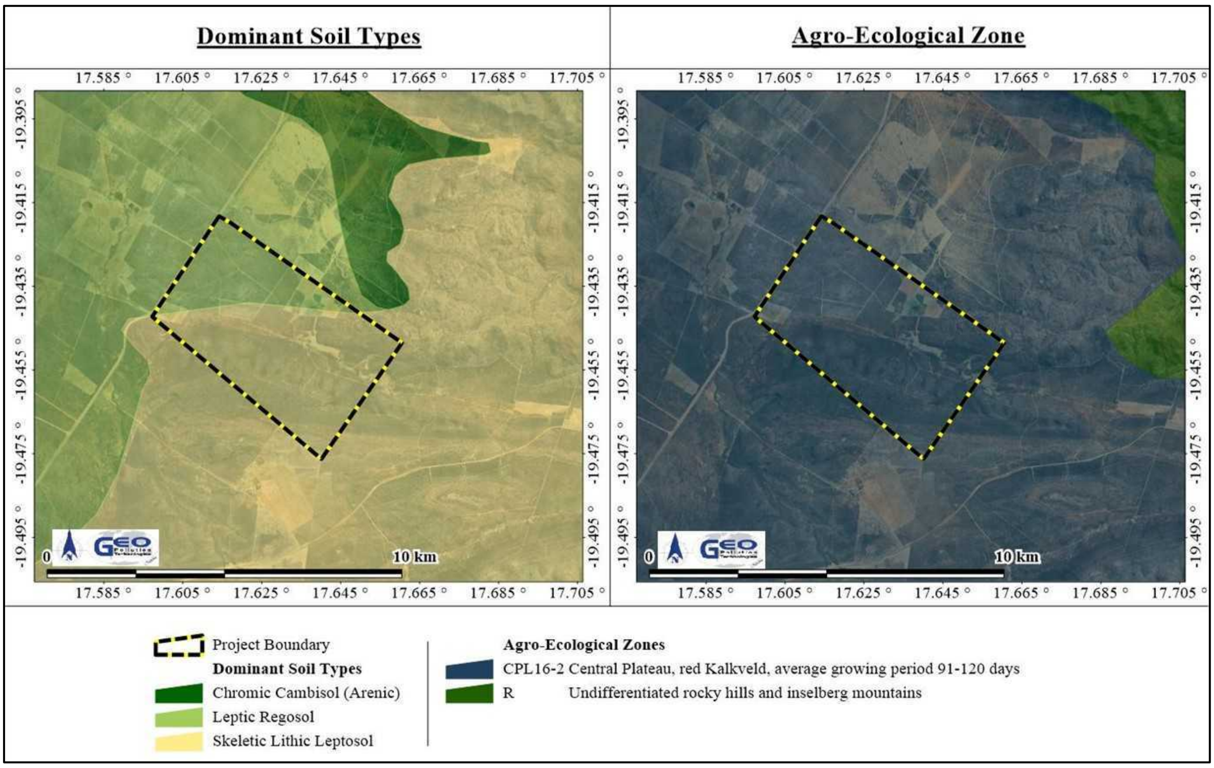


Figure 7-7 Rock type and Agro Ecological Zone (Atlas of Namibia Project, 2002)

Implications and Impacts

Soil contamination by hazardous chemicals and/or the excessive use of fertilizers and pesticides may negatively impact soil and the local ecology. Normal ploughing and tilling agricultural techniques aid in weed control and improved water infiltration. However, excessive tilling may result in soil erosion. By exploring conservation agriculture techniques and assessing their feasibility, it is possible to reduce erosion, increase soil organic content, and improve overall soil health. Different types of soil loose heat at different rates. Loose sandy soils may cool more quickly than heavy, dense clayey soils. Sandy soils therefore have a higher risk of radiation frost.

7.6 PUBLIC WATER SUPPLY

The Proponent and surrounding farming communities are completely reliant on groundwater as a source of potable water supply. The boreholes tap into the Owambo Groundwater Basin and are located within the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area, subdivision C – Nosib (Figure 7-6). Farms in the area all rely on boreholes for water supply for potable and agricultural use. There are no water supply schemes or related pipelines within 30 km of the farm.

Implications and Impacts

Groundwater is a valuable resource in the farming area and is controlled by a water abstraction license as regulated by the Ministry of Agriculture, Water and Land Reform (MAWLR). Groundwater contamination may negatively impact surrounding boreholes. No alternative water supply options exist if extensive contamination or deterioration of groundwater occur. Water abstraction schemes may affect the project which is located downstream of such schemes.

7.7 ECOLOGY

This farm is located in the Acacia sub-biome of the Tree-and-Shrub Savanna Biome. This biome is dominated by Acacias that grow in its arid environment, along with short shrubs and grasses that grow in the shallow soils of the area's hills. The Karstveld vegetation type, comprising mixed woodland species with an average tree height of 3 to 4.5 m, is documented for this area. Typically, 30 to 35% of this vegetation type is covered by woody plants. Plant diversity in this area may range between 400 and 500 species, the second highest diversity category for Namibia. Trees such as *Acacia erioloba, Acacia tortilis subsp spirocarpa, Combretum imberbe, and Elephantorrhiza schinziana* and a variety of other trees are characteristic of this Karstveld vegetation type. According to Curtis & Mannheimer (2005), 107 different tree species may occur in the quarter degree square (QDS) 1917BC. A summary of the protected trees (17), as per legislation in Namibia, is presented in Table 7-5, while a complete list of trees, which may occur in the area, is attached in Appendix D. Hills and ridges within the project boundary have significantly denser tree concentrations than the lower lying and flatter topographical areas

Table 7-5 Trees with conservation concerns in quarter degree squares 1917BC (Curtis & Mannheimer, 2005)

Name	Common Name	Notes
Acacia erioloba	Camel-thorn	Protected by forestry legislation.
Albizia anthelmintica	Worm-cure Albizia; Aru	The low numbers of young trees recorded is a concern, as is the number of dead trees in some areas. It is Protected by forestry legislation.
Berchemia discolor	Bird Plum	This species is Protected by forestry legislation, as well as by traditional Owambo cultures for its fruit and shade. The population does not appear to be in any real danger at the moment, but communities could be encouraged to plant this species.
Boscia albitrunca	Shepherd's Tree	Although widespread and hardy, it is heavily utilised by people and animals. The difficulty that young plants have in becoming established is a concern, but fortunately there appears to be a health and widespread population of young plants. Protected by forestry legislation.
Burkea africana	Burkea	Excessive fire may be compromising recruitment by destroying seeds. Overharvesting for timber may also be of concern in future. Protected by forestry legislation.
Combretum imberbe	Leadwood	Although heavily utilized by people regrowth is good and growth of young trees is vigorous. Because of its religious importance and many uses, it is protected locally. Old specimens warrant protection as monuments. Protected by forestry legislation
Cyphostemma juttae	Blue Kobas, Namibian grape, Wild grape	Endemic with very small population and threatened with pachycaul trade. Least concern according to IUCN

Name	Common Name	Notes
		criteria. Protected by Nature Conservation Ordinance. Protected by forestry legislation.
Erythrina decora	Namib Coral-tree	Endemic to Namibia and very uncommon throughout its range. Worthy of protection very few young trees Protected by forestry legislation.
Euphorbia guerichiana	Paper-bark Euphorbia	CITES Appendix II.
Ficus cordata subsp cordata	Namaqua Rock-fig	Protected by forestry legislation.
Lannea discolor	Live-long	Protected by forestry legislation.
Moringa ovalifolia	Moringa; Phantom Tree	Potentially threatened by pachycaul trade. Damaged by elephants in Etosha National Park. Protected by Nature Conservation Ordinance. Near endemic to Namibia extending into southern Angola. Protected by forestry legislation.
Pachypodium lealii	Bottle Tree	Vulnerable to pachycaul trade. Lack of young trees is a concern. Protected by nature conservation ordinance. Listed on CITES Appendix II. Near-endemic extending into extreme southern areas of Angola. Protected by forestry legislation.
Searsia lancea	Willow Rhus	May be affected by a disease. Protected by forestry legislation. Previously *Rhus lancea*.
Sclerocarya birrea	Marula	Protected locally by communities that use them. Protected by forestry legislation.
Spirostachys africana	Tamboti	Protected by forestry legislation.
Ziziphus mucronata	Buffalo-thorn	Protected by forestry legislation.

Photo 7-5 General vegetation on the farm

Photo 7-6 Large trees on the farm

Different from the vegetation structure, in which plants share ecological requirements and growth forms, the floristic groups is identified by plants being endemic to it. The majority of the farm forms part of the Zambesian Domain Floristic Group and hosts up to 242 species of flora.

The Otavi Mountanlands present suitable habitats for a number of bat species which have been documented to range across the project area. These bats include the following species: Dent's Horseshoe Bat (*Rhinolophus denti*), Striped Leaf-nosed Bat (*Macronycteris vittatus*) and the Greater Long-fingered Bat (*Miniopterus inflatus)*. The farm further falls within the habitat for a number of additional species of concern which may occur within the area. Some of the IUCN Red List of threatened species which are more likely to occur on or in the vicinity of the site are listed in Table 7-6.

Table 7-6 IUNC Red listed species which may occur in the area

Species Name	Common Name	IUCN Red List Status
Sagittarius serpentarius	Secretary bird	Threatened
Torgos tracheliotos	Lappet-faced Vulture	Endangered

Species Name	Common Name	IUCN Red List Status
Necrosyrtes monachus	Hooded Vulture	Critically Endangered
Falco vespertinus	Red-footed Falcon	Vulnerable
Neophron percnopterus	Egyptian Vulture	Endangered (Breeding area)
Aquila nipalensis	Steppe Eagle	Endangered
Acinonyx jubatus	Cheetah	Vulnerable
Trigonoceps occipitalis	White-headed Vulture	Critically Endangered
Smutsia temminckii	Temminck's Pangolin	Vulnerable
Parahyaena brunnea	Brown Hyaena	Near Threatened
Numenius arquata	Eurasian Curlew	Near Threatened
Calidris ferruginea	Curlew Sandpiper	Near Threatened
Macronycteris vittatus	Striped Leaf-nosed Bat	Near Threatened
Ardeotis kori	Kori Bustard	Near Threatened

Some of these species are more likely to occur in the uncultivated portions of the farm where wildlife can roam freely and undisturbed. Various antelope species, predators and large game are known to be present on the farm. Since the property borders farming operations who also have their own “conservation” (less disturbed) areas, an ecological corridor exist between them and the Proponent, which see some species crossing to an from. These include antelope species such as kudu and eland, but also include predator species. Jackal, caracal, and leopard and are known to be on and around the farm.

Photo 7-7 Antelope track

Photo 7-8 Vulture

Photo 7-9 Animal scat

Photo 7-10 Baboon footprint

Implications and Impacts

Pollution of the soil and groundwater by hazardous chemicals and/or the excessive use of fertilizers and pesticides may negatively impact the local ecology. Irresponsible use of pesticides to kill vermin such as jackal may further impact on already threatened vulture populations as well as other scavengers. Pesticides may also magnify (biomagnification) in higher trophic levels, especially top predators. This may lead to reproductive and other physiological defects and ultimately declining populations. Over-abstraction of groundwater may lead to ecosystem changes as groundwater levels decrease, which may have direct impacts on especially cave habitats downstream. Uncontrolled and unplanned fires may destroy ecological resources and threaten wildlife.

Planting of GM maize without implementing the necessary refuges, and not implementing monitoring programmes and preventative and mitigation measures when needed, may result in insect and weed resistance development. This may potentially impact the local ecosystem structure. Concerns related to the killing of non-target insects as a result of planting insect resistant maize are addressed in the specialist report (Appendix C).

7.8 LOCAL ECONOMY

The Oshikoto Region's economy is a diverse representation of various sectors and industries within the region. These include (but are not limited to) mining, tourism and agriculture, all of which have shown potential to be developed. The rural parts of the Tsumeb constituency has much less economic diversity and the agricultural sector, specifically the irrigation schemes between Tsumeb and the project area (which is located on the boarder of the constituency), are large contributors, if not the largest in the constituency. Not only does it create jobs, but it has also been one of the main driving forces of infrastructure development and related capital expenditure which are on-going in planning considerations. Continued employment increases individual economic resilience and provides for increased social security benefits.

In evaluating water use in primary economic activities such as agriculture, it is useful to consider the entire value-chain, i.e. the upstream and downstream activities. Intensive irrigated production schemes are strong economic drivers, as witnessed by the influx of workers to such areas. This potentially makes a significant contribution to the development of the Oshikoto Region and Namibia as a whole.

Water quality will have an effect on the productivity of operations, therefore the economic benefits of ensuring that the water quality and quantity of the groundwater reserve remains at its best, for all users is an essential component of the agricultural process. If water treatment is required, then the cost of production will increase, resulting in a decrease in revenue and feasibility. The same can be said for the quality of the soil, as lowered quality soil will be less economically productive and contaminated soil, such as found in some areas within the constituency, not usable at all. Water and soil are paramount for the continued functioning of the agricultural project and therefore provide a vital ecosystem service to the Proponent.

Regionally, skilled agriculture and fisheries provide the most employment (48%). It should be noted that although fishery falls within the agriculture sector it does not contribute to employment in the Oshikoto region. This trend follows through into the rural areas of the Tsumeb constituency within which the project lies. The economy of the area relies largely on commercial livestock farming supplemented with crop production and charcoal manufacturing. Livelihoods in the constituency are varied, engaging various sectors such as construction, wholesale and retail, administrative (public and defence) and manufacturing.

Table 7-7 Main industry of employed population aged 15 years and above for the Tsumeb Constituency and Oshikoto Region (Namibia Statistics Agency, 2011)

Main Industry	Tsumeb Constituency Rural	Oshikoto Region
Total	29,931	36,638
Agriculture Forestry and Fishing	17,535	17,860
Mining And Quarrying	195	929
Manufacturing	566	1,123
Electricity Gas Steam and Air Conditioning Supply	17	44
Water Supply Sewerage Waste Management and Remediation activities	25	58
Construction	1,156	1,713
Wholesale and Retail trade; Repair of Motor Vehicles and Motorcycles	1,229	1,880
Transportation and Storage	619	997
Accommodation and Food Service activities	707	963
Information and Communication	86	134
Financial Insurance Activities	134	279
Real Estate Activities	2	3
Professional Scientific and Technical Activities	188	260
Administrative and Support Service Activities	1,262	2,435
Public Administration and Defence; Compulsory Social Security	1,202	1,464
Education	1,945	2,285
Human Health and Social Work Activities	762	975
Arts Entertainment and Recreation	69	88
Other Services activities	535	682
Activities of Private Households	1,622	2,229
Activities of extraterritorial organisation and bodies	5	8
Don't Know	70	229

Implications and Impacts

Operations on the farm sustain valuable full time as well as seasonal employment opportunities in a constituency which relies on the agricultural sector. The project contributes to the local and national agricultural sector and specifically in terms of the planned growth in the irrigation sector as envisioned by the local government. Employment and remuneration of such a large workforce within the area stimulates additional economic growth.

The addition of GM maize cultivation, will increase the knowledge of a part of the workforce in terms of the specific requirements linked to GMOs. On a national level, the potential increased yields of GM maize will increase food security during, for example, the outbreak of fall armyworm. In considering Round-Up Ready maize, the cultivation thereof can lead to a reduced use of chemicals and tillage, contributing to preserving soil health. However, concerns have been raised about the impact GMO maize may have on on-GMO farmers as well as the export beef industry. These and additional concerns related to GM maize, are discussed in detail in a specialist report (Appendix C).

7.9 DEMOGRAPHIC PROFILE

The project area is located in the Tsumeb magisterial district in the Tsumeb Constituency of the Oshikoto Region and borders the Grootfonein Constituency of the Otjozondjupa Region. Goods and services are mainly sourced from either Tsumeb. For demographic information of the 2011 and 2023 population and housing census, refer to Table 7-8 (Namibia Statistics Agency, 2011 & 2023) which includes the details for the Tsumeb Constituency in relation to the National and regional averages. However, although the project falls within the Tsumeb Constituency, the nature of the area is rural. Unemployment in the Tsumeb Constituency is lower at 36% compared to the national and regional averages while the literacy rate also is lower.

Table 7-8 Demographic characteristics of the Tsumeb Constituency, the Oshikoto Region (Namibia Statistics Agency, 2011; 2023)

	2011		2023	
	Tsumeb Constituency	**Oshikoto Region**	**Tsumeb Constituency**	**Oshikoto Region**
Population (Males)	11,794	87,066	19, 512	127,374
Population (Females)	11,475	94,907	18,622	129, 928
Population (Total)	23,269	181,973	18,134	257,301
Population density (people/km^2)	34.9%*	40.2%*	10.6	6,7
Unemployment (15+ years)	36	40%	Tbd	36.9%
Literacy (15+ years)	84%	88%	Tbd	Tbd

∗ Calculated as per the economically active segment of the population

Tbd To be determined

Implications and Impacts

The project contributes mainly to demographic processes indirectly in requiring seasonal employment. Temporary migration in the area changes the demographic profile of the project as well as the surrounding area. Employment of so many people in a rural area works against urbanisation of the surrounding sectors. Skills development, training and exposure to best practises in terms of livestock management and irrigation, benefit employees during the operational phase over and above having access to economic resources and food. Increased access to such resources may increase the fertility of the local population. The concentration of the workforce requires planning of governmental services (such as education clinics and public services) to ensure adequate resources.

Diversifying farming activities by adding the cultivation of GM maize increases the economic resilience of the farm and thus provides increased job security to employees.

7.10 Cultural, Heritage and Archaeological Aspects

There are no cultural or heritage aspects known to be present on the farm. The proximity of the farm to Tsumeb, allows for easy integration to cultural and related services for employees.

Implications and Impacts

Existing and proposed areas of operations are not close to any caves or related features. However should any archaeological resources be found, such resources should be reported for investigation. Over abstraction of groundwater should be avoided to ensure no water bearing caves downstream of operations area impacted by dewatering.

8 PUBLIC CONSULTATION

Consultation with the public forms an integral component of an environmental assessment investigation and enables interested and affected parties (IAPs) e.g. neighbouring landowners, local authorities, environmental groups, civic associations and communities, to comment on the potential environmental impacts associated with projects and to identify additional issues that they feel should be addressed in the environmental assessment.

Public participation notices were advertised, twice in two weeks, in the national papers: The notices appeared in the Republikein and the Namibian Sun on 1 and 8 July 2024. A site notice was placed on site and notification letters were hand-delivered or e-mailed to neighbours as well as the relevant ministries. See Appendix E for proof of the public participation processes and registered IAPs.

9 ASSESSMENT AND MANAGEMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts that are expected from the operational, construction, care and maintenance, and potential decommissioning activities of the farm. An EMP based on these identified impacts is presented in this section.

For each impact, an environmental classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). Assessment of impacts is based on the following categories: importance of condition (A1); magnitude of change (A2); permanence (B1); reversibility (B2); and cumulative nature (B3) (Table 9-1).

The environmental classification is calculated as follows:

Environmental classification = A1 x A2 x (B1 + B2 + B3).

The environmental classifications of impacts and the respective classes are provided in Table 9-2.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Table 9-1 Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit/disbenefit of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative disbenefit or change	-2
Major disbenefit or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2

Strong Cumulative Character	3

Table 9-2 Environmental classification (Pastakia 1998)

Environmental Classification	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

9.1 RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

The EMP provides management options to ensure impacts of the agricultural and related activities on the farm are minimised. An EMP is a tool used to take pro-active action by addressing potential problems before they occur. This should limit corrective measures needed, although additional mitigation measures might be included if necessary. The environmental management measures are provided in the tables and descriptions below. For the GMO specific management plan please refer to Appendix C. These management measures should be adhered to during the execution of various activities on the farm. This section of the report is also presented as a stand-alone document for easy reference. All personnel taking part in the operations of the farm should be made aware of the contents of this section, so as to plan the operations accordingly and in an environmentally sound manner.

The objectives of the EMP are:

- to include all components related to operational and possible construction activities of the farm;
- to prescribe the best practicable control methods to lessen the environmental impacts associated with the farm;
- to monitor and audit the performance of operational personnel in applying such controls; and
- to ensure that appropriate environmental training is provided to responsible operational personnel.

Various potential and definite impacts will emanate from the operations, maintenance/construction and decommissioning phases. The majority of these impacts can be mitigated or prevented. The impacts, risk rating of impacts, as well as prevention and mitigation measures are listed below.

As depicted in the tables below, impacts related to the operational phase are expected to mostly be of medium to low significance and can typically be mitigated to have a low significance. The extent of impacts are largely site specific to local and are not of a permanent nature. Due to the nature of the surrounding areas, cumulative impacts are possible and the most important of these are potential groundwater and biodiversity/ecological impacts.

9.1.1 Planning

During the phases of planning for the operations, maintenance/construction and decommissioning of the farm, it is the responsibility of the Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management measures are in place prior to, and during all phases, to ensure potential impacts and risks are minimised. The following actions are recommended for the planning phase and should continue during all other phases of the project:

- Ensure that all the necessary permits from the various ministries, local authorities and any other bodies that governs the operations, maintenance/construction and decommissioning activities on the farm remain valid. These include the water abstraction license, consumer installation certificate and permit for environmental release of GM maize.
- Ensure all appointed contractors and employees enter into an agreement, which includes the EMP. Ensure that contractors, sub-contractors, employees and all personnel present on site understand the contents of the EMP.
- Make provisions to have a Health, Safety and Environmental (HSE) Coordinator to implement the EMP and oversee occupational health and safety as well as general environmental related compliance.
- Make provision for a community liaison officer to deal with complaints.
- Have the following emergency plans, equipment and personnel on site, where reasonable, to deal with all potential emergencies:
    - EMP, risk management plan, emergency response plan and HSE manuals;
    - Adequate protection and indemnity insurance cover for incidents;
    - Procedures, equipment and materials required for emergencies (e.g. firefighting, first aid, etc.).
- Establish and maintain a fund for future ecological restoration, specifically for instances of environmental damage caused during operations including pollution remediation where required. Should project activities cease completely, and future land-use will not involve agriculture, the funds should be utilised to remove all redundant infrastructure and waste.
- Establish and/or maintain a reporting system to report on aspects of operations, maintenance/construction, and decommissioning as outlined in the EMP. Keep monitoring reports on file for bi-annual submission to MEFT in support of environmental clearance certificate renewal applications. This is a requirement by MEFT.
- Appoint a specialist environmental consultant to update the environmental assessment and EMP and apply for renewal of the environmental clearance certificate prior to expiry.

9.1.2 Revenue Generation in the Professional Sector

Consulting and professional services are engaged with for assistance in applications for new permits and renewal for existing permits such as the water license, fuel storage and environmental clearance certificates. In addition, specialist irrigation systems, pumps and implements used by the agricultural project require specialist and professional services. Such services may further be extended to pest control for operations and accounting and legal services for administrative processes. All of these services are paid for and therefore the agricultural project contributes to revenue generation in the local and national sectors. In addition, during many of these processes, such as per the renewal of water licenses, information is generated which informs and facilitates planning of the Proponent as well as affected parties and governmental agencies.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning	Employment and contribution to local and national economy	3	2	3	3	2	54	4	Definite
Daily Operations	Contracted services and contribution to local and national economy	2	1	3	3	1	14	2	Definite
Indirect Impacts	Increased economic resilience in the professional sector	3	1	3	1	1	15	2	Highly Probable

Desired Outcome: Contribution to national treasury and increased economic resilience in the local and national professional sector.

Actions
Enhancement:
- Contract local Namibians where possible.
- Adhering to permit and license conditions on reporting.
- Deviations from this practice must be justified.

Responsible Body:
- Proponent.

Data Sources and Monitoring:
- Service providers’ contracts or agreements or records be kept.
- All reporting, monitoring and information sharing records kept on file.

9.1.3 National Development Goals: Water, Agriculture and Land Use Planning

The agricultural project pins down key development goals and challenges which were identified as part of the Namibian development goals. It may be considered as an agricultural / irrigation project which aims at generating income from local sectors by providing the most value per resource (water, soil and labour). The project will further contribute to the national climate change combatting initiatives through crop diversification and proposed resilient crop cultivation. Developing of the agricultural sector was identified as one of the core plans within the NDPs for Namibia. The agricultural project therefore is considered to be a positive contributor to achieving national development goals.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning	Project implementation in line with the NDP and regional land use planning	4	1	2	1	1	16	2	Highly Probable
Daily Operations	Expansion of the agricultural sector in the Region. Project implementation in line with the regional land use planning	3	2	2	2	2	36	4	Highly Probable
Indirect Impacts	Contributing to achieving the goals set out in Vision 2030 for Namibia	3	1	3	3	3	36	4	Highly Probable

Desired Outcome: Continued contribution to the development of the region as well as implementation of project activities in line with NDPs and Vision 2030.

Actions

Enhancement:

- Liaison with regional and national governmental agencies through appropriate financial and social responsibility reporting.
- Increase recycling initiatives and incorporate additional greenhouse gas reduction activities such as conservation tillage and climate smart agriculture.
- Infrastructure maintenance and development such as, road servitude, water- and sanitation system developments (provision to employees) and node development. Where possible, public and private partnership regarding projects should be considered.

Responsible Body:

- Proponent.

Data Sources and Monitoring:

- All project contributions towards regional development, inclusive of communications held with relevant authorities, to be kept on file.
- Monitoring of borehole water levels and water abstraction (monthly) and submit to the relevant custodian on a quarterly basis.

9.1.4 Skills and Development

Training is essential to all aspects of the operations. Relative to responsibility, every employee requires the skillset to conduct tasks which form part of the operation. General skills in livestock handing, for example, may be acquired through on the job training and guidance from skilled workers. Progressive training in terms of, for example, safe pesticide application or specialised equipment handling (such as tractor operator) may require additional resources to aid in the training such as demonstrations, manuals and explanations. The skills and training of employees allow them to conduct certain tasks safely and or according to the required standard for continue operations.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Employment and transfer of skills, technological advancements	2	1	2	3	1	12	2	Probable
Daily Operations	Employment and transfer of skills	2	1	2	3	2	14	2	Definite
Indirect Impacts	Employment and transfer of skills in Namibia's agricultural sector	2	1	2	3	3	16	2	Definite

Desired Outcome: To see an increase in skills of local Namibians, as well as development and technological advancements in the agricultural industry.

Actions

Enhancement:

- Sourcing of employees and contractors must first be at local level and if not locally available, regional or national options should be considered. Deviations from this practice must be justified.
- Inform employees about parameters and requirements for references upon employment.
- Provide managerial references for unofficial training or skills transfer when conducted.
- Relative to their responsibilities, provide on-farm training for all staff involved in irrigation management, including but not limited to:
  - Correct agricultural techniques
  - Emergency procedures
  - System monitoring for problem identification
  - System maintenance
- Relative to their responsibilities, provide on-farm training for all staff involved in pesticide application / agrochemical , including but not limited to:
  - The safe transport, handling and storage of pesticides
  - Warning and advice pictograms commonly used on pesticide labels
  - Disposal of leftover pesticide and or pesticide containers
- Ensure first-aid and fire-fighting training for a portion of the workforce.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Keep records of all training provided to employees.
- Ensure that all training is certified or managerial references provided (proof provided to the employees) inclusive of training attendance, completion and implementation.
- Include all information in a bi-annual report.

9.1.5 Revenue Generation and Employment

Skilled and unskilled labour are required for the operations and maintenance/construction activities associated with the farm. Importantly, employment provided is permanent and long term. The use of GMO maize is expected to increase the success rate and nett economic benefit of operations. However, due to the variability of GMO seed prices, input costs etc, the nett benefit will vary year on year. It is nonetheless foreseen, based on historic cultivation of GMO in other developing countries, that the overall revenue generation capacity will be increased, contributing to the sustainability of operations and related employment. Livelihoods are thus sustained and the spending power of the local community increased. Through continued long term employment, economic resilience is enhanced of individual employees.

Through employment, the Proponent also contributes to the Social Security while significant contributions are also made to the Namibian Revenue Services. Revenue is generated through the sale of products on national and international markets.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Employment and contribution to local and national economy	2	1	2	2	2	12	2	Definite
Daily Operations	Employment contribution to local and national economy	2	1	3	3	1	14	2	Definite
Indirect Impacts	Decrease in unemployment, contribution to local economy	3	1	3	3	3	27	3	Definite

Desired Outcome: Contribution to national treasury and provision of employment to local Namibians.

Actions

Enhancement:

- The Proponent must employ local Namibians where possible.
- If the skills exist locally, employees must first be sourced from the area, then the region and then nationally.
- Deviations from this practice must be justified.

Responsible Body:

- Proponent.

Data Sources and Monitoring:

- Bi-annual summary report based on employee records.

9.1.6 Ideas and Aspirations

There are varies controversies and view points related to GMO cultivation and consumption. Therefore, care was taken during the public consultation phase of the project, to clearly stipulate the intension of the Proponent to cultivate GMO maize. In addition groundwater used for irrigation in Namibia, is another contentions issue of deliberation among especially the farming communities. The main point of concern relates to the available groundwater reserves and whether adequate reserve determinations are available for the various aquifers.

An overall concern of communities farming near future GM maize fields is possible cross-pollination and the related effects therefore. In such instances, the future economic aspirations of the particular party may be affected since the current price of GM Maize is lower than that of conventional maize. The different pricing schedule for conventional and GM maize stems from the pricing schedule adopted for South Africa. However, the Namibian non-GMO premium is much higher than in South Africa. The current difference in price for maize per ton, is 8%. A complex factoring system was employed by the Namibian Grain Producers Association to reach this difference. It takes into account yields per hectare, national markets as well as allowances for drought conditions This in turn results in greater pressure on consumers to whom this cost is carried forward. This aspect therefore not only affect the different maize producers, but also the consumers. Whether for, or against the cultivation of GMO, ideas van aspirations of parties are affected. Some, such as adjacent land owners, more than others.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Information sharing about proposed expansion and related possible environmental constraints	2	2	2	2	3	28	3	Probable
Daily Operations	Information sharing related to cultivation of GM produce	2	1	2	2	2	12	2	Probable

Desired Outcome: Continued sharing of activity plans with IAPs and governing agencies. Maintaining an open door policy with neighbours and employees.

Actions

Mitigation:

- Information sharing about the project's progress should be made available to governmental agencies, interested and affected parties and the IAPs, The Proponent and affected parties should use the information generated during the environmental assessment to realistically plan for future growth. Open communication regarding future development should be maintained.
- Contractor's tenders to include best practise requirements for construction safety, security and environmental management. Pollution, poaching and unauthorised habitat construction to carry contractual penalties.
- A community liaison officer should be appointed during the construction phase especially to facilitate community grievances and concerns.

Responsible Body:

- Proponent.

Data Sources and Monitoring:

- Records kept of all information shared with authorities, neighbours and employees,

9.1.7 Demographic Profile and Community Health

Farming activities rely on labour. Jobseekers migrating to the Tsumeb area may lead to increased unemployment and expansion of informal settlements. Here, factors such as communicable disease like HIV/AIDS as well as alcoholism and drug abuse may thrive. These are typically aggravated when an influx of seasonal workers, and possible foreign construction teams and contractors, occur. An increase in foreign people in the area, linked to unemployment, may potentially increase the risk of criminal and socially/culturally deviant behaviour. However, since the farm is well established with an existing employee base and returning seasonal employees, it is not foreseen that the project will result in significant migration to the Tsumeb area.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	In-migration and social ills related to foreign contractors temporarily on site	2	-1	1	1	2	-8	-1	Probable
Daily Operations	Social ills possibly associated with staff and jobseekers	2	-1	1	2	2	-10	-2	Probable
Indirect Impacts	The spread of disease	2	-1	2	2	2	-12	-2	Improbable

Desired Outcome: To prevent the occurrence of social ills and prevent the spread of diseases such as HIV/AIDS.

Actions:

Prevention:
- Appointment of reputable contractors where applicable.
- Adhere to all local authority by-laws relating to environmental health, which includes, but is not limited to, sanitation requirements for employees.
- Provide educational, awareness information for employees on various topics of social behaviour and HIV/AIDs.
- Disciplinary steps, within the legal parameters of Namibia, to be taken for socially deviant behaviour at the employee-housing compound or during working hours, should be clearly stipulated in employment contracts.

Mitigation:
- Take disciplinary action against employees not adhering to contractual agreements with regard to socially deviant behaviour (e.g. alcohol or drug abuse during working hours).

Responsible Body:
- Proponent.

Data Sources and Monitoring:
- Summary report based on educational programmes and training conducted.
- Employee contracts on file.
- Bi-annual report and review of employee demographics.

9.1.8 Agricultural Produce

The project is in line with the objectives of Namibia's NDPs and contributes to the economy of, and food security in, Namibia. Locally produced crops decrease the amount of crops that needs importing. Cultivation of GMO maize is expected in increase annual crop yields due to decreased insect damage, especially during a heavy infestation or plague, and competition of weeds. Less weeds and especially problematic grasses, also provide a cleaner crop yield.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction and Daily Operations	Contribution to economy, contribution to food security in Namibia	1	2	3	3	2	16	2	Definite
Indirect Impacts	Reduced import needs, increase in trade balance, spread of knowledge and skills, increased crop productivity	1	2	3	3	3	18	2	Definite

Desired Outcome: Maximum contribution to the food security and economy of Namibia. Provide a positive contribution to the trade balance of Namibia by reducing the amount of imported produce.

Actions

Enhancement:

- Teach employees on sustainable farming practices to enable the spread of knowledge and skills and thereby increase the productivity of small-scale farming as well.
- Diversification and continuous improvement to maximise sustainability of the farm.

Responsible Body:

- Proponent.

Data Sources and Monitoring:

- Bi-annual reporting on educational programmes and training conducted.

9.1.9 Health, Safety and Security

Daily operational and intermittent maintenance and construction activities on the farm are reliant on human labour. Such activities have varying degrees of health and safety risks. Examples include the operation of vehicles and machinery with moving parts, such as harvesters, and the handling of hazardous chemicals with inherent health hazards, such as pesticides and fuel, when ingested, inhaled or physical contact occur. Encounters with wild animals, and especially venomous species like snakes, may pose risks to employees. The provision of personal protective equipment, and the intended use thereof is paramount. Security risks relates to unauthorized entry on the farm, theft and sabotage.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Physical injuries, exposure to chemicals and criminal activities	1	-2	3	3	1	-14	-2	Probable
Daily Operations	Physical injuries, exposure to chemicals and criminal activities	1	-2	3	3	2	-16	-2	Probable

Desired Outcome: To prevent injury, health impacts and theft.

Actions

Prevention:

- Implement and maintain an integrated health and safety management system, to act as a monitoring and mitigating tool.
- Comply with all health and safety standards as specified in the Labour Act and related legislation.
- Clearly label dangerous and restricted areas as well as dangerous equipment and products such as agrochemical.
- Lock away or store all equipment and goods on site in a manner suitable to discourage criminal activities (e.g. theft).
- Provide all employees with required and adequate personal protective equipment (PPE) where required.
- Ensure that all personnel receive adequate training on the operational procedures of equipment and machinery and the handling of hazardous substances.
- Train selected personnel in first aid and ensure first aid kits are available on site.
- The contact details of all emergency services must be readily available.
- Implement a maintenance register for all equipment whose malfunction can lead to injury or exposure to hazardous substances.
- Apply and adhere to all industry specific health and safety procedures and regulations applicable to the handling of food produce for markets.

Mitigation:

- Treat all minor work related injuries immediately and obtain professional medical treatment if required.
- Assess any safety problems and implement corrective action to prevent future occurrences.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Record any incidents with the actions taken to prevent future occurrences.

- Compile a bi-annual report of all incidents reported. The report should contain dates when training was conducted and when safety equipment and structures were inspected and maintained.

9.1.10 Fire

Construction activities, failing electrical infrastructure, mechanical operations and fires outside of designated areas, may increase the risk of the occurrence of unplanned and / or uncontrolled fires, which may spread into the nearby fields and surrounding farms. Lightning may cause natural fires during the dry season. Farming operations does present a fire risk due to charcoal production on the farm. Uncontrolled fires which have generated in other areas will present a risk to existing and prosed operations.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Fire risk	1	-2	2	2	1	-10	-2	Probable
Daily Operations	Fire risk	1	-2	2	2	1	-10	-2	Probable

Desired Outcome: To prevent property damage, veld fires, possible injury and impacts caused by uncontrolled fires.

Actions

Prevention:

- Clearing of firebreaks, especially along fences.
- Prepare a holistic fire protection and prevention plan. This plan must include evacuation plans and signage, an emergency response plan and a firefighting plan.
- Ensure fire-fighting equipment are maintained in good working order at all times. Ensure such equipment is readily available / unobstructed access.
- Personnel training (safe operational procedures, firefighting, fire prevention and responsible housekeeping practices).
- Ensure all flammable chemicals are stored according to material safety data sheet (MSDS) and SANS instructions and all spills or leaks are cleaned immediately.
- Maintain regular site, mechanical and electrical inspections and maintenance.
- Maintain firefighting equipment and promote good housekeeping.
- Notify the farmers' association as well as all surrounding farmers if planned burns (e.g. to create firebreaks) are planned.
- Allow fires used for purposes such as cooking (by staff) in designated areas only.

Mitigation:

- Implement the fire protection and firefighting plan in the event of a fire.
- Quick response time by trained staff will limit the spread and impact of fire.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Maintain a register of all incidents on a daily basis. Include measures taken to ensure that such incidents do not repeat themselves.
- Compile a bi-annual incidents report. The report should also contain dates when fire drills were conducted and when firefighting equipment were tested and training given.

9.1.11 Noise

Noise is generated by various operational and possible construction activities. Machinery like generators, vehicles and harvesters cause elevated noise levels that may result in hearing impairment after long term exposure. Activities are generally remote from receptors other than the Proponent, his employees and their families residing on the farm. The nature of the noise is related mainly to the ongoing operations and maintenance.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Excessive noise generated from construction activities – nuisance and hearing loss	1	-1	2	2	1	-10	-1	Probable
Daily Operations	Noise generated from the operational activities – nuisance and hearing loss	1	-1	2	2	1	-10	-1	Definite

Desired Outcome: To prevent any nuisance and hearing loss due to noise generated.

Actions

Prevention:

- Follow Health and Safety Regulations of the Labour Act and/or World Health Organization (WHO) guidelines on maximum noise levels (Guidelines for Community Noise, 1999) to prevent hearing impairment.
- Regularly service all machinery to ensure minimal noise production.

Mitigation:

- Hearing protectors as standard PPE for workers in situations with elevated noise levels.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Health and Safety Regulations of the Labour Act and WHO Guidelines.
- Maintain a complaints register.
- Bi-annual report on complaints and actions taken to address complaints and prevent future occurrences.

9.1.12 Waste Production

Various waste streams result from the operational and possible construction and maintenance activities. Waste may include hazardous waste associated with hydrocarbon products and chemicals, as well as soil and water contaminated with such products. Construction waste may include building rubble and discarded equipment. Domestic waste will be generated by the residents and employees on the farm. Most of the farming related waste can be re-used and or recycled, however certain waste, such as empty pesticide containers are hazardous and should be disposed of accordingly to hazardous waste requirements.

Waste presents a contamination risk and when not removed regularly may become a health and/or fire hazard and attract wild animals and scavengers. Sewage is a form of liquid biological waste that needs disposal.

Since no official waste disposal facilities, especially for hazardous waste, are available, all waste that cannot be re-used are burned at dedicated waste sites.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Excessive waste production, littering, illegal dumping, contaminated materials	1	-2	2	2	2	-12	-2	Definite
Daily Operations	Excessive waste production, littering, contaminated materials	1	-2	2	2	2	-12	-2	Definite

Desired Outcome: To reduce the amount of waste produced and prevent pollution and littering.

Actions

Prevention:

- Implement waste reduction measures. All waste that can be re-used/recycled must be kept separate.
- Ensure adequate temporary storage facilities for disposed waste are available.
- Prevent windblown waste from entering the environment.
- Prevent scavenging (human and non-human) of waste at the storage facilities.
- Educate employees on the importance of proper waste handling and disposal.

Mitigation:

- Waste should be disposed of regularly and at appropriately classified disposal facilities, this includes hazardous material (empty chemical containers and contaminated materials, soil and water).
- Discarded waste should be disposed of and burned regularly at a dedicated site to reduce health and pollution risks.
- Empty chemical containers that may present a contamination/health risk must be treated as hazardous waste. Workers should not be allowed to collect such containers for purposes of storing water or food. This can be achieved by puncturing or crushing such containers prior to disposal.
- Liaise with the applicable authorities regarding waste and handling of hazardous waste.
- Ensure all ablution facilities are connected to properly constructed septic tank systems to prevent groundwater contamination.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Maintain a register of disposal of hazardous waste. This should include type of waste, volume as well as disposal method/facility.
- Record any complaints received regarding waste with notes on actions taken.
- All information to be included in a bi-annual report.

9.1.13 Ecosystem and Biodiversity Impact

Agriculture and related activities are ongoing on the farm. Possible expansion is planned on existing cleared areas and no further impacts on vegetation are thus expected from additional land clearing. Rangeland improvement is an ongoing endeavour as part of the aftercare program while, livestock numbers are continually evaluated to avoid the risk of overgrazing.

Irresponsible pesticide use, for example as method of vermin control, may impact on scavengers such as vultures and in the long run on top predators through biomagnification in higher trophic levels. Similarly, the use of insecticide on crop fields may also affect non-target species. It would therefore be advantageous to use GM maize which, for example in the case of BT Maize, target a certain problem species. Less insecticide can be applied to reduce the risk of harm to non-target species. Over-abstraction of groundwater may potentially have devastating effects on plant and animal populations reliant on it. It not only include the drying up of springs, dying of trees and migration or dying animals but also the lowering of cave water levels.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Impact on fauna and flora. Loss of biodiversity	2	-1	3	2	2	-14	-2	Probable
Daily Operations	Impact on fauna and flora. Loss of biodiversity – poaching, poisoning, etc.	2	-1	2	2	2	-12	-2	Probable

Desired Outcome: To avoid pollution of, and impacts on, the ecological environment.

Actions

Prevention:

- Strictly adhere to pesticide application instructions and use pesticides only for the purposes for which it is registered and marketed. Importantly, pesticides should not be used to kill vermin unless specifically registered for that purpose, and even then alternative, environmentally friendly methods should be investigated and used.
- Restrict access to pesticides, insecticides and any other material which can be used by poachers.
- Prevent spray drift by applying pesticides during calm weather conditions.
- Ensure the employees applying pesticides are trained and / or skilled in the application thereof.
- Educate all contracted and permanent employees on the value of biodiversity and strict conditions prohibiting harvesting and poaching of fauna and flora must be part of employment contracts. Include prohibitions or regulations on the collection of firewood.
- Regular inspection of fences, game footpaths and other sites for snares, traps or any other illegal activities.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.

Mitigation:

- For construction activities, if any, contain construction material to a designated laydown area and prevent unnecessary movement out of areas earmarked for clearing and construction.
- Report any extraordinary animal sightings to the MEFT.
- Prevent scavenging of waste by fauna.
- Take disciplinary action against any employees failing to comply with contractual conditions related to poaching and the environment.

Responsible Body:

- Contractor.
- Proponent.

Data Sources and Monitoring:

- Report on all extraordinary animal or plant sightings or instances of poaching.
- Keep frequent records of borehole water levels and abstracted water volumes to identify any trends or consistent reduction in water levels.
- Compile a bi-annual report on all monitoring results.

9.1.14 GM Crops Becoming Invasive

Concerns have been raised regarding the possibility of GM crops establishing themselves outside of farmland with the potential of becoming invasive. After decades of planting traditional maize, no instances of this have been recorded and it is highly unlikely that the GM cultivars will be any different. Maize has no close related species occurring naturally within Namibia, thus further decreasing the possibility of them establishing and becoming invasive.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Impact on fauna and flora. Loss of biodiversity – poaching, poisoning, etc.	2	-1	2	2	2	-12	-2	Probable

Desired Outcome: To prevent the unintended proliferation of GM maize outside dedicated crop fields.

Actions

Prevention:
- Contain GM seeds and prevent spillages during transport.
- Spill clean-up plan where accidental spills occur during transport.
- Prevent theft of GM crop seeds.

Mitigation:
- Refer to GM cultivation contingency plans for the transport of GM seeds.

Responsible Body:
- Proponent.

Data Sources and Monitoring:
- Spill management plan.
- Record all spills and include maize strain, date, location and spill clean-up measures with photo records.
- Submit the spill report to the NCRST.

9.1.15 Pesticides Resistance

In GM crop fields, pesticide resistance has been reported in insects (against Bt proteins) and weeds (against glyphosate). This is however no different from pesticide resistance reported in non-GM crop fields. Over reliance on the use of glyphosate and the lack of crop and herbicide rotation by farmers, in some regions, contribute to the development of weed resistance. In order to address this problem and maintain good levels of weed control, farmers have increasingly adopted more integrated weed management strategies incorporating a mix of herbicides, other herbicide tolerant crops and cultural weed control measures. These include, using other herbicides with glyphosate rather than solely relying on glyphosate; using herbicide tolerant crops that are tolerant to other herbicides, such as glufosinate; and using cultural practices such as mulching. These add cost to the GM herbicide tolerant production systems compared to about 10-15 years ago, although relative to the current conventional alternative, the GM herbicide tolerant technology continues to offer important economic benefits.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Development of pesticide resistance	2	-1	2	2	2	-12	-2	Probable

Desired Outcome: To delay, or ideally prevent, the onset of pesticide resistance in insects and weeds.

Actions
Prevention:

- Develop and implement an insect and weed resistance management plan in collaboration with the seed supplier.
- The plan should among others include.
    - All farmers must adhere to the refuge strategy as stipulated by the GM seed supplier.
    - As part of the insect resistance management plan, intermittently apply insecticides to kill any pest insects that may have developed Bt resistant traits.
    - Application of glyphosate herbicide as per the prescribed concentration (i.e. not lower or higher concentrations as this may be ineffective) and application procedures.
    - Weed control prior to planting which should include herbicides of alternative active ingredients to allow killing of weeds that may have developed resistance to glyphosate.
    - Weed control prior to its production of viable seeds.
    - Cleaning of farm implements to prevent distribution of potential resistant weeds.
    - Crop rotation.
- Regular inspection of fences, game footpaths and other sites for snares, traps or any other illegal activities.
- Over-abstraction of groundwater may potentially have devastating effects on plant and animal populations reliant on it. It not only include the drying up of springs, dying of trees and migration or dying of animals but also the lowering of cave water levels.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.

Responsible Body:

- Proponent HSE Officer, seed supplier.

Data Sources and Monitoring:

- Insect and weed resistance management plan kept on site.

- Regular inspection of all fields to ensure early detection of extraordinary damage to crops that would indicate Bt resistance.
- If Bt resistance is expected, implement the insect resistance management plan and notify the NCRST and seed supplier.
- Inspection of all fields after application of glyphosate to ensure early detection of surviving weeds that may indicate resistance.
- If glyphosate resistance is expected, implement the weed resistance management plan and notify the NCRST and seed supplier.
- Keep record all instances of suspected insect or weed resistance. Note at least the species, date, extent and measures taken.
- Keep record of all instances of insecticide and herbicide application as a measure to combat weeds or to prevent / delay resistance in insects and weeds. Note at least the date,insecticide and/or herbicide used, concentration of active ingredients as applied, and the reason for application.

9.1.16 Soil Disturbance and Contamination

Without good and suitable soil, existing and proposed farming operation will not be possible. All farming operations have an impact on the soil, some by a lesser degree and others more extensively. Livestock require drinking posts. At these sites there is usually an accumulation of manure which undergoes frequent trampling. Similarly, septic tank-french drain systems may affect the soil, especially if not properly constructed and maintained. In these areas the soil structure and composition may be affected.

Overgrazing may lead to soil degradation and erosion. However, crop cultivation has a much more significant impact on not only soil structure, but also composition. Land preparation techniques involve tillage of all areas while infrastructure establishment may necessitate earthworks. Cultivated fields, have higher occurrences of soil compaction which require conventional tillage. Soil is compacted by mechanical activities such as planting, crop spraying and harvesting as well as livestock being allowed on the field after harvesting during droughts.

Once crop field have been established, the addition of agrochemical may change the soil composition. Fertiliser is added for certain elements lacking in the existing soil while pesticides may remain in the soil until broken down. In some instances, the irrigation itself, which is often more than the natural rainfall, may further alter the soil composition as the water dissolves of reacts with elements of the soil.

Apart from the crop and cattle related activities, hydrocarbon spills and leaks from machinery, equipment of failing fuel storage infrastructure may also affect the soil composition. All of the processes has the potential to contaminate the soil rendering it less feasible for crop cultivation.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2)Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction	2	-1	2	2	1	-10	-2	Improbable

<u>Desired Outcome:</u> To prevent the contamination, compaction, erosion, or structure disturbance of soil.

<u>Actions</u>
Prevention:
- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application. Where possible application decision should be based on soil testing and plant analysis. Fertiliser application should consider soil temperature and moisture content and not be applied to severely compacted soils.
- Maintain sewerage systems and conduct regular monitoring.

- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.
- Where possible, soil compaction from stock grazing and/or heavy machinery movement minimised.
- Retain indigenous vegetation buffers along soil berm and cut-off trenches.
- Increased crop residue left in the soil where possible.
- Restrict heavy machinery to designated areas.

Mitigation:
- All spills must be cleaned up immediately.
- Consult relevant MSDS information and a suitably qualified specialist where needed.

Responsible Body:
- Proponent
- Contractors

Data Sources and Monitoring:
- Maintain Material Safety Data Sheets for hazardous chemicals.
- Continued visual monitoring for soil compaction.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

9.1.17 Groundwater and Surface Water Contamination

Leakages and spillages of hazardous substances from vehicles, waste oil handling and accidental fuel, oil or hydraulic fluid spills during the operational phase may contaminate the environment. Increase of nutrient levels (from over application of fertilizers or pesticides) in the soil that can leach to the groundwater. Runoff from over-irrigation and or rainfall events may carry chemical components, such as fertilisers and or pesticides from the site. Pollution due to sewerage system overflow or leakage may further put the groundwater at risk.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2)Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction	2	-1	2	2	1	-10	-2	Improbable

Desired Outcome: To prevent the contamination of groundwater, surface water and soil.

Actions

Prevention:

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.
- Train and or guide persons involved with the sewerage systems, or any related effluent system, in terms of maintenance and operation to ensure the system is operated effectively.

Mitigation:

- All spills must be cleaned up immediately.
- Consult relevant MSDS information and a suitably qualified specialist where needed.

Responsible Body:

- Proponent.
- Contractors.

Data Sources and Monitoring:

- Maintain Material Safety Data Sheets for hazardous chemicals.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Groundwater should be sampled and analysed to test for nitrate concentrations from the fertilizer and for traces of chemicals used in pesticides and herbicides.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.

- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

9.1.18 Groundwater Abstraction

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or unusable groundwater is present on the land. Abstraction of groundwater must be done in a sensible way not to impact on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater. Recharge to the area is considered to be comparatively high.

In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system. Over time an equilibrium (or steady state) is normally reached with rising water tables following good recharge events and declining water tables when recharge is below average. Inflow into the system would typically be from infiltration following rainfall in the area and in upstream areas. Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system as well as evapotranspiration losses. Groundwater abstraction through boreholes is important as this is normally necessary to sustain human and animal demands where such users became essentially dependant on the abstracted groundwater as a reliable and sustainable source.

Typical consequences of over abstraction will include a lowering in the water table. This may further lead to the drying up of boreholes, springs, and shallow wells. Vegetation will also be impacted where such vegetation has access to groundwater.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2)Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Over-abstraction of the local aquifer, decrease in the local hydraulic head	2	-2	2	2	2	-24	-3	Probable

Desired Outcome: To utilise the groundwater sustainably.

Actions

Prevention:

- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring as well as rainfall measured and recorded.
- Maintain safe abstraction rates prescribed by test pump evaluations (an abstraction permit with prescribed rates from the MAWLR is a requirement for this project).
- All irrigation infrastructure meets water license requirements related to flow meters, and limits on flow rate, volume and area irrigated.
- Regular maintenance of the irrigation system and related infrastructure be conducted. Where flow meters need to be replaced, the MAWLR should be informed accordingly.
- Continual monitoring for blocked nozzles or emitters, leaking hydrants or hoses, irrigator alignment etc.
- Soil moisture assessment conducted along with daily visual checks for excessive runoff or ponding.

Mitigation:

- Reduce abstraction when the water levels nears 5 m below the average rest water level of each borehole.

Responsible Body:

- Proponent.

Data Sources and Monitoring:

- Monthly boreholes rest water level monitoring.
- Rainfall records.
- Baseline values should be reviewed every three years based on all historic water level data.
- A summary report on all monitoring results must be prepared.
- The Proponent supply monitoring returns to the MAWLR, as required by the permit.

9.1.19 Visual Impact

Farming operations and possible expanded irrigated, is and will be conducted across farmland which have mostly already been transformed into an agricultural area more than 50 years ago. Cultivated areas are demarcated on old topographic maps, indicating that the area has long since been recognised as an agricultural area. Satellite imagery of 1984 confirm these agricultural areas on the property, which is surrounded by similar operations. Expansion areas will therefore add to the existing landscape character.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Aesthetic appearance and integrity of the site	1	-1	2	2	2	6	-1	Probable
Daily Operations	Change in landscape character and aviation navigational interest	1	-1	2	2	2	6	-1	Probable

<u>Desired Outcome:</u> To minimise aesthetic impacts associated with the farm.

<u>Actions</u>
Mitigation:

- Regular waste disposal, good housekeeping and routine maintenance on infrastructure will ensure that the longevity of structures are maximised and maintain a low visual impact.

<u>Responsible Body:</u>

- Proponent
- Contractors

<u>Data Sources and Monitoring:</u>

- Compile a bi-annual report of all complaints received and actions taken.

9.1.20 Cumulative Impact

Possible negative cumulative impacts (i.e. the build-up of minor impacts to become more significant) associated with the operational phase and any maintenance/construction activities are mainly linked to traffic, reduction in soil and groundwater quality and groundwater availability. The cumulative increase in employees in the area may put more pressure on biodiversity as a result of poaching or harvesting of plant and animal products. The cumulative positive impacts from farming in the Oshikoto Region relates to increased and sustained employment, revenue generation and overall improved living conditions and livelihoods as a result of increased spending power.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Construction and Operations (Negative)	Waste production, pollution, etc. The build-up of minor impacts to become more significant	2	-1	2	2	1	-10	-2	Probable
Daily Construction and Operations (Positive)	Employment, skills development, revenue generation	2	1	2	2	1	10	2	Definite

<u>Desired Outcome:</u> To minimise cumulative all impacts associated with the farm.

<u>Actions</u>

Mitigation:

- Addressing each of the individual impacts as discussed and recommended in the EMP would reduce the cumulative impact.
- Reviewing biannual reports for any new or re-occurring impacts or problems would aid in identifying cumulative impacts. Planning and improvement of the existing mitigation measures can then be implemented.

<u>Responsible Body:</u>

- Proponent.

<u>Data Sources and Monitoring:</u>

- Reviewing monitoring results based on all other impacts will give an overall assessment of the impacts of the operational phase.

9.2 Decommissioning and Rehabilitation

Closure and decommissioning of agricultural and related activities on the farm as a whole is not foreseen during the validity of the environmental clearance certificate or in the near future. However, it is more likely that certain components may be decommissioned. Decommissioning is therefore included for this purpose as well as the fact that construction activities may also include modification and decommissioning of infrastructure. Future land use after decommissioning should be assessed prior to decommissioning and rehabilitation initiated if the land would not be used for future purposes. Should decommissioning occur at any stage, rehabilitation of the area may be required. Decommissioning will entail the complete removal of all infrastructure including buildings and irrigation infrastructure. Any pollution present on the site must be remediated. The impacts associated with this phase include noise and waste production as structures are dismantled. Noise must be kept within the Health and Safety Regulations of the Labour Act and WHO standards. Waste should be contained and disposed of at a dedicated waste disposal site and not dumped in the surrounding areas. The EMP for the farm will have to be reviewed at the time of full decommissioning to cater for changes made to the site and to implement guidelines and mitigation measures.

9.3 Environmental Management System

The Proponent could implement an environmental management system (EMS) for their operations. An EMS is an internationally recognized and certified management system that will ensure ongoing incorporation of environmental constraints. At the heart of an EMS is the concept of continual improvement of environmental performance with resulting increases in operational efficiency, financial savings and reduction in environmental, health and safety risks. An effective EMS would need to include the following elements:

- A stated environmental policy which sets the desired level of environmental performance;
- An environmental legal register;
- An institutional structure which sets out the responsibility, authority, lines of communication and resources needed to implement the EMS;
- Identification of environmental, safety and health training needs;
- An environmental program(s) stipulating environmental objectives and targets to be met, and work instructions and controls to be applied in order to achieve compliance with the environmental policy;
- Periodic (internal and external) audits and reviews of environmental performance and the effectiveness of the EMS and,
- The EMP.

10 CONCLUSION

Agricultural and related activities as performed on farm, by the Proponent, contributes positively to the economy of Namibia. Food is produced for national markets and the sale of livestock for meat production to both local and international markets. A number of employment opportunities are sustained and skills development within the local workforce occur. Revenue is generated that contributes to the Namibian economy.

Negative impacts associated with operational and intermittent maintenance and construction activities on the farm, as summarised in, section 9 can successfully be mitigated. Implementing a HSE policy will contribute to effective management procedures to prevent and mitigate impacts. All regulations relating to the agricultural and related activities of the Proponent, including health and safety legislation, should be adhered to and implemented where applicable. Groundwater and soil pollution must be prevented at all times and over abstraction of groundwater prevented. Fire prevention should be key, fire response plans in place, and regular firefighting training provided to key employees. The GMO management plan as present in Appendix C must be implemented and strictly adhered to. All staff must be made aware of the importance of biodiversity and the poaching or illegal harvesting of animal and plant products prohibited. This includes the proper handling and correct application of pesticides. Any waste produced must be properly disposed, re-used, or recycled where possible.

The EMP (Section 9) should be used as an on-site reference document for the operations of the farm. Parties responsible for transgression of the EMP should be held responsible for any rehabilitation that may need to be undertaken. The Proponent could use an in-house Health, Safety, Security and Environmental Management System in conjunction with the EMP. All operational personnel must be taught the contents of these documents.

Should the Directorate of Environmental Affairs (DEA) agree with the impacts and related mitigation measures, they may issue an environmental clearance certificate to the Proponent. The environmental clearance certificate will render this document legally binding on the Proponent. The assessment process's aim is not to stop the farming activities, or any of its components, but to rather determine its impact and guide sustainable and responsible development as per the spirit of the EMA.

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Appendix A: Certificates / Awards


agra Auctions
2022
2022
AGRA WEANER
CHAMPIONSHIP SERIES
TOWN: Otavi
CATEGORY: Feedlot Potential
POSITION: 2nd Place
SPONSORED BY:
Bank Windhoek
Sanlam santam
Indongo
TOYOTA
Indongo
AGRIBANK
Feedmaster
TotalEnergies
MSD
Animal Health

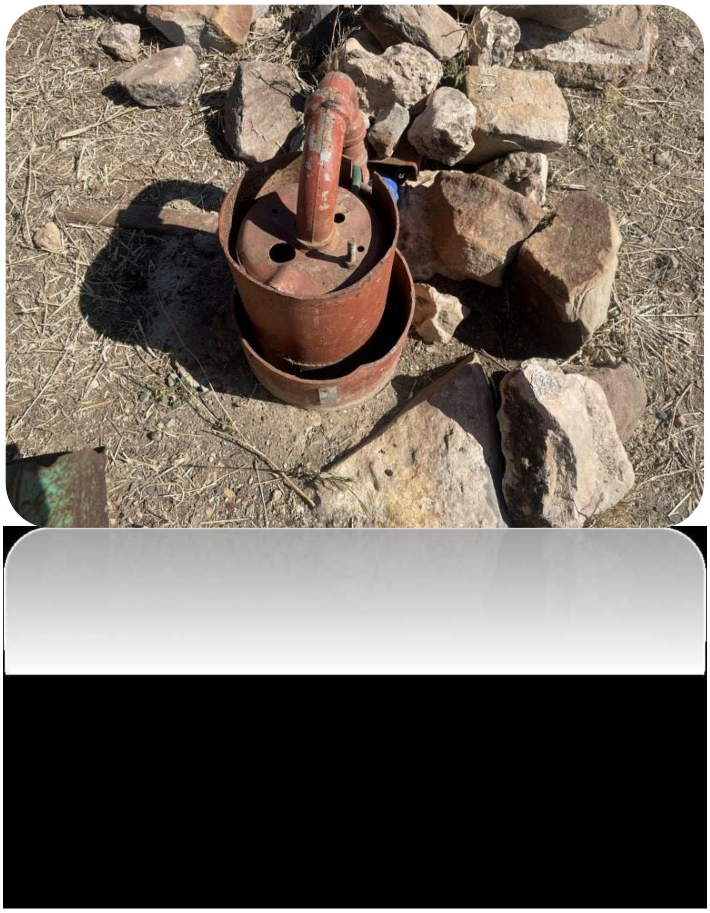

NAHA
Certificate
OUTSTANDING
WHITE MAIZE PRODUCER
OF THE YEAR
ERIC VAN DRUTEN
Karst Production Zone
Recognised by the National Agronomy & Horticulture Awards (NAHA)
14/09/2023
Dr Fidelis N. Mwazi (PhD)
Chief Executive Officer
Date
NAHA
National Agronomy & Horticulture Awards
NAMIBIAN
AGRONOMIC BOARD
BEST
AWARD
2023


CERTIFICATE
NATIONAL AGRONOMY & HORTICULTURE AWARDS (NAHA) 2022
PROUDLY PRESENTED TO
ERIC VAN DRUTEN
BEST HORTICULTURE PRODUCER OF THE YEAR
PRODUCTION ZONE: KARST
CHIEF EXECUTIVE OFFICER
NAMIBIAN
AGRONOMIC BOARD
16 NOVEMBER 2022
DATE

Appendix B: Hydrogeological Specialist Study

FARM EMILIENHOF NO FMB/00588, OSHIKOTO REGION

HYDROGEOLOGICAL SPECIALIST STUDY



Assessed by:

Assessed for:

Van Druten Family Trust

June 2025

<table>
<tr><td>Project:</td><td colspan="2">FARM EMILIENHOF NO FMB/00588, OSHIKOTO REGION - HYDROGEOLOGICAL SPECIALIST STUDY</td></tr>
<tr><td>Report Version/Date</td><td colspan="2">V1
June 2025</td></tr>
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<tr><td>Copyright</td><td colspan="2">Copyright on this document is reserved. No part of this document may be utilised without the written permission of Geo Pollution Technologies (Pty) Ltd.</td></tr>
<tr><td>Report Approval</td><td colspan="2">
Pierre Botha
Managing Director</td></tr>
</table>

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LIST OF ABBREVIATIONS

CHIRPS-2	Climate Hazards Group Infra-Red Precipitation with Station data version 2
cm	Centimetre
cmol/kg	Centimole per kilogram
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
g/cm^3	Grams per cubic centimetre
ha	Hectare
km	Kilometre
km^2	Square kilometre
$kWh/m^2/day$	Kilo watt hours per metre squared per day
m	Metre
m^3/h	Cubic metre per hour
Ma	Million years
mamsl	Metres Above Mean Sea Level
MAR	Mean Annual Rainfall
MAWLR	Ministry of Agriculture, Water and Land Reform
mbs	Metres below surface
MERRA-2	Modern-Era Retrospective analysis for Research and Applications version 2
mg/cm^3	Milligrams per cubic centimetre
mg/kg	Milligram per kilogram
mm	Millimetre
mm/a	Millimetre per annum
NASA	National Aeronautics and Space Administration
No	Number
OML	Otavi Mountain Land

1 INTRODUCTION

Geo Pollution Technologies (Pty) Ltd was appointed by the Van Druten Family Trust (the Proponent) to undertake a hydrogeological specialist study for the farm Emilienhof FMB/00588 (Figure 1-1) located in the Oshikoto Region. The farming unit will further be known and discussed as the project area. The B1 trunk road is located immediately west of the farm Emilienhof FMB/00588. The main commercial activities of the Proponent on the farm includes crop cultivation and livestock farming. For purposes of crop cultivation, the Proponent utilizes approximately 115 ha, of which 61 ha is purposed for irrigation (centre pivot), while the rest is dryland farming. Pending the outcome of this specialist study, the total hectares of land to be irrigated simultaneously, may be increased. Irrigation is from groundwater, by means of centre pivot irrigation systems.

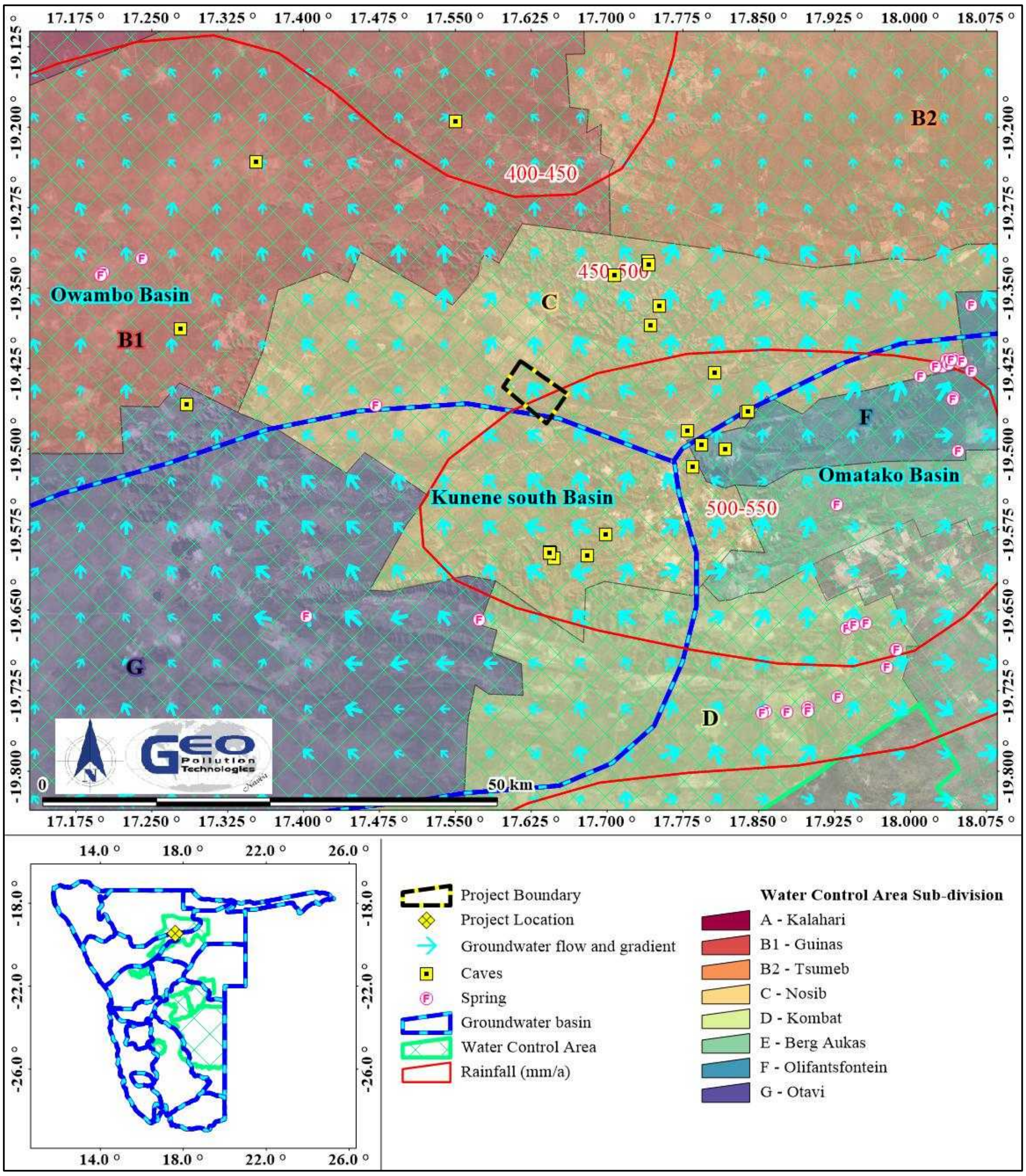


Figure 1-1 Project location and hydrogeological characterisation

2 SCOPE OF WORK

The aims of the study were to:

1. Conduct a hydrogeological assessment based on data obtained from an in-field hydro-census survey.
2. Gather historic information and compile a hydrogeological assessment based on the information.
3. Prepare a specialist report of the investigation.

3 METHODOLOGY

Obtain and review all available geological and hydrogeological information/reports for the investigation area. Review and delineation of hydrogeological catchment and sub-catchments within the investigation area. This will be based on historic groundwater level data contained in the Department of Water Affairs (DWA) database and from hydro-census data gathered on behalf of the Proponent. Prepare a specialist report of the investigation.

4 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

To protect the environment and achieve sustainable development, all projects, plans, programmes and policies deemed to have adverse impacts on the environment require an environmental impact assessment (EIA), as per the Namibian legislation. The key legislation provided in Table 4-1 govern the environmental assessment process in Namibia and/or are relevant to the project.

Table 4-1. Namibian Law applicable to the project

Law	Key Aspects
The Namibian Constitution	♦ Incorporate a high level of environmental protection. ♦ Land, water and natural resources below and above the surface of the land and in the continental shelf and within the territorial waters and the exclusive economic zone of Namibia shall belong to the State if they are not otherwise lawfully owned.
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	♦ Defines the environment. ♦ Promote sustainable management of the environment and the use of natural resources.
Water Resources Management Act Act No. 11 of 2013, Government Notice No. 269 of 2023	♦ Provide for management, protection, development, use and conservation of water resources. ♦ Prevention of water pollution and assignment of liability.
Soil Conservation Act Act No. 76 of 1969, Government Notice No. 494 of 1970	♦ Law relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources Namibia.

Relevant water resource development and related activities listed as activities requiring an environmental clearance certificate are (Government Notice No. 29 of 2012):

Section 8: Water resource developments:

- 8.1 The abstraction of ground or surface water for industrial or commercial purposes: the Proponent is making use of the groundwater for irrigation-based farming.
- 8.2 The abstraction of groundwater at a volume exceeding the threshold authorised in terms of a law relating to water resources.
- 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems.
- 8.7 Irrigation schemes for agriculture excluding domestic irrigation.
- 8.8 Construction and other activities in water courses within flood lines.

- 8.9 Construction and other activities within a catchment area.

The relevance of 8.2 is not clear as to under which act such a threshold is defined, if any. The Water Resources Management Act (Act No. 11 of 2013) do not define such a threshold and existing water control areas in which abstraction permits would be required, was not repealed. The repealed Water Act (Act No. 54 of 1956) only requires abstraction permits within water control areas, see Figure 1-1. According to the new Water Resource Management Act (Act No. 11 of 2013) an abstraction licence is now required regardless whether the project is located within a water control area or not. Abstraction licenses are currently issued by the Ministry of Agriculture Water and Land Reform (MAWLR). The project falls inside a control area; thus, an abstraction permit is a requirement.

Within the Water Resources Management Act (Act No. 11 of 2013) it is clearly stipulated that the purification and disposal of industrial water and effluents as well as the disposal of effluents by local authorities is subjected to the requirements of the Act. Agricultural activities is not subjected to the requirements of the Act, making the implementation of 8.6 questionable. The return period for flood lines is not provided for, nor a definition of flood lines to make 8.8 applicable. It is however in the Proponent's best interest to ensure that the project area is outside a flood risk area. All land in Namibia is in some form of catchment area, making the practical implementation of 8.9 questionable. It however remains important to consider all activities that would/may impact on the groundwater.

5 DESCRIPTION OF NATURAL ENVIRONMENT

5.1 HYDROGEOLOGICAL LOCATION AND CHARACTERISATION

The project area (Farm Emilienhof FMB/00588) (19.447167°S, 17.630559°E) is located in the Owambo Groundwater Basin (Figure 1-1). The project area falls within a subdivision (Nosib - C), of the Grootfontein-Otavi-Tsumeb Water Control Area. As declared in Government Notice 1969 of 13 November 1970 and Proclamation 278 of 31 December 1976 (Extension).

Implications and Impacts

Groundwater Basin committees will likely be formed under the Water Resources Management Act, Act No. 11 of 2013. This will likely give more powers to groundwater users in a basin to ensure sustainability of groundwater usage, but also encourage the optimal usage of groundwater. The project area falls inside a declared water control area and permits are required for drilling and rehabilitation of boreholes as well as for groundwater abstraction.

5.2 CLIMATE

According to the Köppen-Geiger Climate Classification system the project is located in a hot semi-arid climate (BSh) (http://koeppen-geiger.vu-wien.ac.at/present.htm) (Kottek et al., 2006). This means that the area receives precipitation below potential evapotranspiration, but not as low as a desert climate and has a mean annual temperature of at least 18°C.

Additionally, long-term precipitation data was obtained for the project area from the CHIRPS-2 (Climate Hazards Group Infra-Red Precipitation with Station data version 2) database (Funk et al., 2015). The CHIRPS-2 dataset (Climate Hazards Group Infra-Red Precipitation with Station data version 2) consist of long-term precipitation data (1981 to near-present), obtained from satellite imagery and in-situ station data and therefore represents more recent data. Data is averaged over an area of roughly 5 km by 5 km. This averaging effect should be kept in mind during data analyses as high precipitation from single thunderstorm cells would be averaged out, thereby providing a reduced daily maximum precipitation value.

The Atlas of Namibia average rainfall for the area is 450 to 500 mm/a with a variation of 30 to 40% (Atlas of Namibia, 2022). Based on the CHIRPS-2 dataset the rainfall is well within rage with 492.18 mm/a, with a coefficient of variance of 26.71%. Both datasets indicate monthly rainfall peaking in January to March. CHIRPS-2 also indicates heavier precipitation (single day events) occurring between March and April, with a single day maximum of 83.26 mm in March being the highest. CHIRPS-2 daily and seasonal precipitation data is presented in Table 5-1 and in Figure 5-1 (Funk et al., 2015). Seasonal (July to June) total precipitation, centred on the average line for the last 43 years, is presented, with the daily total precipitation and the seasonal cumulative precipitation. From the figure it is clear that the rainfall for 7 out of the last 10 seasons were below average. The potential evapotranspiration is 2,300 to 2,400 mm/a. By dividing the mean annual potential evapotranspiration into the mean annual precipitation, an aridity index value for the area was computed as 0.22, which indicates the area to be semi-arid.

Table 5-1 Rainfall statistics based on CHIRPS-2 data (Funk *et al.*, 2015)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (mm/m)	21.26	32.44	34.51	0.00	0.00	0.00	0.00	0.00	0.00	6.92	8.19	23.55
Maximum (mm/m)	298.04	207.30	199.61	92.70	3.87	0.30	0.03	0.00	7.18	63.77	95.93	195.69
Average (mm/m)	121.16	110.89	93.43	23.39	0.22	0.02	0.00	0.00	0.61	22.12	36.75	79.72
Variability (%)	51.63	47.49	38.23	89.01	332.91	340.56	405.28	0.00	254.29	63.79	51.98	49.87
Daily Maximum (mm)	52.27	40.24	83.26	61.85	3.87	0.19	0.03	0.00	5.48	32.09	25.18	45.69
Average Rain Days	13.28	11.47	8.02	2.93	0.12	0.30	0.07	0.00	0.44	4.00	7.98	10.95
Season July - June average 492.18				Season coefficient of variation: 26.71					3 Day return period: 88.82			
Date range:		1981-Jan-01	to	2024-Jun-30			Lat: 19.447°S			Long: 17.631°E		

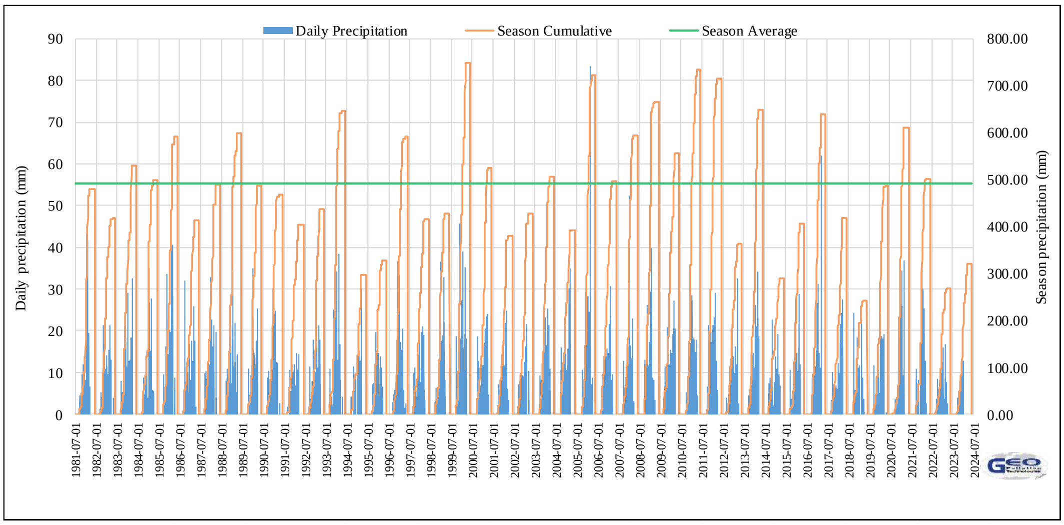


Figure 5-1 Daily and seasonal rainfall from CHIRPS-2 data (Funk *et al.*, 2015)

Similar to precipitation data, temperature data is also lacking for the project area, with the Atlas of Namibia presenting only crude, large scale averages. To have an idea of temperatures in the area, monthly temperature data was retrieved from the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) data set for a height of 2 m above surface (Ronald Gelaro, et al., 2017). This data set is a NASA atmospheric reanalysis, incorporating satellite data integration and aims at historical climate analyses at 0.5° x 0.625° spatial resolution. This translates to roughly 3,640 km², which still is a large area, but is somewhat less crude than the Atlas data.

Table 5-2 presents statistics of daily data abstracted from the MERRA-2 data set for the last 43 years. The lowest temperature of -2°C was recorded in June. It should be noted that this seems to occur rarely as the average days below 0°C is less than zero. A maximum temperature of 41°C was measured in January and in November. The average diurnal temperature (difference between daily minimum and maximum temperature) range between 13°C and 18°C. Direct normal solar irradiance for the area is 6.811 kWh/m²/day.

Table 5-2 Temperature statistics based on Merra-2 data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (°C)	9	8	8	7	3	-2	0	3	6	5	5	9
Maximum (°C)	41	39	39	36	34	30	30	34	38	40	41	40
Average (°C)	25	24	24	22	20	17	16	20	24	26	26	26
Diurnal (°C)	13	13	13	15	16	17	17	18	18	17	15	14
Average days < 0°C	0	0	0	0	0	0	0	0	0	0	0	0

Implications and Impacts

Rainfall events are often thunderstorms with heavy rainfall that can occur in short periods of time ("cloud bursts"). Rainfall in the area is above the Namibian average but varies significantly year on year. Heavy rainfall can lead to soil erosion when improper agricultural practises are employed, while dry seasons will necessitate greater reliance on groundwater resources. Recurring drought conditions may impact on groundwater availability due to reduced aquifer recharge. Pollutants that enter the groundwater can pollute this valuable resource. Rainfall is important for groundwater recharge.

5.3 TOPOGRAPHY & DRAINAGE

The project area falls within the Karstveld landscape, an area dominated by limestone with little or no surface run-off and a strong development of sinkholes, dolines and caves. Moderate folding of the geology occurred during the Pan African Orogeny (680-450 Ma) and resulted in the formation of synclines and anticlines, generally trending east-west. The local topography ranges from rugged mountains in the south to relative flat valleys in the north (Figure 5-2).

Surface elevation of the project area ranges from 1,403 mamsl at the most northern corner to 1,588 mamsl in the southern portion of the project area. The valley to the north has a slope of less than 2.5°. Drainage is only well defined in the mountainous portion of the project area, with sheet wash expected on the valley portion. Drainage is mainly to the north and the area falls within the Etosha Pan catchment.

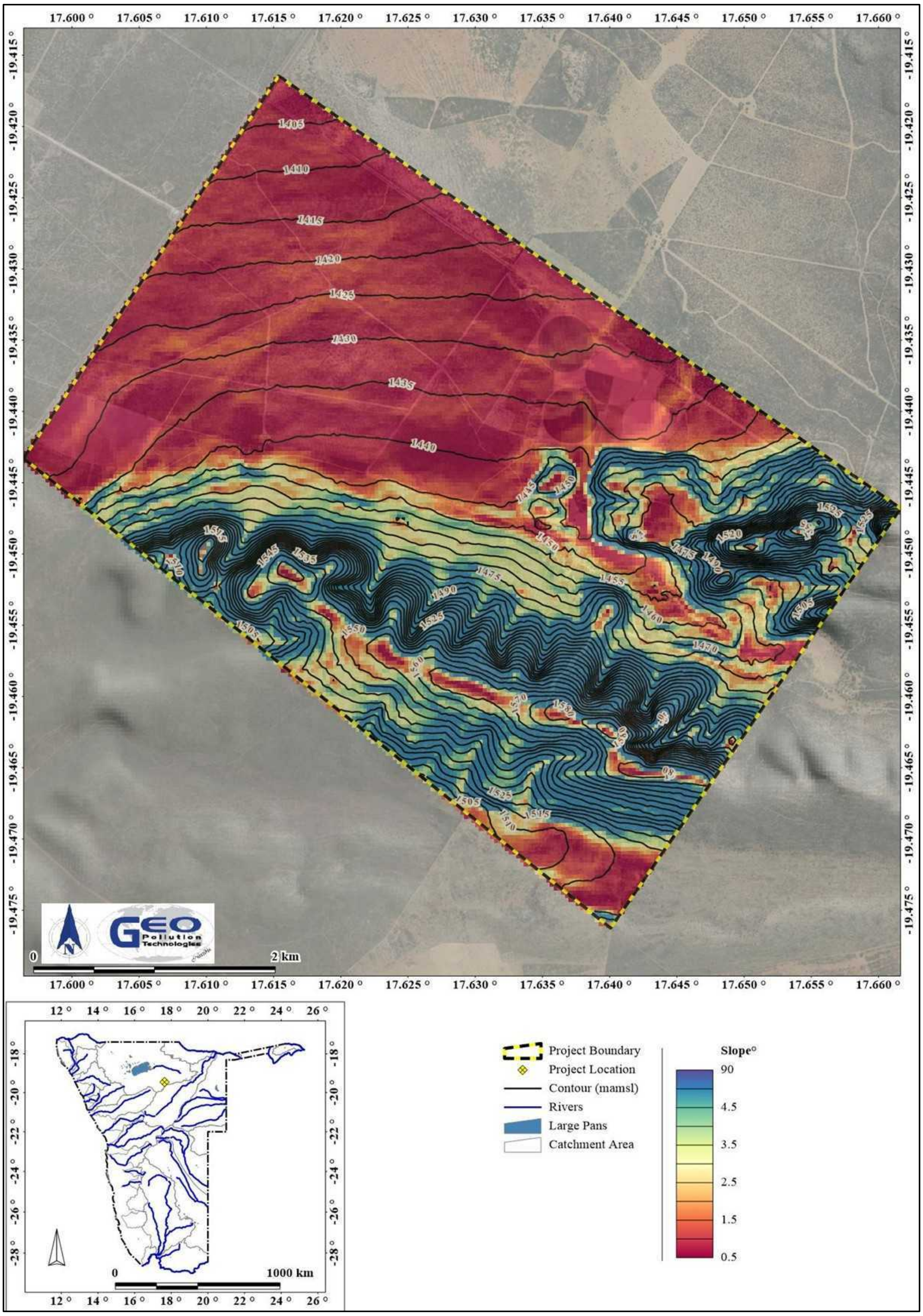


Figure 5-2 Topography and drainage

Implications and Impacts
The area to be developed is generally flat and well suited for agricultural activities. The lack of major surface runoff and drainage may lead to pooling and even flooding of plains during heavy rainfall events. This may negatively impact soil quality and cause localised flooding of infrastructure, if located in flood prone areas, or if such areas are not considered in designs. The risk of erosion is relatively low, except closer to the mountains. The local geology helps to prevent localised flooding as the surface layer is mainly characterised as Kalahari sediments with a high permeability.

5.4 GEOLOGY

The project area is underlayn by two different types of soil (Figure 5-3). Dominant soil type for the northern part where irrigation is planned is Leptic Regosol which refers to a young, undeveloped soil type lacking in diagnostic horizons and revealing very little evidence of its exact formation. These soils are common in areas where arid conditions have severely restricted the erosive processes and deposition of sediments. This also has the effect of making regosols on slopes highly erosive and not suitable for the cultivation of rain-fed crops. In addition to this, the regosol of this particular area is known for having, between 25 and 100 cm from the soil surface, continuous hard rock. The composition of soil in this particular area is roughly 60-65 % sand, 10-15 % silt and 30-35 % clay which gives it the characteristics and texture of silt loam soil. Bulk density was computed to be 1,450-1,500 mg/cm³ which means that the soil will affect the root growth of various plants, but not necessarily restrict it. Soils in this area typically reach depths of >190 cm, have a pH of 4.6-5.5 and a cation exchange capacity of 10-13 cmol/kg. Furthermore, this region has a water capacity of 60-80 mm at root depth.

The dominant soil type on the southern portion of the project area is Skeletic Lithic Leptosol which refers to a soil type with a stony characteristic or very shallow depth over a continuous rock surface. These soils are typically found in hills where erosion takes place at a higher rate than soil formation or sediment deposition. Due to this and the fact that these soils form a thin layer with high drainage, leptosols are poor candidates for crop production. The composition of soil in this particular area is roughly 65 to 70% sand, 10 to 15% silt and 25 to 30% clay which gives it the characteristics and texture of sandy clay loam soil. Bulk density was computed to be 1,450 to 1,500 mg/cm³ which means that the soil will affect the root growth of various plants, but not necessarily restrict it. Soils in this area typically reach depths of 140 to 150 cm, have a pH of 5.5 to 6 and a cation exchange capacity of 7 to 10 cmol/kg. Furthermore, this region has a water capacity of 40 to 60 mm at root depth (Atlas of Namibia, 2022).

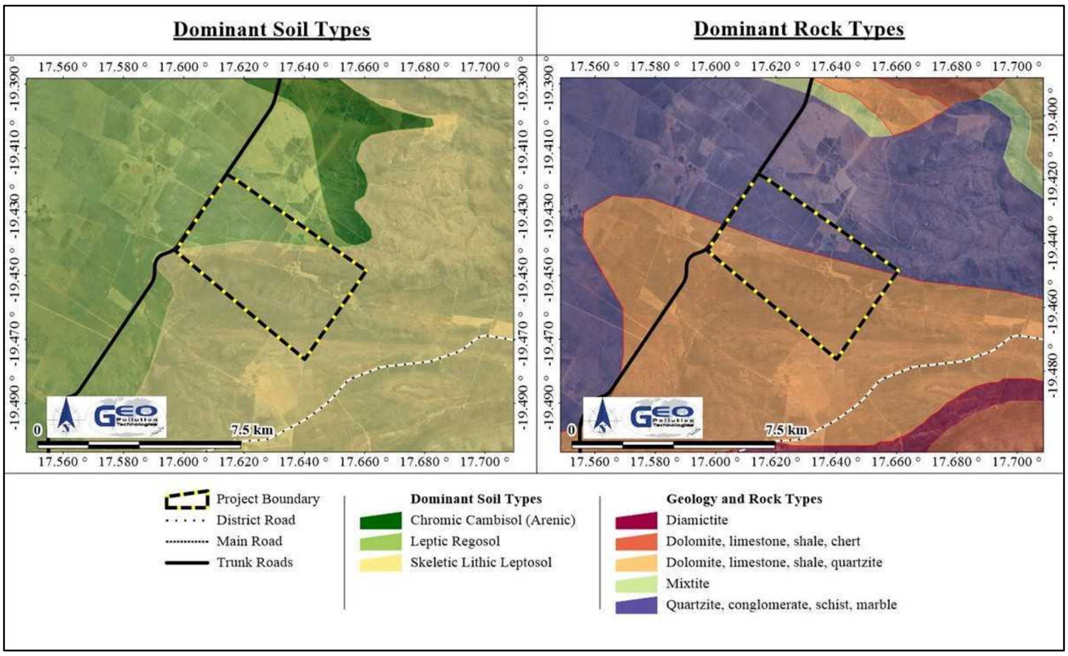


Figure 5-3 Dominant soil and rock types (Atlas of Namibia, 2022)

The project area falls within the Northern Platform Zone of the Damara Sequence. A tectonostratigraphic zone in which the carbonate-dominated Otavi Group was deposited in a lagoon like environment. Predominant east-west-trending anticlinal structures are common. Locally the Namibian Age formations are partially covered by Quaternary Age deposits, comprising of sand, calcrete and gravel (Figure 5-4 and Table 5-3).

At the project location the underlaying Damara Sequence consists of dolostones, limestone, diamicitite, phyllites, quartzites, and shales of the Tsumeb and Abenab Subgroups. These subgroups belong to the Otavi Group.

Moderate folding of the strata occurred during the Pan African Orogeny (680-450 Ma) and resulted in the formation of synclines and anticlines, generally trending east-west. The development of joints and fractures in the rocks are associated with the folding, which have an impact on the hydrogeological characterization of the area. The project area is largely impacted by thrusted faulting that led to the development of multiple synclines and anticlines within the mapping extend Figure 5-4 (Miller, 2008).The Nosib and Sovis Anticline as well the Khorab, Uitsab, and Olifantshoek Syncline are all in and around the project area. With fault lines trending in an east-west direction parallel to the various synclines.

Various northeast striking magnetic dykes are known to be present in the subsurface, as inferred from aeromagnetic data. The dykes seem to be related to the Paresis intrusion which are situated just south of Otjiwarongo, with dykes radiating from this intrusion. These dykes are locally thought to have shattered the host rocks during its formation. Where dolomite is the host rock, it forms a zone favourable for the development of karst features and groundwater accumulation. The remnant dyke can be found northwest of the project location, just outside of the mapping extend of Figure 5-4. The main fault orientation is roughly east to west.

Geophysical-interpreted dykes occur in the area and strike towards the northeast. As mentioned, the Remnant dyke is located on the western side of the project area. This dyke is identifiable on the aeromagnetic data. The nature of these dykes tends to be mineralised faults with high hydraulic conductivity values. Both the Tsumeb and Remnant dykes represented a major exploration target for the NamWater water supply programme to Windhoek. The dykes are thought to have shattered the host rocks during its formation (Hoad, 1992).

Several known karst features are present in the region. These include the mineralised karst chimneys of both the Tsumeb and Abenab Mines (Bäumle, 2003), as well as several sinkhole lakes (Otjikoto and Guinas) and caves.

The Gross Otavi and the Kombat mines are located approximately 23 to 29 km to the south of the project area respectively. This hydrothermal deposit represents a highly mineralized zone of which metals like vanadium as well as lead, copper and zinc were mined until 1948 and 1958 respectively when the ore reserves were depleted and the mines were closed (von Bezing, Bode, & Jahn, 2014). The Tsumeb Mine is approximately 62 km to the northeast; mining ceased here in 1994.

Metamorphic Complex and more permeable formations of the Damara Sequence. The nearest of these contact zone springs is present approximately 14 km to the west of the project area, see Figure 1-1. No caves or lakes are known of in proximity (<10 km radius) to the project area.

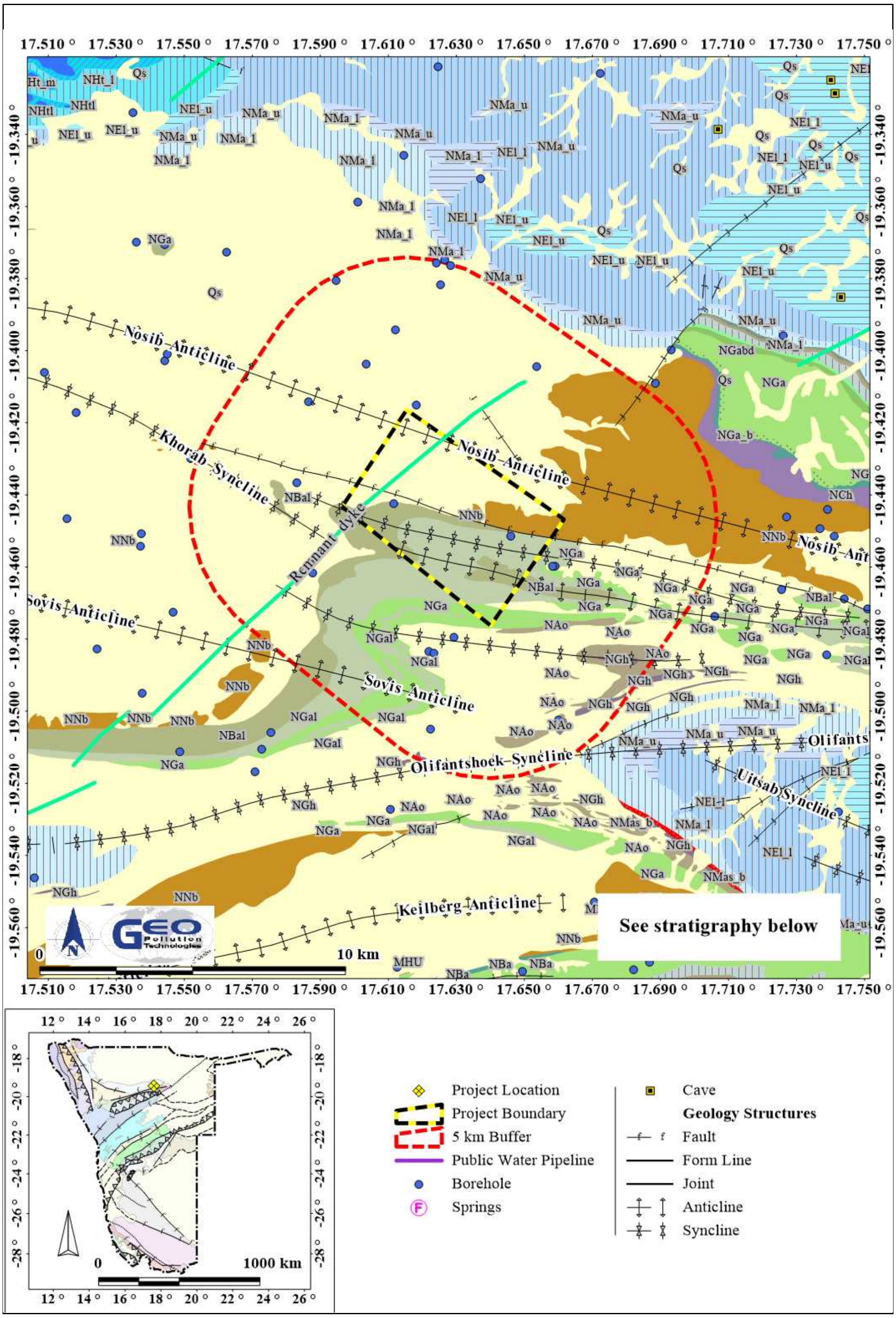


Figure 5-4 A 1:250 000 Geological map

Table 5-3 Stratigraphic succession of Figure 5-6

Age	Lithcode	Supergroup	Group	Subgroup	Formation	Member	Complex	Main_Litho	Other_Rock
Quaternary	Qs							sand; gravel; calcrete	
Namibian	NHt_m	Damara	Otavi	Tsumeb	Huttenberg			dolostone (bedded)	phyllite
	NHt_l							dolostone (bedded)	chert (algal)
	NHtl							limestone	shale
	NEl_u				Elandshoek			dolostone (bedded)	
	NEl_l							dolostone (massive)	
	NMa_u				Maieberg			dolostone (bedded)	
	NMa_l							limestone/marl (bedded)	
	NMas_b							shale	
	NMaKb					Keilberg		dolostone	
	NGh				Ghaub			diamictite	
	NAo			Abenab	Auros			limestone;dolostone	shale
	NAo_u							dolostone	
	NAos							shale	limestone
	NAo_l							dolostone (cherty)	
	NGu				Gauss	Gruis		dolostone (bedded)	
	NGa							dolostone (massive)	
	NGal							limestone	
	NGa_b							dolostone;shale	
	NGabd							dolostone (bedded)	
	NBa				Berg Aukas			dolostone (laminated; light/dark)	
	NBal							limestone	
	NCh		Swakop/Otavi	Usakos/Abenab	Chuos			diamictite; pebbly schist	quartzite; conglomerate; dolostone; shale
	NNb				Nabis			quartzite;arkose	conglomerate;shale
Kheisian	MHU						Huab MC	paragneiss;orthogneiss	metasedimentary rocks;granite;mafic dykes

5.5 HYDROGEOLOGY

The project area is situated in the Owambo Groundwater Basin. Localised groundwater flow may take place along preferred flow paths in different directions, but the larger scale groundwater flow is expected to be in a northly direction. Local flow patterns may vary due to groundwater abstraction.

Groundwater flow is expected to take place throughout primary porosity primary porosity in the surface sediment cover and through secondary porosity in the karstic/dolomitic aquifer or the fractured aquifer system where groundwater flow is expected to flow along the fractures, faults (secondary porosity) and other geological structures present within the underlying formations (hard rock or consolidated formations.

The karst aquifer within the Otavi Mountain Land (OML) is recognized as the primary groundwater resource in the region, characterized by water of generally good quality. Recharge to these aquifers occurs primarily through local rainfall infiltration, facilitated by several factors such as comparatively high rainfall, minimal soil cover in mountainous areas, and the storage capacity within Kars systems. These conditions enable rapid infiltration during precipitation events and the storage of significant volumes of water within the aquifers. The water table averages about 28 m below surface in the project location. This makes the abstraction of groundwater ideal to be used as the main source of water. The groundwater is then used for crop irrigation and cattle farmingClick or tap here to enter text..

According to the Ministry of Agriculture, Water and Forestry (MAWF, 2006) the farm is located inside the Grootfontein-Otavi-Tsumeb Subterranean Water Control Area, Government Notice 1969 of 13 November 1970 and Proclamation 278 of 31 December 1976 (Extension). The farms also fall under a sub-division of the water control area (Otavi - G). Government regulates groundwater usage in this area and all other groundwater related activities like drilling, cleaning or deepening of boreholes and rates of water abstraction. See Figure 1-1 for a map indicating the water control area, groundwater basin and inferred groundwater flow.

Groundwater quality data is presented in Figure 5-5 as Maucha plots. From the figure it is clear that the groundwater of the project area is mostly of a calcium-magnesium-bicarbonate type water, which suggest the water is recently recharged.

Groundwater information was obtained from Department of Water Affairs (DWA) borehole database. This database is generally outdated and more boreholes might be present. There are 21 known boreholes within the project area and a 5 km buffer around the area. See Table 5-4 and Figure 5-6. The average depth of 18 of the boreholes is 80.08 m below surface and the yield of 18 of the boreholes ranges between 0.30 and 22.70 m³/h, with an average yield of 6.72 m³/h. The average groundwater level of 12 of the boreholes is 42.15 m below surface, ranging between 9.00 m and 126.00 m below surface. From Figure 5-6 it seems as if the shallow boreholes might have higher nitrate concentrations, compared to the deeper boreholes. No other water quality / depth relation was noted.

Table 5-4 Groundwater statistics

	DEPTH (mbs)	YIELD (m^3/h)	WATER LEVEL (mbs)	TDS (ppm)	SULPHATE (ppm)	NITRATE (ppm)	FLUORIDE (ppm)
Data points	18	18	12	16	16	12	16
Minimum	29.00	0.30	9.00	330.00	4.00	0.60	0.20
Average	80.08	6.72	42.15	588.63	38.44	10.11	0.61
Maximum	228.60	22.70	126.00	858.00	117.00	30.00	1.10
Group A	33.33%	16.67%	16.67%	100.00%	100.00%	66.67%	100.00%
Limit	50	>10	10	1000	200	10	1.5
Group B	33.33%	22.22%	50.00%	0.00%	0.00%	8.33%	0.00%
Limit	100	>5	50	1500	600	20	2.0
Group C	27.78%	50.00%	25.00%	0.00%	0.00%	25.00%	0.00%
Limit	200	>0.5	100	2000	1200	40	3.0
Group D	5.56%	11.11%	8.33%	0.00%	0.00%	0.00%	0.00%
Limit	>200	<0.5	>100	>2000	>1200	>40	>3
21 known boreholes within the project area and a 5 km buffer around the area							

Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:

Group A: Water with an excellent quality
Group B: Water with acceptable quality
Group C: Water with low health risk
Group D: Water with a high health risk, or water unsuitable for human consumption

Implications and Impacts

Local groundwater recharge is expected to be high, especially in the mountain areas. This can make the groundwater vulnerable to pollution from over application of fertilizers, pesticides, and herbicides. The high recharge will make groundwater abstraction more sustainable.

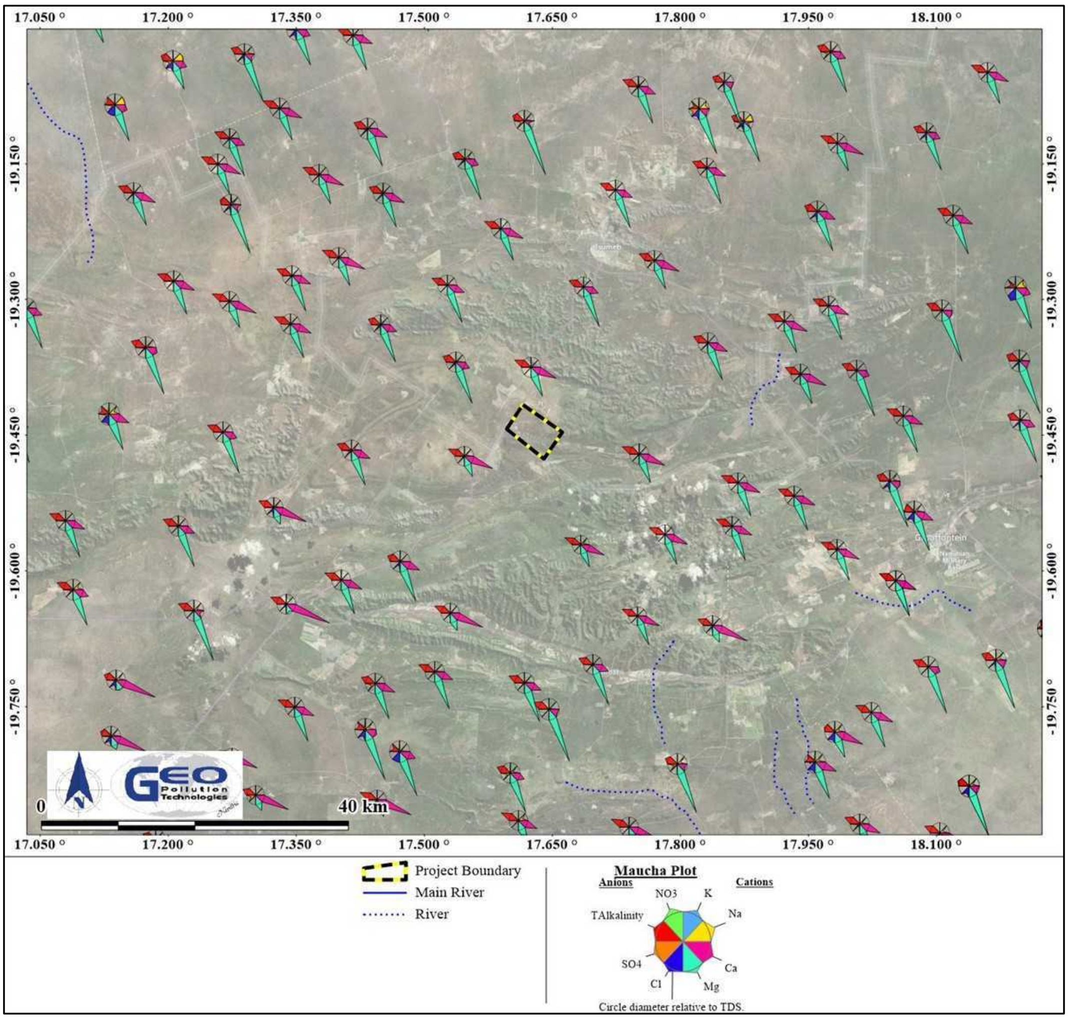


Figure 5-5 Groundwater quality

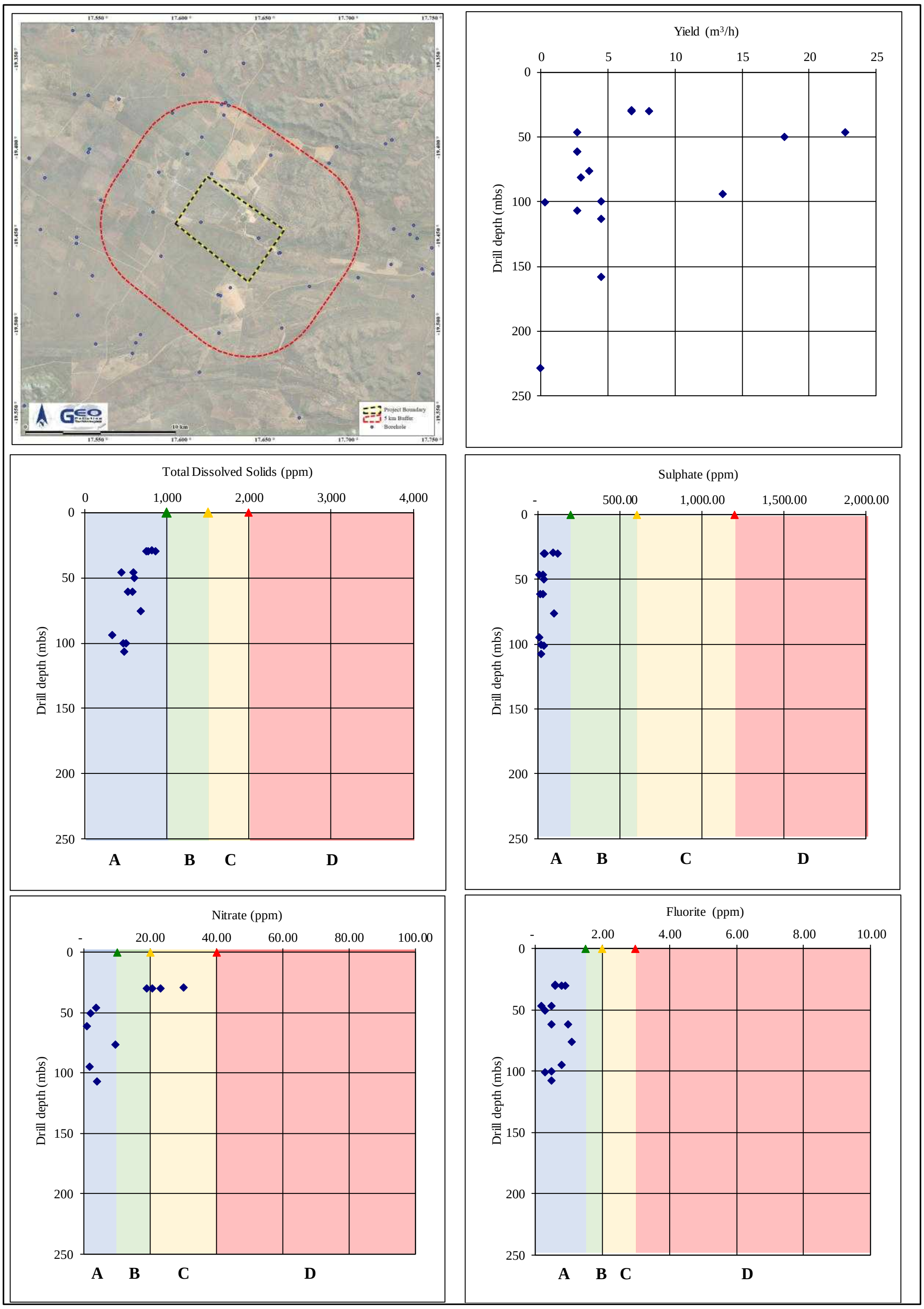


Figure 5-6 Borehole depth relations

6 ASSESSMENT OF WATER LEVEL MONITORING DATA

In order to construct a hydrological cross-section of the study area, monitoring borehole information and related water-level monitoring data was sourced from the Ministry of Agriculture, Water and Land Reform (MAWLR) (Figure 6-1). Appropriate boreholes were selected along the inferred groundwater flow path to showcase the current level and historic groundwater behaviour. The following boreholes were identified: WW30694; WW27811; WW39083; WW9736; WW31485; WW30901, and WW32621.

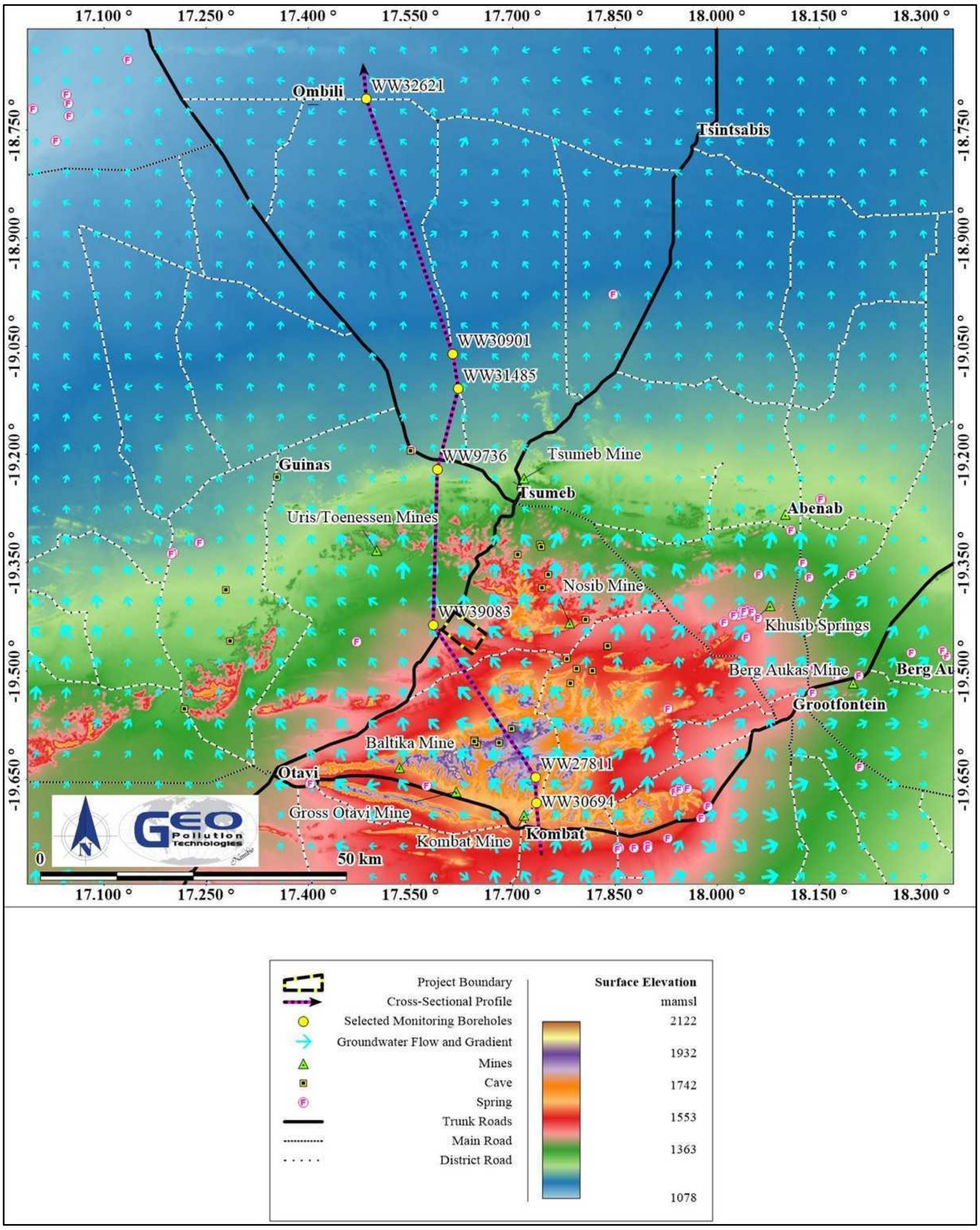


Figure 6-1 Monitor borehole locations, caves, springs and mines

The cross-section is intersecting two groundwater basins, namely the Kunene South groundwater basis and the Owambo groundwater basin, in which the project area is located. In Figure 6-2 the average, minimum, and maximum water levels is indicated for each borehole. Note the relative large groundwater level fluctuations at the start of the profile, compare with significantly smaller fluctuations towards the project area and beyond. Rhythmic recharge and flow of groundwater from the higher laying areas is causing the fluctuations, with the water levels stabilizing as the terrain flattens out.

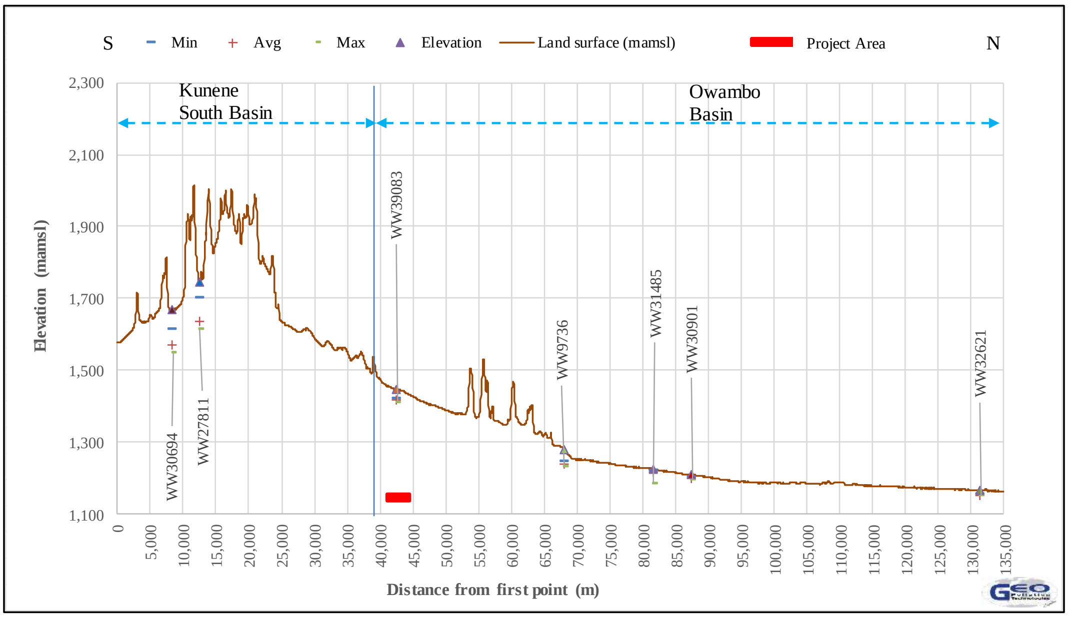


Figure 6-2 Regional water level profile

Boreholes WW30694 and WW27811 are close to the water divide and also near the Kombat mine, with the farthest one being 6.5 km away. The water level has shown significant fluctuations and changes over the monitoring period (Figure 6-3). There is a clear correlation with water levels spiking during high rainfall periods. Impact from mine dewatering is also evident with water levels rising after flooding of the mine. Where mine dewatering started soon after flooding, the impact is less. After the last flooding event no significant dewatering took place and the water level mainly showed an increase in level.

Boreholes WW39083, WW9736, WW31485, WW30901, and WW32621 are all located in the Owambo basin. With WW39083 being the nearest monitoring well to the project area. The water levels of these boreholes have less fluctuations and a steady groundwater inflow from higher laying areas maintain the groundwater level.

The Proponent has supplied water level measurement data of three production boreholes (WW200925, WW200926 and WW200927) that are located on the project area (Figure 6-4). The water levels remained relatively stable despite the boreholes being used for irrigation purposes. Low rainfall during the period of 2023 - 2024 likely impacted the water levels.

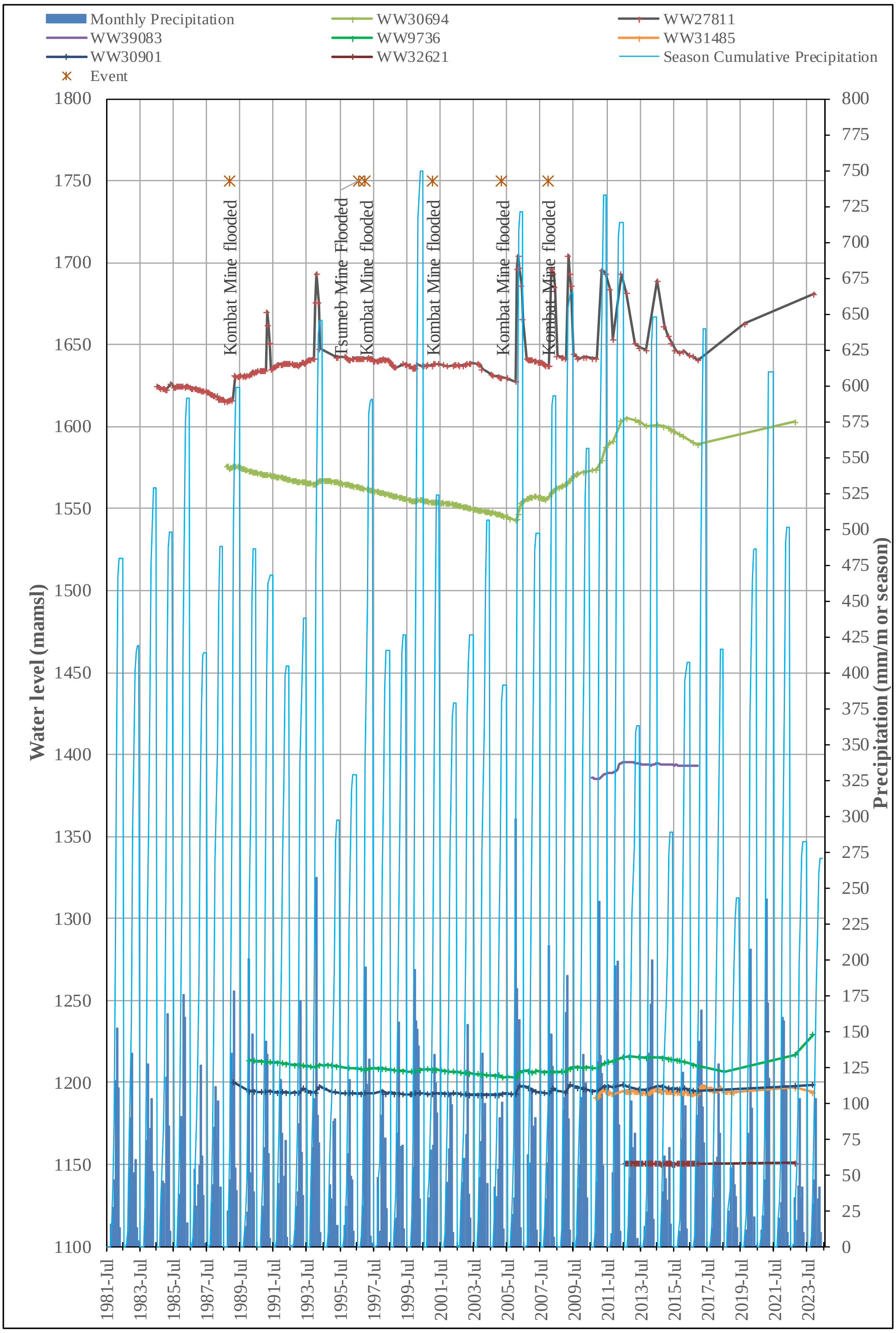


Figure 6-3 Regional water level changes and monthly rainfall

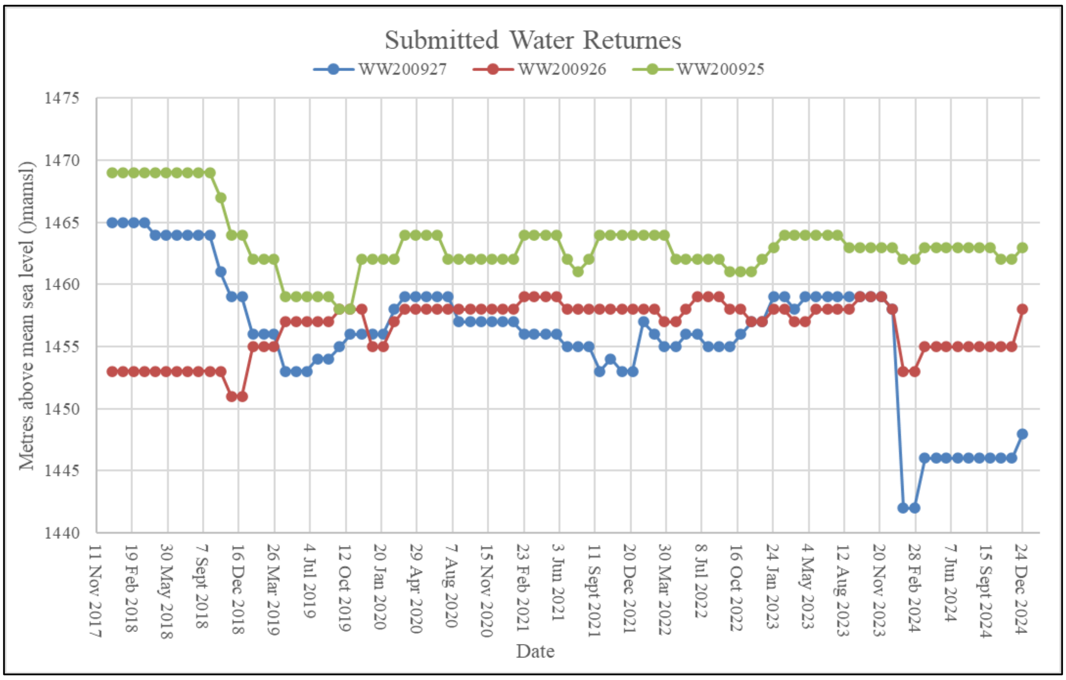


Figure 6-4 Water level measurements from the Farm Emilienhof FMB/00788

Implications and Impacts
The project is located in an area with stable water levels. Inflow from higher laying areas seems to buffer the water levels against major floctuations.

7 WATER SUPPLY

7.1 GROUNDWATER USAGE

The only available source of water on or near the project area is the local underlaying aquifer. The Proponent has drilled several boreholes on the different parts of the project area in order to utilise the groundwater for irrigation, stock watering and domestic uses.

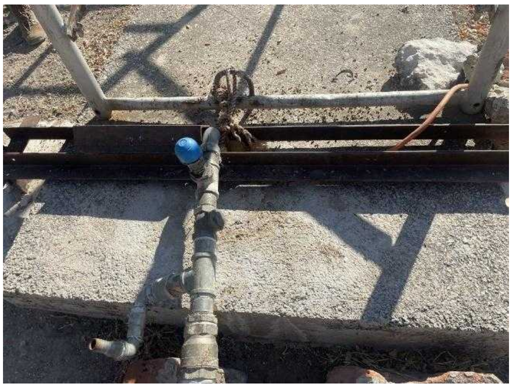
During a hydrocensus on the project area, twelve boreholes were found. Information regarding their use, status and physical description was gathered. Figure 7-1 illustrates the locations of the boreholes. Of the twelve boreholes investigated, six were in use, of which four was used for irrigation, two was used for domestic and stock purposes and the remaining one was used for stock watering. All operational boreholes were equipped with submersible pumps, while the 4 irrigation boreholes are equipped with flowmeters. Accurate rest water level measurements could not be obtained from any of the boreholes as it was influenced by active pumping nearby. Some of the boreholes were obstructed by the installed infrastructure and could thus not be measured. The hydrocensus data is summarised in Table 7-1.

Figure 7-1 Borehole locality map

Table 7-1 Summary of groundwater information obtained from field investigations

Map Ref.	Farm Name	Borehole Name(s)	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
EB1	Emilienhoff FMB/00588	SAS Gat	Irrigation	79	90	
EB2	Emilienhoff FMB/00588	WW200925	Irrigation	120	90	19
EB3	Emilienhoff FMB/00588	WW200926	Irrigation	120	90	26
EB4	Emilienhoff FMB/00588	WW200927	Irrigation	120	60	37
EB5	Emilienhoff FMB/00588	Berg Gat 1	Not used	60	2	25
EB6	Emilienhoff FMB/00588	Berg Gat 2	Not used	60	2	29
EB7	Emilienhoff FMB/00588	WW39401	Domestic/ Stock		5	22
EB8	Emilienhoff FMB/00588	Bobbejaan Flop Gat	Not used			
EB9	Emilienhoff FMB/00588	Bobbejaan Pos Gat	Not used			
EB10	Emilienhoff FMB/00588	Teerpad Land	Not used	148	245	36
EB11	Emilienhoff FMB/00588	WW39337	Stock		2.5	
EB12	Emilienhoff FMB/00588	Kalkbank Gat	Not used	60		

 Photo 7-1 EB1 - Irrigation	 Photo 7-2 EB2/ WW200925 - Irrigation
 Photo 7-3 EB3/ WW200926 - Irrigation	 Photo 7-4 EB4/ WW200927 - Irrigation
 Photo 7-5 EB5 – Not used	 Photo 7-6 EB6 - Not in use

 **Photo 7-7 EB7/ WW39401 – Domestic and stock**	 **Photo 7-8 EB8 Not in use/dry**
 **Photo 7-9 EB9 Not in use/dry**	 **Photo 7-10 EB10 Not in use/dry**
 **Photo 7-11 EB11/ WW39337 - Stock drinking**	 **Photo 7-12 EB12 Not in use**

Implications and Impacts

Groundwater is a valuable resource in the farming area as the Proponent utilises the groundwater for a variety of uses. These include irrigation, stock watering and domestic use. The amount of water the Proponent may use is controlled by a water abstraction licensing system as regulated by the Ministry of Agriculture, Water and Land Reform. Groundwater contamination may negatively impact surrounding boreholes, and groundwater users in the wider area. No alternative water supply options exist if extensive contamination or deterioration of groundwater occur.

8 ASSESSMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts and provides possible mitigation measures that are expected from the project. The Rapid Impact Assessment Method (Pastakia, 1998) will be used during the assessment. Impacts are assessed according to the following categories: Importance of condition (A1); Magnitude of Change (A2); Permanence (B1); Reversibility (B2); and Cumulative Nature (B3) (see Table 8-1).

The Environmental Classification = A1 x A2 x (B1 + B2 + B3), see Table 8-2.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Table 8-1 Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit / detriment of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative detriment or change	-2
Major detriment or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2

Strong Cumulative Character	3

Table 8-2 Environmental classification of impacts (Pastakia 1998).

Environmental Classification (ES)	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

8.1 GROUNDWATER ABSTRACTION

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or poor-quality groundwater is present on the land. Abstraction of groundwater must be done in a sensible way not to impact on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater. A typical groundwater balance was compiled to illustrate the potential consequences of over abstraction of groundwater, see Figure 8-1. Recharge to the area is considered to be high. It is considered that recharge can vary from 0 % to 4 % of rainfall with an average of 2 % of the rainfall. In periods of drought there may be no recharge while in above average rainfall recharge could be above 4 % (Hoad N, 1993).

In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system. Over time an equilibrium (or steady state) is normally reached with rising water tables following good recharge events and declining water tables when recharge is below average.

Inflow into the system would typically be from infiltration following rainfall in the area and in upstream areas. The inflow component will further be enhanced by the high secondary porosity nature of the karst aquifer.

Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system as well as evapotranspiration losses. Groundwater abstraction from boreholes is important as this is normally necessary to sustain human and animal demands where such users became essentially dependant on the abstracted groundwater as a reliable and sustainable source.

Typical consequences of over abstraction will include a lowering in the water table. This may lead to the collapse of underground cave roofs where the hydrostatic pressure, used to support the roof of a cave, decrease. The increased flow of water may enhance the dissolution of dolomitic rock, leading to an increase in karst structures. Lowering of water tables may further lead to the drying up of boreholes, springs, underground caves and the subsequent loss of organisms that lives in the subsurface and surface water. Vegetation will also be impacted where such vegetation has access to groundwater.

Based on current water level fluctuations in the area, a short term threshold of 5 m below the long term average water level is set from where abstraction rates should be reduced. Note that this level refers to rest water levels and not pump water levels.

All boreholes should be equipped with a dipper pipe to enable safe water level measurements.

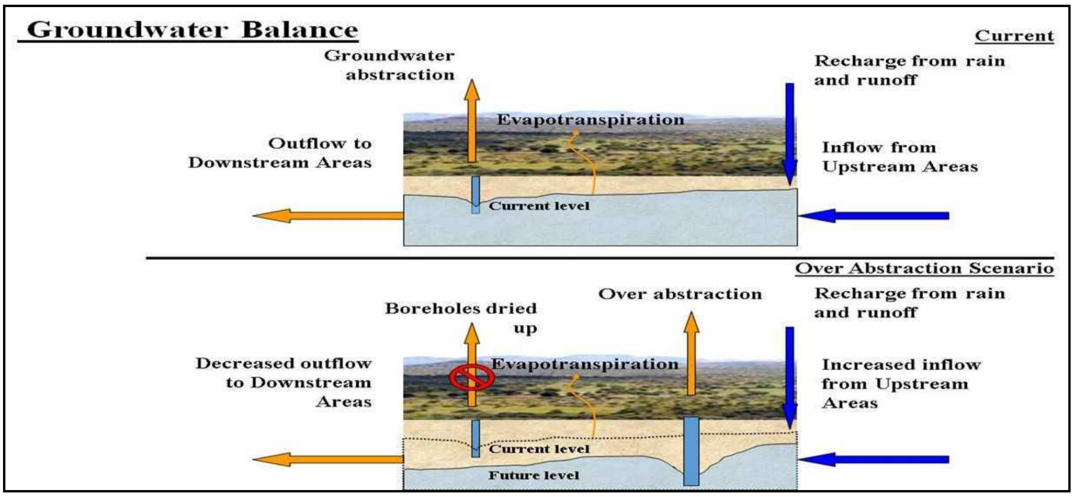


Figure 8-1 Conceptual groundwater balance with over abstraction scenario

Table 8-3 Assessment – Groundwater abstraction

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Over-abstraction of the local aquifer, decrease in the local hydraulic head.	2	-2	2	2	2	-24	-3	Probable

Desired Outcome: To utilise the groundwater sustainably.

Actions
Prevention:
- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring.
- Maintain safe abstraction rates prescribed by test pump evaluations (an abstraction permit with prescribed rates from the MAWLR is a requirement for this project).

Mitigation:
- Reduce abstraction when the water levels nears 5 m below the average rest water level of each borehole.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Monthly boreholes rest water level monitoring.
- Baseline values should be reviewed every three years based on all historic water level data.
- A summary report on all monitoring results must be prepared.
  The Proponent supply monitoring returns to the MAWLR, as required by the permit.

8.2 GROUNDWATER, SURFACE WATER AND SOIL CONTAMINATION

Leakages and spillages of hazardous substances from vehicles, waste oil handling and accidental fuel, oil or hydraulic fluid spills during the operational phase may contaminate the environment. Increase of nutrient levels (from over application of fertilizers or pesticides) in the soil that can leach to the groundwater. Pollution due to sewerage system overflow or leakage may further put the groundwater at risk.

Table 8-4 Assessment – Groundwater, surface water and soil contamination

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery.	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction.	2	-1	2	2	1	-10	-2	Probable

Desired Outcome: To prevent the contamination of groundwater, surface water and soil.

Actions

Prevention:

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.

Mitigation:

- All spills must be cleaned up immediately.
- Consult relevant Material Safety Data Sheet (MSDS) information and a suitably qualified specialist where needed.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Maintain Material Safety Data Sheets for hazardous chemicals.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Groundwater should be sampled and analysed to test for nitrate concentrations from the fertilizer and for traces of chemicals used in pesticides and herbicides.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

9 CONCLUSION

Groundwater on the project area is high yielding and of acceptable quality for human consumption. Four of the twelve boreholes are utilisation for irrigation purposes, although care must be exercised when long term irrigation takes place and nitrate values should be monitored regularly.

Based on current water level fluctuations in the area, as presented in Figure 6-3 a short term threshold of 5 m below the long term average water level is set from where abstraction rates should be reduced. This threshold may require adjustment during drought periods as abstraction from neighbouring farms may also influence the regional water levels. Careful cooperation between neighbouring farms and beyond is required to optimally utilize the groundwater resource without depleting it as depletion will be detrimental to all. This should include self-monitoring and assessment of water levels in the area as data obtained from DWA indicates a lack of sufficient monitoring in the recent years. Proper monitoring data will provide the required information to make informed decisions and will assist to obtain increased abstraction volume permits when needed and if justified.

Groundwater vulnerability to contamination would be the highest around boreholes, around geological structures as well as where shallow groundwater is present. Contaminated surface runoff can create a pathway to the groundwater, putting the groundwater at risk. Potential sources of groundwater pollution include normal runoff from roofs, properties and surfaced areas, e.g. roads. These impacts are normally of a low magnitude and can be managed through proper housekeeping.

Based on current water level and abstraction volumes continuous monitoring is recommended to determine if higher abstraction volumes may be considered.

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Appendix C: GM Maize and Cotton in Namibia Specialist Report

ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE AND COTTON FOR AGRICULTURAL PURPOSES IN NAMIBIA

Assessed by:

Geo Pollution Technologies Namibia

Assessed for:

Agricultural Industry

October 2024

<table>
<tr><td>Project:</td><td colspan="2">ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE AND COTTON FOR AGRICULTURAL PURPOSES IN NAMIBIA: SPECIALIST ASSESSMENT</td></tr>
<tr><td>Report: Version/Date:</td><td colspan="2">Final
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<tr><td>Report Approval</td><td colspan="2">
André Faul
Environmental Scientist</td></tr>
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EXECUTIVE SUMMARY

Introduction
Stakeholders in the agricultural sector intend to apply for the registration of genetically modified (GM) maize for environmental release in Namibia. Under the Biosafety Act and Environmental Management Act of Namibia, the environmental release of a GM organism requires an environmental risk assessment to be conducted. This document reports on an assessment conducted by Geo Pollution Technologies (Pty) Ltd for the environmental release of GM maize and cotton. The specific GM events for maize are MON 810, MON 89034, NK 603 and stacks (combinations) of these events, and for cotton MON 88913 and the stacked event MON 88913 × MON 15985.

These maize and cotton events have primarily been designed to provide insect and / or herbicide resistance. Insect resistance is targeted at the fall armyworm and African maize stalk borer in maize, and the African boll worm in cotton. These pests can cause significant crop losses within days of infestation in traditional non-GM maize and cotton fields. In insect resistant events, moth larvae are controlled by specific proteins that were introduced into the maize and cotton through genetic engineering. Herbicide resistant maize and cotton are resistant to the systemic, non-selective herbicide glyphosate. This enables farmers to manage all weeds in maize and cotton fields by applying glyphosate without harming the maize and cotton itself.

Scope and Methodology
A specialist assessment report was prepared by conducting an extensive literature review and interviewing experts in the field of agricultural economics, specifically in the Namibian environment. The report addresses both GM maize and GM cotton and can thus be used as literature source in environmental impact assessments for farmers' who wish to cultivate GM maize and/or GM Cotton.

Literature Review and Aspects of GM Maize and Cotton Cultivation
A vast amount of scientific and unscientific (popular) publications are available. To separate fact from myth requires in-depth consideration of various publications. A number of expert scientific reviews on the topic of genetically modified organisms (GMOs) are available. The most recent of these covering two decades worth of literature and data.

The main concerns related to the cultivation of GMOs in general are the potential health effects they may have on the consumers as a result of their changed genetic composition, and the potential impact on biodiversity as a result of their environmental release.

Based on the review of existing scientific literature, no concrete evidence could be found that substantiate the various claims of negative impacts caused by GMOs. What became evident is that many anti-GMO lobbyists portray GMOs in a negative light without critical examination of the existing scientific data. Some of these campaigns have been so successful that amidst a severe shortage of food, Zambia's government refused a consignment of food aid consisting of GM maize. Thus far, the only real argument that has some scientific credibility pertaining to negative impacts of GM crops, is that insect and weed resistance can develop in light of the designed GM traits. However, this is not more so than resistance development in conventional non-GM maize (and other crop) cultivation activities.

Conclusion
Economically, the cultivation of GM maize and cotton have been shown, more often than not, to be more profitable and higher yielding (especially for insect resistant crops), than its non-GM counterpart. This is evident in the complete adoption of GM cotton in South Africa with no traditional cotton being planted anymore. The profitability and yields also increase significantly during years of significant pest infestations. In a country like Namibia, with mostly marginal agronomic potential, and likely to be significantly affected by climate change, it makes sense to diversify agronomic practices by introduction GM crops into the system. This assessment report will guide the implementation process and provide a framework within which adopters of GM maize and cotton for cultivation must operate. It remains the responsibility of each farmer to perform the necessary calculations to establish feasibility of GM maize and cotton cultivation for his / her specific circumstances.

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LIST OF ABBREVIATIONS

ATF	Namibian Agricultural Trade Forum
Bt	*Bacillus thuringiensis*
Btk	*Bacillus thuringiensis krustak*i
DDT	Dichlorodiphenyltrichloroethane
DNA	Deoxyribonucleic acid
EIA	Environmental Impact Assessment
EMA	Environmental Management Act No 7 of 2007
EPSPS	Enolpyruvylshikimate-3-phosphate synthase
EU	European Union
FAO	Food and Agriculture Organization
GE	Genetically Engineered
GM	Genetically Modified
GMO	Genetically Modified Organism
HGT	Horizontal Gene Transfer
HIV	Human Immunodeficiency Virus
HT	Herbicide Tolerant
ISAAA	The International Service for the Acquisition of Agri-biotech Applications
ISPM	International Standards for Phytosanitary Measures
IUCN	International Union for the Conservation of Nature
LMO	Living Modified Organism
NASEM	National Academies of Sciences, Engineering, and Medicine
NAU	Namibia Agricultural Union
NBA	National Biosafety Authority
NCRST	National Commission on Research Science and Technology
NDP5	Fifth National Development Plan
SADC	Southern African Development Community
SPS	Sanitary and Phytosanitary
Subsp.	Subspecies
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
WHO	World Health Organization
WTO	World Trade Organization

GLOSSARY OF TERMS

Actual Yield – The real tonnage/ha harvested, which typically are less than potential yield because of reducing factors, limiting factors and less than perfect conditions.

Assessment - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

Competent Authority - means a body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Cumulative Impacts - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Environment - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

Environmental Release – For purposes of this document this means the release of genetically modified crops for controlled agricultural purposes.

Genetic Modification / Genetic Engineering – the process of altering the genetic material of an organism to produce a genetically modified organism.

Genetically Modified Organism - organisms whose genetic material (genome) has been artificially altered, through genetic engineering, to express favourable physiological traits or produce desired biological products.

Herbicide Resistance – The ability of a plant, typically referring to weeds, to withstand the effects of a herbicide.

Horizontal Gene Transfer – The transfer of genetic material between single cell and / or multicellular organisms where offspring is not produced.

Insect Resistance – The ability of a plant to resist insect damage either through natural means or as a result of genetic modification.

Mitigate - The implementation of practical measures to reduce adverse impacts.

Potential Yield - The maximum tonnage/ha that a crop can produce given no reducing factors (weeds, pests, diseases, etc.), an abundance of water and nutrients, and optimum carbon dioxide levels, radiation, temperature, etc.

Significant Effect/Impact - means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Sustainable Development - "Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations" – the definition of the World Commission on Environment and Development (1987). "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" – the definition given in a publication called "Caring for the Earth: A Strategy for Sustainable Living" by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

Tolerance – The ability of a plant or animal to tolerate a pesticide. Often used interchangeably with resistance.

1 BACKGROUND AND INTRODUCTION

Worldwide, vast expanses of land has been cleared to make way for crop farming to produce food and other agricultural products. With the human population exceeding eight billion, traditional methods of practising agriculture are struggling to meet the demand for food. This is further exacerbated by climate change impacts on rainfall and desertification. Therefore, the agricultural sector continuously investigates and apply increasingly intensive farming methods, to maximise yield and profitability per farming unit. Modern biotechnology has the potential to revolutionize the agricultural industry by developing genetically modified organisms (GMOs) that, due to specific engineered traits, can increase yields and profits while simultaneously simplifying crop cultivation.

Agriculture is one of the key economic sectors in Namibia and one of the major contributors to employment. To meet the growing demand for maize for food and feed production as well as cotton, it is the intention of some farmers to register genetically modified (GM) maize and cotton for environmental release in Namibia. To achieve this, such farmers must apply for permission from the Biosafety Council, of the National Commission on Research, Science and Technology (NCRST), to cultivate GM maize in Namibia. To allow for the registration of GMOs in Namibia, an environmental impact assessment, and an associated management plan, is required as per the Environmental Management Act (EMA) of Namibia (Act No. 7 of 2007). The GM maize earmarked for registration expresses three different genetically engineered (GE) traits, being 1) insect resistance (Mon 810 and Mon 89034), 2) glyphosate resistance (NK 603), and 3) both insect and glyphosate resistance (Mon 810 × NK 603 and Mon 89034 × NK 603). The GM cotton earmarked for registration is 1) glyphosate resistance (MON 8913) and 2) glyphosate and insect resistance (MON 88913 × MON 15985).

2 OBJECTIVES

The main objective of this study is to provide sufficient information to feed into environmental impact assessments for individual farmers who wish to cultivate GM maize and cotton. This will be achieved by:

1. Providing a brief explanation of what constitutes a GMO.
2. Presenting a literature review on GM maize and cotton, the potential benefits, impacts and main concerns related to GM maize and cotton and GMOs in general.
3. Providing a summary of the legal and regulatory framework related to GMOs in Namibia.
4. Evaluating the potential environmental impacts that may result from the cultivation of the selected GM maize and cotton strains in Namibia.
5. Identifying a range of management actions to mitigate the potential adverse impacts to acceptable levels.

3 NEED AND DESIRABILITY

The Fifth National Development Plan of Namibia (NDP5) recognises the importance of the agricultural sector in Namibia. Currently agriculture supports approximately 70% of Namibians and provide employment to roughly a third of the workforce. The NDP5's desired outcome is to see a reduction in food insecurity through an increase in food production [agriculture]. A reduction in agricultural potential (yield) is however expected in light of climate change and desertification. In addition, the occurrence of periodic drought cycles drastically reduce agricultural productivity in Namibia. Therefore, technological advancements are required should Namibia wish to increase food production by means of agriculture.

Maize is one of the staple foods in Namibia and a key ingredient in many animal feed products. Due to the lack of rainfall, the commercial cultivation of maize is only feasible in selected areas, and on relatively small scale. As a result, Namibia is a net importer of maize. Local maize production volumes are dependent on rainfall (dryland cropping), sufficient volumes of stored water (groundwater and dams) and suitable soils. Cotton is an ideal small-scale cash crop in drier climates, due to its resilience under lower rainfall conditions. Yields of both maize and cotton are affected by the outbreak of pests like the fall armyworm and boll worm that can rapidly damage vast stands of maize and cotton respectively. (See Appendix A for examples of newspaper articles making headlines on pests affecting the agriculture sector.).

Genetically modified crops have the ability to resist or withstand some of the obstacles in crop cultivation. This may result in various direct and indirect benefits and ultimately contribute to food and feedstuff security. Benefits of cultivating pest and herbicide resistant GM crops include:

- Increased actual yields leading to enhanced food and feedstuff security for local and international markets.
- Resilience in the agricultural sector.
- Increased income and thus spending power.
- Increased revenue paid to government.
- Decreased insecticide use.
- More convenient and potentially safer pest control.
- More time for additional income generating activities which can in turn lead to more employment.

4 LITERATURE REVIEW

In the first part of the literature review, a short explanation of the basics of GMOs is provided.

4.1 Genetically Modified Organisms

The World Health Organisation (WHO) defines and explains GMOs as follows:

"Organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination. The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA [deoxyribonucleic acid] *technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between nonrelated species. Foods produced from or using GM organisms are often referred to as GM foods"* (WHO 2014).

Genetically modified organisms are thus organisms whose genetic material (genome) has been artificially altered, through genetic engineering, to express favourable physiological traits or produce desired biological products. Genetic modification is not a new concept, the method however has changed significantly in the last four to five decades.

4.1.1 Selective Breeding

As far back as 30,000 years ago, people selectively bred wolves that shared similar favourable phenotypic traits. The result of this selective breeding is that the offspring is more likely to have the genes responsible for that specific trait. In turn, by selecting the offspring with the trait, and again breeding with them, increases the chances of the offspring containing those genes. As this process is repeated, a wolf with a different genotype and phenotype is eventually produced. This is exactly how the numerous dog breeds in existence today, originated (e.g. doberman, labrador, beagle, etc.). Their original ancestors were wolves, but their genotype, and thus phenotype, are now completely different. So much so that dogs are regarded as an entirely new species.

Maize and cotton are no exceptions when it comes to selective breeding. Originally, maize was a wild grass, teosinte, with tiny ears and very few kernels (Photo 4-1). Through selective breeding, dating back as far as 9,800 years, maize now produce large ears with many kernels (Photo 4-2). Cotton was also bred to have more and longer fibres than their wild relatives (Photo 4-3) (https://faculty.sites.iastate.edu).

Selective breeding is thus a slow process of changing the genome of an organism, in order to develop traits favourable to man. Other examples include the numerous colours in budgies, canaries and some parrots, seedless watermelons, larger fruits and vegetables, cattle better suited for specific environments, cows producing more milk, etc.

Photo 4-1 **Teosinte ear**

Photo 4-2 **Maize ear**

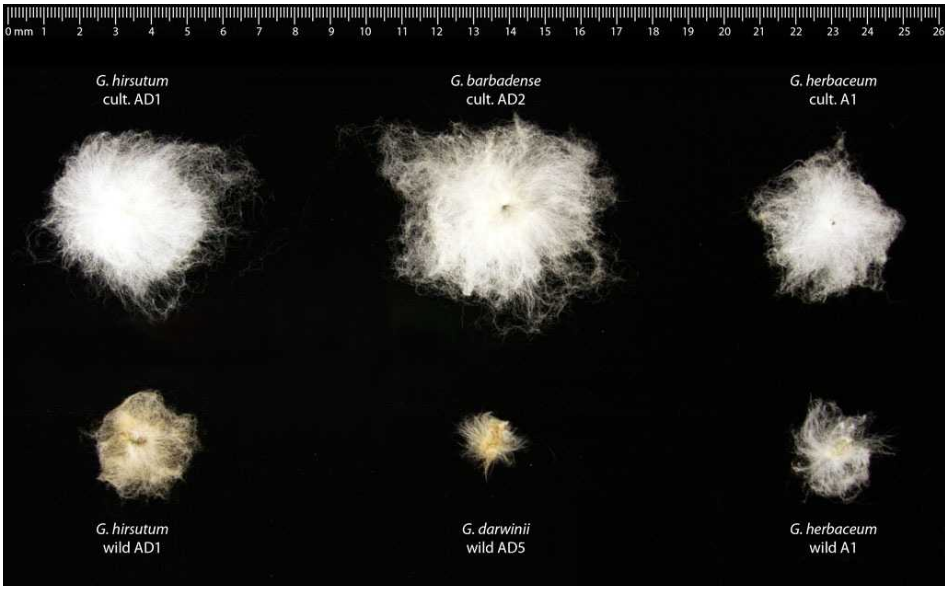

Photo 4-3 **Comparison of three species of wild and domesticated cotton (from https://faculty.sites.iastate.edu)**

4.1.2 Brief History of Genetically Modified Organisms

Although selective breeding also results in organisms that are genetically different (modified), "GMO" typically refers to the modern techniques of genetic engineering.

In 1973, the first GM bacteria was engineered (Cohen et. al. 1973) when scientists succeeded in "cutting" a gene from one strain of bacteria and "pasting" it into the genome of another bacterium. By 1974, the first GM mammal, a mouse, was engineered (Jaenisch and Mintz 1974). Eight years later, in 1982, the first medication produced by a GMO was approved for human use (Ladisch and Kohlmann 1992). In the latter case, bacteria was engineered to synthesize insulin in large enough amounts to allow its purification and subsequent administration to patients. The insulin had the exact same structure as that produced in humans. By the early 1990's, the first commercially available GM tomato was placed on the market as food (Bruening and Lyons 2000). In 2017 GM salmon, the first GM animal approved as food, were placed on the market in Canada. GM animals for food production are however still controversial and generally not well received by the general public.

4.1.3 Genetic Engineering Methodology

The genetic modification of an organism is known as an "event". An event can be a single modification or multiple modifications. Where multiple modifications are present it is referred to as a "gene stacked event".

A variety of genetic engineering (GE) techniques exists. A lengthy and complete description / explanation of each of the technologies falls outside of the scope of this report. Instead, brief, non-technical descriptions of some of the techniques are provided as background information. The descriptions of the techniques were obtained from National Research Council (US) Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health (2004). What is important to know is that genetic code is a "universal language", meaning one organism has the ability to read and encode the genes of almost all other organisms. It is as a result of this ability that GE is possible.

Microbial vectors – The plant disease causing *Agrobacterium tumefaciens* naturally occur in soil and has the special trait of being able to transfer a portion of its own DNA into a host plant cell. By doing so, it causes gall disease in susceptible plants. In the 1980s, *Agrobacterium* lacking the disease causing genes were developed, while still maintaining its ability to insert DNA into the host. Substituting the disease causing *Agrobacterium* DNA, with DNA from another species that expresses desirable traits, allows *Agrobacterium* to insert the "new" DNA into a host plant. The DNA is subsequently integrated into the host's cells. By growing a fertile plant from the modified plant cell, produces a plant that may express the desired trait. Since it is a universal language, the host plant will express the traits of the inserted gene by producing the proteins it codes.

Microprojectile Bombardment – With this method, DNA is attached to microscopic pellets, which are "shot" at plant cells. This way, DNA is inserted into the plant cell, and subsequently expressed.

Retroviral Vectors – Retroviruses are viruses able to transport their own genes into the cells they infect. The genes are then integrated with the host cells' genome. With retroviral vectors, certain genes of the virus are removed and replaced by the gene to be introduced into the host. When the virus delivers the new gene together with some enzymes to the host cell, the gene is integrated into the host, which can then express the desired trait. The virus therefore acts like a "Trojan horse".

4.1.4 Global Status of Genetically Modified Crop Production

In general terms, the economic benefits of cultivating GMO crops are well-researched and well-known globally. Empirical evidence of the economic benefits has been available for decades. Countries that adopted GMO technology during the early years have proceeded to steadily increase the area under GM crop cultivation, as well as the number GM varieties grown in their territories. This trend still continues. At the same time, more and more countries are joining this trend by either lifting or relaxing previously introduced bans and restrictions on the importation of GMO food and feedstuffs and/or allowing the cultivation of GMO crops. The main crop producing and exporting countries have almost all adopted GMO technology and, as a result, have continued to expand their agricultural production base, as well as their overall agricultural output and exports.

Cotton was one of the first crops to be bio-engineered and adopted at a global level. It was much easier to accept the introduction of bio-engineered cotton (as a non-food crop) in contrast to bio-engineered crops cultivated as foodstuffs (both for human and for animal consumption) such as maize, wheat and to a lesser extent, soybeans. Due to less controversy and sensitivity around crops that were not meant to be used as human or animal food, genetically modified cotton became the first crop that was accepted for introduction in farming systems on the African continent and have been cultivated in Africa as far back as the 1990s (Hofs, J.L. & Kirsten, J., Working Paper, 2001-17).

In a regional context, cotton was also the first genetically modified crop to be approved for commercial cultivation in South Africa and, at present, 100% of cultivated cotton in South Africa is from GM seeds. The economic and management benefits obtainable from the use of GM cotton has resulted in a situation where there is no longer any conventional cotton being planted in South Africa.

In 1996, 2.8 million hectares of GM crops were cultivated in the United States of America, China, Canada, Argentina, Australia and Mexico (ISAAA, 1997). By 2018, this figure has grown to 191.7 million hectares in 26 countries by approximately 17 million farmers (ISAAA, 2018). An additional 44 countries imported GMOs for food and feed purposes, which brings the total number of countries adopting GM crops to 70 (ISAAA, 2018). As of 2017, the top five countries growing GMOs in terms of crop area are the United States, Brazil, Argentina, Canada and India. It is also interesting to note that these countries are amongst the biggest organic agricultural producers in the world, along with China, Australia and the EU, which is in itself interesting as it shows the complementarities that do exist between the two fields of agricultural production. They are not mutually exclusive and can indeed co-exist and flourish in the same country. In 2019, the number of countries in Africa that have approved GM crops for food, field trials and/or environmental release doubled from three to six (ISAAA 2019) and by 2023, nine African countries are listed on the ISAAA website as having approvals for GM crops (https://www.isaaa.org/). South Africa, being the largest producer of GM crops with a total of 72 events approved for canola, cotton, maize, rice and soybeans (https://www.isaaa.org/). During the 2020/21 marketing year, 3.3 million hectares of land were cultivated with maize, cotton and soybeans of which approximately 2.8 million hectares were planted with GM variants (Esterhuizen & Cladwell, 2021). All cotton produced in South Africa in this period were GM variants while 85% of maize were GM variants.

The commercialisation of GM crops has occurred at a rapid rate since the mid-1990s, with important changes in both the overall level of adoption and impact occurring in 2016. Positive gains have been divided 48% to farmers in developed countries and 52% to farmers in developing countries. There continues to be very significant net economic benefits at the farm level amounting to US$18.2 billion in 2016 and US$186.1 billion for the period 1996–2016 (in nominal terms). PG Economics (2018) estimates that farmers in developing countries received US$5 for each dollar invested in genetically engineered crop seeds in 2017. About 65% of the gains have derived from yield and production gains with the remaining 35% coming from cost savings.

Genetic engineering technology has also made important contributions to increasing global production levels of the four main crops, having, for example, added 213 million tonnes and 405 million tonnes respectively, to the global production of soybeans and maize since the introduction of the technology in the mid-1990s. Cultivating GMO crops has provided significant benefits to farmers globally, including increased yield and lower production costs. Importantly, GMOs also help to alleviate poverty for the millions of resource-poor farmers and farm families around the world. As countries look to expand their domestic GM product pipelines and crop production, even more farmers will have access to improved seeds and the benefits they provide (PG Economics, 2018).

South Africa and Sudan have had great successes with GM crops (Abdallah 2014; Pellegrino et al. 2018). South Africa is the ninth largest GM crop producing country in the world (Esterhuizen & Cladwell, 2021). South Africa's production of maize (non-GM and GM maize) increased over the last four decades while the area planted, decreased (Figure 4-1)

(Esterhuizen & Cladwell, 2021). Average maize yields per hectare increased from 2.2 tons per hectare to 4.5 tons per hectare since the adoption of GM maize (Figure 4-2) (Esterhuizen & Cladwell, 2021).

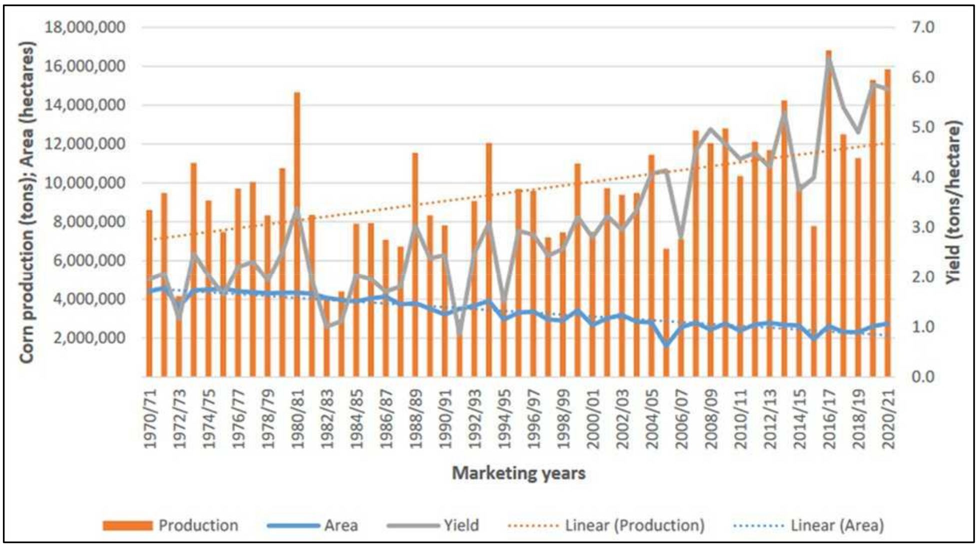

Figure 4-1 **Maize production trend in South Africa over the last 50 years (source: Esterhuizen & Cladwell, 2021)**

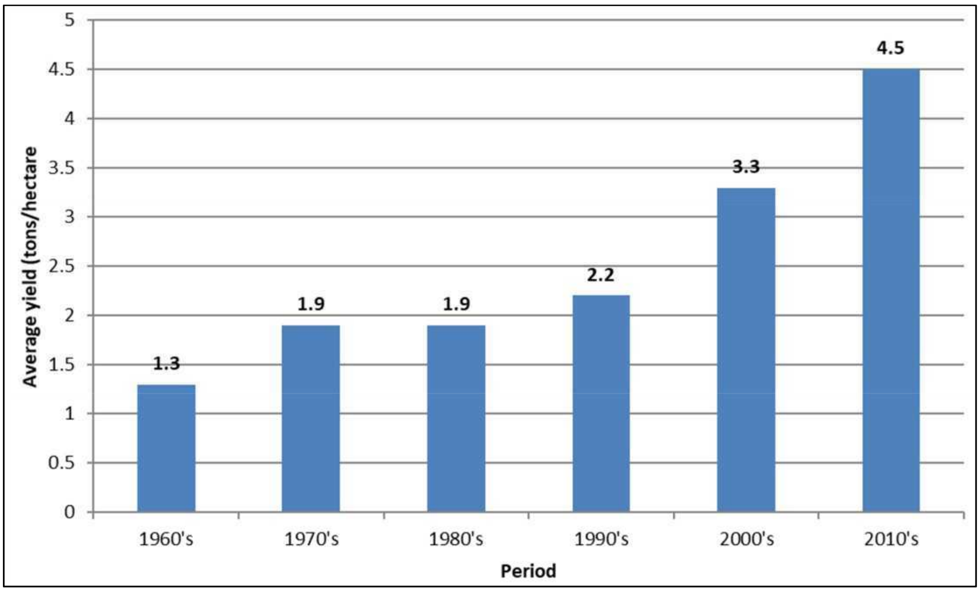

Figure 4-2 **South African average maize yield/ha increase (source: Esterhuizen & Cladwell, 2021)**

As mentioned, seventy-two GM events have approval for feed, food or environmental release in South Africa. Since the first GM crops were adopted in South Africa a shift in the perception of the public on GM crops and food has occurred. A public perception survey indicated that the understanding and awareness of biotechnology increased significantly between 2004 and 2015

(Gastrow et al. 2017). Forty-nine percent of the population believe GM food is safe to eat while 53% believe it is good for the economy. The increase in positive perception is largely attributable to increased education and knowledge on biotechnology.

4.2 GENETICALLY MODIFIED MAIZE FOR AGRICULTURE IN NAMIBIA

Namibia is a net maize (*Zea Mays*) importer, mostly from South Africa. White maize is one of Namibia's staple food grains while yellow maize are mostly used for animal feed. White maize is planted mainly as a dry-land crop, but also under irrigation where surface water (Hardap Dam, Kavango River) or groundwater is abundant. The main white maize cultivation areas are the maize triangle (Otavi – Grootfontein – Tsumeb), along the Kavango River (Green Schemes), Hardap Scheme and eastern Namibia around Hochfeld and Summerdown. Limited production of white maize also occur in the Zambezi and Omusati Regions. On communal farms maize production is mainly for own use.

The main pests encountered in the cultivation of maize in Namibia is the Lepidopterans (moths and butterflies) *Busseola fusca* (African maize stalk borer), *Spodoptera frugiperda* (fall armyworm) and to a lesser degree *Spodoptera exempta* (African army worm). All three are the larval stage of species of moths. The African maize stalk borer is native to sub-Saharan Africa while the fall armyworm is an alien invasive from the Americas, first encountered in Africa in 2016. The larval stages of these moths can cause massive destruction in maize fields if detected too late or if not actively controlled through pesticide application.

Weeds typically compete with a crop's resources and must in most case be actively managed. This can be achieved either by mechanical removal (tillage and manual labour like hoeing) or herbicide application. Herbicides can be non-selective or selective in nature. Non-selective herbicides will kill all plants it comes in contact with. Selective herbicides will selectively kill certain plants while not damaging others. Selectivity can be based on a plant's age or growing stage, morphology, absorption potential, etc. A feature often used in selective weed control is the difference between monocotyledonous (grasses) plants and dicotyledonous (broadleaf) plants. Certain herbicides will kill only broadleaf weeds while others target only grasses. Since maize is a monocotyledonous plant, herbicides controlling broadleaf plants can be sprayed onto post-emergent maize, but not herbicides for controlling grasses.

Existing GM maize events for agricultural purposes are insect resistance, glyphosate herbicide resistance, as well as both insect and glyphosate resistance. Namibian farmers wish to be granted permission to cultivate GM maize in order to reduce losses in maize production from pests and weeds, as well as reduce costs in cultivation of maize. The following sections discuss the specific events for which permission is required.

4.2.1 Event MON 810

Event MON 810 developed by Monsanto (now incorporated into Bayer) is marketed under the trade name YieldGard®. It is an insect resistant strain, specifically targeting the order Lepidoptera, which comprises of moths and butterflies (and their larvae). It is engineered to express insecticidal toxins from the bacterium *Bacillus thuringiensis* subsp. *kurstaki*, commonly referred to as Btk. *B. thuringiensis krustaki* is a gram-positive, rod-shaped bacterium widely distributed in soil. In nature, Btk produces a delta-endotoxin with insecticidal properties against the orders Lepidoptera, Coleoptera (beetles), Hymenoptera (ants, wasps, bees and sawflies) and Diptera (true flies) as well as the phylum Nematoda (round worms). The endotoxin is in the form of parasporal crystals comprised of one or more proteins – Cry and Cyt proteins. When Btk bacteria is ingested by these organisms, these proteins adversely affects their digestive systems, leading to their death. Due to this ability, Btk is used as biological pest control agent against lepidopterans.

In MON 810, the gene coding for the Cry1Ab protein in Btk was isolated and inserted into the genome of maize. This event allows for the maize, known as Bt maize, to produce the same Cry1Ab protein with insecticidal properties. When larvae of the typical maize pests, African maize stalk borer and fall armyworm, eat the leaves of Bt maize, they suffer the same fate as ingesting the bacterium itself, thus protecting the maize against these pests.

4.2.2 Event MON 89034

Monsanto also developed event MON 89034 marketed under the tradename YieldGard® VT PRO. It is based on the same Btk bacterium, but expresses the proteins Cry1A.105 and Cry2Ab2, and has improved insecticidal properties over MON 810.

4.2.3 Event NK 603

Event NK 603, marketed as Roundup Ready® maize, is also a Monsanto product. It is resistant to glyphosate, a non-selective post-emergent systemic herbicide. Glyphosate (N-phosphonomethyl-glycine) is absorbed by plants and binds to the plant enzyme enolpyruvylshikimate-3-phosphate synthase (EPSPS). By binding to EPSPS, glyphosate blocks the enzyme's function in the shikimic pathway, preventing the production of aromatic amino acids and metabolites. This ultimately results in plant death by "starvation". Glyphosate is the active ingredient in the herbicide Roundup.

The bacterium, *Agrobacterium* sp. strain *CP4*, is a common soil bacterium that expresses a glyphosate-tolerant EPSPS enzyme. Glyphosate resistant maize is produced by inserting the CP4 EPSPS gene into maize. Glyphosate resistance is thus brought on by the EPSPS enzyme, now produced by the maize, which continues to function in the shikimic pathway. This enables the continued production of aromatic amino acids and metabolites for growth, despite the presence of glyphosate.

4.2.4 Gene Stacked Events

In addition to the single events proposed to be planted in Namibia as discussed above, combinations of these events, or gene stacked events, are also under consideration. Event MON 89034 × NK 603 for example express both insect and glyphosate resistance and was developed by inserting the genes CP4 EPSPS, Cry1A.105 and Cry2Ab2 into maize. Similarly, NK 603 × Mon 810 contains the genes for CP4 EPSPS and Cry1Ab, also providing for insect and glyphosate resistance.

4.3 Genetically Modified Cotton for Agriculture in Namibia

Namibia is a net cotton (*Zea Mays*) exporter as there are no cotton ginneries in Namibia. Cotton is planted mainly as a dry-land crop, but also under irrigation where surface water (Hardap Dam) or groundwater is abundant. The main cotton cultivation areas are the maize triangle (Otavi – Grootfontein – Tsumeb), along the Kavango River (Green Schemes) and the Hardap Scheme.

The main insect pest encountered in the cultivation of cotton in Namibia is the Lepidopteran, *Helicoverpa armigera* subsp. (Arican bollworm). The larval stage of this moth, the caterpillar, feeds on, not only cotton, but a variety of other crops' leaves, flowers buds, pods, fruits and seeds. In cotton they bore into the seed pod (the cotton boll) where they are relatively well protected against typical pesticides. The African bollworm can result in significantly decreased cotton yields where infestations occur and increases cotton production costs as a result of increased requirements for the use of pesticides.

Weeds also compete with cotton's resources and must, similarly to maize (section 4.2), be actively managed through mechanical removal (tillage and manual labour like hoeing) or herbicide application. In contrast to maize, cotton is a dicotyledonous plant, and herbicides controlling broadleaf plants cannot be sprayed onto post-emergent cotton. Only herbicides selective for monocotyledonous plants (i.e. grasses) can be sprayed on cotton.

Existing GM cotton events for agricultural purposes are insect resistance, glyphosate herbicide resistance, as well as both insect and glyphosate resistance. Namibian farmers wish to be granted permission to cultivate GM cotton in order to reduce losses in cotton production from pests and weeds, as well as reduce costs in cultivation of cotton. The following sections discuss the specific events for which permission is required (the traits, and biotechnology behind them, are similar to that of the maize events, and such similarities will not be repeated here).

4.3.1 Event MON 88913

Event MON 88913, marketed as Roundup Ready™ Flex™ Cotton, is also a Monsanto product. It is resistant to glyphosate and the traits and biotechnology used are similar to, for example, NK 603 maize.

4.3.2 Event MON 88913 x MON 15985

In addition to the single event MON 88913 proposed to be planted in Namibia, a combination of events, or gene stacked event, MON 88913 × MON 15985 developed by Monsanto, is also considered. It is marketed under the trade name Roundup Ready™ Flex™ Bollgard II™ Cotton. Event MON 88913 × MON 15985 expresses both insect and glyphosate resistance and was developed by inserting the genes CP4 EPSPS, Cry2Ab2 and cry1Ac into cotton. While, in terms of its insect resistance trait it is similar to MON 810 and MON 89034 maize by producing Bt proteins, it expresses cry1Ac proteins which is not present in the maize events.

4.4 Aspects of Cultivating GM Maize and Cotton

The production and environmental release of GMOs for food and feed purposes is a controversial topic. Opinions are divided on GMOs and arguments for and against it are centred on, among others, health concerns, biodiversity impacts, food security and ethics. In this section, a summary is provided on various aspects of cultivating GM maize and cotton. A major source used is a very extensive and objective review, of hundreds of studies on GM crops, summarised in the book *Genetically Engineered Crops: Experiences and Prospects*. The book was compiled by The National Academies of Sciences, Engineering, and Medicine, of the United States of America (USA), hereafter referred to as NASEM, who is tasked, among others, to provide independent, objective analysis and advice to the nation of the USA (National Academies of Sciences, Engineering, and Medicine (NASEM), 2016). Where other literature is cited, the source is referenced.

4.4.1 Genetically Modified Crop Yield

The significant increase in the global human population is increasing pressure on food security. Since the early 1800's the world population has increased from one billion to over 8 billion in 2023. By 2050 it is expected to reach 9.7 billion (United Nations, 2019). In order to ensure food security, food and feedstuff production have to become more intensive / productive in order to get better yields without increasing the amount of land cleared for agriculture. Approximately three quarters of global maize production is used as animal feed. It is a high-energy feed for livestock and is fed either unprocessed or processed as an ingredient of feed.

In terms of crop yield, one should distinguish between potential yield and actual yield. Potential yield is the maximum tonnage/ha that a crop can produce given no reducing factors (weeds, pests, diseases, etc.), no limiting factors (i.e. an abundance of water and nutrients) and optimum carbon dioxide levels, radiation, temperature, etc. The actual yield is the real tonnage/ha harvested, which typically are less than potential yield because of reducing factors, limiting factors and less than perfect conditions.

NASEM (2016) concluded that genetic engineering of crops to increase potential yield, does not seem to be more effective than selectively breeding crops for the same purpose. However, GM crops outperforms non-GM crops in terms of actual yield (Brookes 2019; Esterhuizen 2019; Pellegrino 2018). Based on 21 years of data on cultivation of insect resistant GM maize in Spain and Portugal, an increase in yield of 11.5% and more was observed. This, together with reduced expenditure on pesticides (see section 4.4.2), resulted in an average increase in farm income of €173/ha/year (N$2,819 at current exchange rate) (Brookes 2019). In South Africa, the estimated economic gain from using biotech crops in the period 1998 to 2016 is

U$2.3 billion while for 2016 alone it is U$330 million (N$33.8 billion and N$4.8 billion respectively) (Brookes and Barfoot, 2018; ISAAA, 2017). In a meta-analysis of 21 years' worth of field data, Pellegrino et al. (2018) confirmed a 10.1% average actual yield increase in maize. Similarly, a meta-analysis by Klümper and Qaim (2014) indicated a 22% yield increase for Bt maize and cotton (as an aggregate) when compared to traditional non-GM variants. Khuda (2017) modelled the average effects of Bt cotton on short-run profits, yields and farm inputs in Pakistan in 2008/9. In his study he found that Bt cotton yields increased by 9% in comparison with traditional cotton cultivars.

4.4.2 Pesticide Use

Intensive commercial farming methods include the use of insecticides and herbicides to control unwanted (pest) species. In maize, the African maize stalk borer, fall armyworm and African bollworm can account for massive crop losses, if not controlled. These pests were initially controlled with organochlorines and later with organophosphates. Although organophosphates are considered less toxic than the organochlorines, both are still considered to be highly detrimental to the environment. Newer insecticides contain active ingredients such as pyrethroids, carbamates, neonicotinoids and ryanoids.

Reviewing various case studies, NASEM (2019) concluded that reduced volumes of insecticides are applied on Bt crops when compared to non-Bt crops. This is supported by Brookes and Barfoot (2017), Khuda (2017), Pellegrino (2018) and Brookes (2019). The latter noting that 678,000 kg less insecticide active ingredient was used in Spain alone for the period 1998 to 2018. Where Bt and non-Bt fields are near to each other, it has been shown that even non-Bt crops required less insecticides. This is due to the nearby Bt crops reducing pest population sizes. There seems to be some instances where reduction in herbicide use is noted when herbicide resistant crops are planted. However, there is not enough sound scientific evidence to support decreased (or increased) use of herbicides (NASEM 2019). Herbicide resistant crops do however make weed control easier and more effective. Some instances of increased actual yields are also associated with herbicide tolerant crops (Brooks and Barfoot 2018).

4.4.3 Comparison of Costs and Benefits

The decision to allow the cultivation of GM crops in Namibia can be influenced or informed by various aspects and criteria. One of these aspects is the economic costs and benefits of introducing GM crops. It has already been proven at a global stage that GM crops hold substantial financial benefit over conventional crops, especially when faced with extreme climatic conditions and natural disasters such as increased pests' activity. Overall, there continues to be a considerable and growing body of evidence, in peer reviewed literature, that quantifies the positive impacts of crop biotechnology, including its economic benefits. Research over the last two decades has provided overwhelming positive results in favour of GM crops when it comes to the benefits of introduction of GM crops. Graham Brookes and Peter Barfoot have tracked farm income and production impacts since 1996 when the first GM crops were introduced, and their analysis has demonstrated over time that GM crops have a financial benefit over conventional crops. Their analysis concentrated on gross farm income effects because these are a primary driver of adoption amongst farmers (both large commercial and small-scale subsistence). They also quantified the (nett) production impact of the technology, and recognised that broader economic impacts exist, such as on labour usage, household incomes, local communities and economies.

Their research has concluded that in the last 21 years, crop biotechnology has helped farmers grow more food using fewer resources by reducing the damage caused by pests and better controlling weeds. The highest yield increases have occurred in developing countries and this has contributed to a more reliable and secure food supply base in these countries. In South America, herbicide tolerant technology has helped farmers reduce tillage, shortening the time between planting and harvesting, allowing them the opportunity to grow an additional soybean crop after wheat in the same growing season.

With higher yields and less time and money spent managing pests and weeds, farmers have earned higher incomes (also because they have more time at hand to spend on other income-generating activities). This has proved to be especially valuable for farmers in developing countries where, in 2016, an average of $5 was received for each extra dollar invested in biotech crop seeds.

The widespread use of GM crop technology is also changing agriculture's land footprint by allowing farmers to grow more without needing to use additional land. To maintain global production levels at 2016 levels, without biotech crops, would have required farmers to plant an additional 10.8 million hectares (ha) of soybeans, 8.2 million ha of maize, 2.9 million ha of cotton and 0.5 million ha of canola, an area equivalent to the combined land area of Bangladesh and Sri Lanka. To put this in perspective, this is approximately 27% of Namibia's total land area.

Because Namibia has not formally introduced GM crops into its production systems as yet, historical exact data is unavailable and one cannot calculate the exact financial costs/benefit compared to conventional crops at this stage (Namibian Agricultural Trade Forum (ATF), 2023).

While maize cultivation in Namibia has been ongoing uninterruptedly in Namibia for decades, the same is not true for cotton cultivation. Qualitatively, Namibia's agronomic crops and fodder production areas, where traditionally maize, wheat, sunflowers, groundnuts, millet/mahangu, oats and lucerne have been grown, are all suitable for cotton production. Historically, cotton was successfully grown prior to independence and for some time thereafter on the Hardap irrigation scheme as well as in the dryland production areas of the 'maize triangle', the area around Grootfontein and in the Kavango Region. In those years, dryland yields varied from 300 kg to 1.6 tons per hectare (rainfall dependent), while irrigation farmers' averages were around 5 tons per hectare, with some farmers harvesting up to 7 tons/hectare and sometimes 9 tons/hectare on very good soils. Dryland yields per hectare on an annual basis were in most cases not profitable, and a practice whereby cotton stood over to be harvested in year 2 and sometimes year 3 as well, was the only way to ensure overall profitability could be realised (Francois Wahl, Personal Communication, 2023).

In the early 2000's a fundamental shift occurred in the agronomic industry in Namibia and cotton production declined drastically as a result. Two main reasons for this decline include i) the prices of wheat and maize that increased more than twofold; and ii) synthetic fibre prices declined, which competed head-on with cotton fibre, thereby making it no longer that lucrative to produce cotton. In addition, globally, GM cotton was introduced more and more at the time, making other countries', including South Africa's cotton production, more competitive vis-à-vis conventional cotton production that was still being practiced in Namibia, and, as a result, prices in South Africa was also driven down. Namibian cotton production almost came to a complete halt as a result.

Currently in Namibia, there are more and more farmers from traditional cattle farming areas in the north, north east and east of Namibia with access to land and water for irrigation, that are diversifying into agronomic, oilseed and horticulture production – thereby expanding the areas in Namibia where land can be cultivated successfully. Fibre production, such as cotton, will also be suitable in these new environments.

As mentioned previously, cotton has been proven as an ideal small-scale cash crop in drier climates, due to its resilience under lower rainfall conditions. It can therefore be deemed as a suitable alternative cash crop in Namibia as well for small-scale and dryland farmers, based on successes achieved elsewhere - globally and in Africa. The main stumbling blocks in convincing small-scale farmers into cotton farming has traditionally been their reluctance to plant non-edible cash crops instead of food crops like mahangu and maize, the lack of a nearby markets and local ginneries, lack of economies of scale/critical mass, long transport distances, transport costs and bulkiness of the product, the labour intensive production system for hand-picked cotton, and pest/weed control challenges as a result of insect infestation and the need to make use of manual weeding, inter alia (Namibia Agricultural Trade Forum, 2023).

From a quantitative or economic perspective, in order to provide some indication of what the financial costs/benefits could be, a commodity budget can be drawn up to show the estimated costs and incomes to be derived from specific crops. Commodity budgets have been calculated historically by several entities in South Africa for example and for different climatic and farming conditions, many of these similar to the farming conditions and practices that are used in Namibia. An excellent commodity budget tool (© 2023 - Profarmer) has been developed by the Griqualand West Cooperative in South Africa. Many farmers in South Africa and Namibia have historically been using tools such as the Profarmer© Tool to calculate the costs and benefits of farming with specific crops/cultivars in their respective farming areas. Maize and cotton production are also covered by the Profarmer© Tool and updated figures are prepared on an annual basis. An annual subscription allows users access to the Tool and users can include own data and yield/cost/income figures to allow for specific circumstances.

Maize

Maize production and input costs as well as yields and price information have been obtained from the Profarmer© Tool. The results thereof are included in Appendix B. The information has been summarised in Table 4-1 and contains cost calculations for both non-GM (current conventional maize being grown in Namibia) and GM maize (BT maize) and for both dryland and irrigation conditions. Information for yellow maize varieties is also included.

Whereas the exact figures will vary for Namibian conditions and from farm to farm, the important aspect that we are trying to highlight here is the comparison between GM maize and non-GM maize. It is clear that there are some notable differences between conventional maize and GM maize production systems. In general terms, the GM maize is expected to realize higher yields per hectare compared to the conventional maize (due to less damage from insects for example). Notably, there will also be a differentiation when it comes to the production costs. The GM cultivars provide for a lower total production cost/ha compared to conventional maize. This is mainly due to lower costs as a result of reduced pesticide/insecticide/herbicide applications and less tillage. GM maize seeds are however priced at a premium compared to conventional seeds and input costs will be higher as a result, especially under irrigation conditions where a huge investment will be made if yield expectations are to be maximised and 80,000 - 90,000 seed kernels are planted per hectare. The cost of seed will therefore be quite high; however this will be offset by the estimated higher yields, which overall would provide for a positive benefit.

Even though the figures in Table 4-1 are for South African farming systems, the net results should be more or less the same from a Namibian point of view, especially for the production cost side. Namibian production costs are overall around 20-30% higher than South Africa and these costs must be substituted into the budget tool by individual Namibian farmers with their real figures in order to get the exact comparisons. Assumptions need to be made at farm level regarding a couple of variables, such as the price of maize, expected yield, costs of inputs such as fuel, labour, fertiliser, interest rates, etc. At the moment, Namibian maize farmers are receiving higher prices for their maize than farmers in South Africa (ATF, 2019). Depending on the actual price of maize, the break-even yield/ha could be substantially influenced, which could make maize production either more, or less profitable, compared to South African conditions. All that needs to be done is to substitute the Namibian prices for inputs and for the maize harvest for those that currently apply to South African farmers. With a higher maize price, the breakeven yield for Namibian farmers would be much lower and profit margins could materialise at much lower yields. This could influence the decision on how much GM maize seeds are to be planted, which would lower input/production costs even further.

Table 4-1 Summary table: comparative production costs and incomes for GM and non-GM maize cultivars under known South African conditions (2019 figures used)

	Dryland non-GM White Maize	Dryland Bt White Maize	Dryland non-GM Yellow Maize	Dryland Bt Yellow Maize	Irrigated non-GM White Maize	Irrigated Bt White Maize	Irrigated Non-GM Yellow Maize	Irrigated Bt Yellow Maize
Expected Yield (ton/ha)[1]	5.5	5.5	5.5	5.5	13.0	13.0	13.0	13.5[2]
Expected Price (R/ton)	R3,420	R3,420	R3,450	R3,450	R3,420	R3,420	R3,450	R3,450
Gross Value (R/ha)	R18,810	R18,810	R18,975	R18,975	R44,460	R44,460	R44,850	R46,575
Production costs (R/ha incl. interest)	R15,594	R15,516[3]	R15,597	R15,519	R40,692[4]	R41,979	R40,700	R42,113
Breakeven yield (ton/ha)	4.56	4.54	4.52	4.5	11.9	12.27	11.8	12.21
Margin (R/ha)	R3,216	R3,294	R3,378	R3,456	R3,768	R2,481	R4,150	R4,462
Nett benefit/cost (R/ha)[5]	**(R78)**	**R78[6]**	**(R78)**	**R78[6]**	**R1,287**	**(R1,287)[7]**	**(R312)**	**R312[8]**

[1] Expected yield/ha depends on a number of issues, including the specific cultivar that has been developed and released for a particular production year and peculiar on-farm conditions, both controllable (for example seeds planted/ha) and non-controllable (such as rainfall).

[2] Higher yield/ha according to cultivar developer specifications, compared to non-GMO varieties

[3] Lowest production cost/ha for dryland conditions

[4] Lowest production cost/ha for irrigation conditions

[5] Compared to its GM or non-GM counterpart

[6] Highest nett benefit for dryland conditions

[7] Nett cost for irrigation conditions

[8] Highest nett benefit for irrigation conditions

Cotton

In order to provide an economic comparison for purposes of this report, the production and input costs as well as yields and price information of the 2022/23 summer planting season and 2023 winter planting season have been obtained from the Profarmer© Tool and has been included in this report (Appendix C). The information has been summarised in Table 4-2 and contains cost calculations for GM Cotton for both dry-land and irrigation conditions. As mentioned earlier, there are for a couple of decades already no longer any conventional cotton grown in South Africa (the country is 100% GM in so far as cotton production is concerned); hence it is not possible and in any event pointless to obtain production figures for non-GM cotton varieties. Secondly, since Namibia is not producing any cotton currently, and historic production figures for Namibia are also not available any longer, a proper cost/benefit comparison is not possible between Namibian cotton production vis-à-vis GM cotton production. At most, an individual farmer will have to use its own production figures and variables over time in order to build a record of costs/benefits for comparison purposes.

Whereas the exact figures will vary for Namibian conditions and from farm to farm, the important aspects that we are trying to highlight here are the profitability variables for dryland and irrigated GM Cotton. Price of seed cotton per tonne as well as yields per hectare are the most critical and will determine whether cotton in general and GM cotton in particular can be grown profitably under Namibian production conditions or not. The South African averages that have been collected over many years have pointed to a scenario where cotton production is profitable with breakeven yields as per above table (in relation to a specific price obtained in the market for the product).

Should a Namibian farmer be able to obtain a higher (or lower) yield per hectare or a higher (or lower) price for his/her cotton, then obviously the profitability outcome and breakeven yield will be influenced (either positively, or negatively). Namibian farmers will also have to take into account additional transport costs as there are currently no ginneries in Namibia and most probably all cotton will need to be sold in South Africa, hence an additional input cost that needs to be factored in. There are also variances in relation to hand-picked cotton (labour component) vis-à-vis machine picked cotton (capital cost and machinery cost including fuel). All this is farmer unit/system specific and therefore has to be calculated on a case-by-case basis for each farmer.

However, despite the absence of conventional cotton production data for comparative purposes, the results obtained under South African conditions indicates that both dryland and irrigated GM cotton is profitable, with breakeven yields in 2023 and 2022 of 4.58 and 4.66 tons/ha (for irrigated cotton) and 1.24 and 1.41 tons/ha (for dryland cotton) respectively. This was achieved against a 2022 winter cotton price of R11,950/ton and a 2023 summer cotton price of R11,870/ton. A sensitivity analysis, factoring in various price and yield scenarios, is therefore important for each farmer.

Table 4-2 Summary table: production costs and incomes for GM cotton cultivars under known South African conditions (2022 and 2023 data used)

	Dryland GM Cotton (2023 Winter)	Dryland GM Cotton (2022/23 Summer)	Irrigated GM Cotton (2023 Winter)	Irrigated GM Cotton (2022/23 Summer)
Expected Yield (ton/ha)9	1.5	1.5	5.5	5.5
Expected Price (R/ton)	R11,950	R11,870	R11,950	R11,870
Gross Value (R/ha)	R17,925	R17,805	R65,725	R65,285

[9] Expected yield/ha depends on a number of issues, including the specific cultivar that has been developed and released for a particular production year and peculiar on-farm conditions, both controllable (for example seeds planted/ha) and non-controllable (such as rainfall).

Production costs (R/ha incl. interest)	R14,820	R16,765	R54,683	R55,295
Breakeven yield (ton/ha)	1.24	1.41	4.58	4.66
Breakeven price (R/ton)	R9,880	R11,177	R9,942	R10,054
Margin (R/ha)	**R3,105**	**R1,040**	**R11,042**	**R9,990**

Source: Profarmer©. 2023

In general terms, as with other GM crops such as maize, wheat and soybeans, the GM cotton cultivars are expected to realize higher yields per hectare compared to conventional cotton (due to less damage from insects for example). Notably, there will also be a differentiation when it comes to the production costs. The GM cultivars provide for a lower total production cost/ha compared to conventional crops. This is mainly due to lower costs as a result of reduced pesticide/insecticide/herbicide applications, less mechanical weed control and tillage, and reduced fuel and machinery costs. GM seeds are however often priced at a premium compared to conventional seeds and input costs will be higher as a result, especially under irrigation conditions where a huge investment will be made if yield expectations are to be maximised and many seed kernels are to be planted per hectare. The cost of seed will therefore be quite high; however, this will be offset by the estimated higher yields, which overall would provide for a positive benefit.

Assumptions also need to be made at farm level regarding a couple of other variables, such as the price of cotton, expected yield, costs of inputs such as fuel, labour, machinery cost, packing material, transport, fertiliser, interest rates, etc. Since Namibia does not have a cotton gin, the assumptions regarding where the cotton is to be sold is very important. Likewise, transport differentials will need to be taken into account if the buyers are from outside Namibia. In the past, Namibian cotton was hand-picked and sold to South African Ginners in the Mpumalanga and Limpopo Provinces in South Africa. Towards the latter stages of cotton production in Namibia, a ginnery in Modder River in South Africa provided a ginning service to Namibian farmers at a fee. A contract price will therefore need to be negotiated with buyers prior to planting to ensure that accurate profitability calculations can be made in the budgeting process.

Depending on the actual price of cotton, the break-even yield/ha could be substantially influenced, which could make cotton production either more, or less profitable, compared to South African conditions. Of course, the input costs for Namibian conditions will also differ from South African conditions, hence the breakeven yield under Namibian conditions could be higher. Historically, Namibian production costs are overall more expensive than that of South Africa and these costs must be substituted into the budget tool by individual Namibian farmers with their real figures in order to get the exact comparisons. All that needs to be done is to substitute in the budget tool the prices of all inputs and expected yields with Namibian estimates/actual figures, instead of using the provided figures, which currently apply to South African farmers. Also, with a lower cotton price, the breakeven yield for Namibian farmers would be much higher and profit margins could be under pressure, requiring higher yields, and vice versa.

As mentioned elsewhere in this report, yield losses and crop devastation and related financial losses as a result of pests such as the African maize stalk borer, fall armyworm, Africa army worm and cotton boll worm have amplified the need for alternatives that could safeguard crops and yields against these devastating natural phenomena. The negative financial impact that a reduction in yield result in, coupled with the additional costs of spraying of pesticides (direct cost of pesticides as well as additional costs of manpower, fuel and mechanisation costs), all amplify the benefit that the introduction of BT maize could bring for both the small-scale and largescale farmer in Namibia. Army worm breakouts can devastate household food security in a matter of days, while the reduction in yields and additional costs of pesticide application could render largescale commercial irrigated maize non-profitable.

Other alternative GM crops that could show great potential in the traditional Namibian dryland farming areas, as well as the areas under irrigation could also be introduced. These include GM Maize, GM Wheat and GM Soybeans, with these crops having the potential to serve as excellent food and cash crops for farmers in addition to the traditional crops that are currently being produced, both for household food security and commercially. There is currently an upward demand for cotton - worldwide and in the region - and this could be the catalyst to introduce BT cotton as an alternative cash crop to farmers in Namibia. Cotton have already proven to be successfully grown in Namibia in the 1980's and 1990's and a collapse in world prices compared to alternatives such as maize and wheat, as well as synthetic fibres, was some of the reasons why farmers stopped producing cotton (Namibia Agricultural Trade Forum, 2023).

The SADC (Southern African Development Community) Industrialisation Strategy and Roadmap 2015–2063, and in particular the SADC Industrial Development Policy Framework, aims to promote industrialisation, enhance competitiveness, and deepen regional integration through structural transformation, leading to increased manufactured goods and exports. The SADC Region has prioritised the clothing and textile sector as one of nine key sectors to be supported in its industrial development ambitions, and the production of cotton in Namibia could be a catalyst for Namibia to enter into and participate in the highly-valued textiles and garment manufacturing cross-border value chain (https://www.tralac.org/documents/resources/sadc/1281-sadc-industrial-development-policy-framework-2014/file.html).

4.4.4 Trade and Marketing Issues

Given the rapid increase in the production of GMOs and the ever-expanding capabilities of biotechnology applied to food production, it is surprising that in sub-Saharan Africa—the poorest region in the world with the lowest agricultural productivity—very few countries cultivate GM crops. In fact, many countries have instituted outright bans on imported food containing GM products. One of the most high-profile examples was Zambia's ban on GM food imports, including famine relief shipments in the face of millions suffering from starvation, in 2002.

It seems that the main "stumbling block" that prevents the introduction of GM products into consumer markets or the cultivation of GM crops remains the "perception" that GM products are frowned upon by consumers. Their preferences may very well dictate what products will sell best at the corner shop; however, it is not based on a legal requirement or the results from scientific research. Consumers' perceived preference to consume non-GM products remain a voluntary preference and as a result it has been for decades wrongfully perceived that certain countries have "banned" food and feedstuffs containing GM products/ingredients. Countries across Africa and Asia that have been hesitant to introduce GMO crops, have cited the risk of future export losses as a rationale for rejecting GM technology. The reasoning behind this is because they believed that supermarket chains in major markets like the EU and Japan have instituted private standards to avoid GM ingredients in the products they sell (Gruère and Sengupta, 2009).

Over the years however, the perception that the EU has regulations/import bans in place against the importation of foodstuffs from outside that contains GMOs, has proofed to be a myth. Not only do some countries in the EU actively produce GM feed and foodstuffs; but they all allow the importation of GM feed and foodstuffs (even into those countries that may not have actively adopted GM technology in their agricultural production systems). In Germany for example, GM crops are not allowed to be planted, however they do allow feed and foodstuffs containing GMOs to be imported, which is then either consumed directly by the German consumer or finds its way into the agricultural value chains. In the EU, 60% of animal feed is imported (European Commission, 2015). The protein-rich soya in that feed comes overwhelmingly from countries that plant GM soybeans - Brazil, Argentina and the

US. The imported GM soybeans end up in the dairy, beef, pork, chicken industries, amongst others.

In the African context, in recent years, even countries like Zambia, who had a zero tolerance for anything "GMO-like", have started to allow the importation of foodstuffs obtained from GMO products (such as breakfast cereals and prepared foodstuffs containing GMO ingredients) into its domestic market. In July 2019, the National Biosafety Authority (NBA) of Zambia has granted four companies new permits to import products that may contain GMOs (Zambia Reports, 2019). The permits were granted to Gatbro Distributors, Pick n Pay, Southern National Import and Export Limited and Choppies Super Stores. Permits were issued following a recommendation from the Scientific Advisory Committee of the NBA, to the Board, to issue the permits after risk assessment was conducted on the products that may contain GMOs and were found to be safe for human consumption.

According to the Namibian Agricultural Trade Forum (ATF), the importation of GM feed and foodstuffs have never been disallowed in Namibia. Almost all processed agricultural products and foodstuffs are imported from outside Namibia (mainly the EU and South Africa) and the majority of these contain GM ingredients. Namibia is also a nett importer of cereals and other agronomic crops such as wheat, maize (both white and yellow), rice, soybeans, potatoes, etc. Argentina, Canada and South Africa are main suppliers to Namibia and they are mostly cultivating GM crops. In addition to foodstuffs, almost all of Namibia's animal feeds are produced using mostly imported ingredients that contain GMOs (soybeans, cotton seed, oil cake and yellow maize for example). These animal feeds are used by our livestock industries (beef, small stock, chicken, game, dairy, pork), including those livestock sectors that have traditionally been exporting to overseas markets such as Norway and the European Union, as well as regionally to South Africa. These markets historically accepted meat and meat products from countries that either utilise GM products as animal feed or actively grow GM crops themselves. In addition, these markets also allow the use of GM-based animal feed (either imported or locally-produced) in their own meat production value chains. Any sudden or new restrictions or bans on the export of meat from Namibia to these markets (EU, Norway, South Africa for example) - should Namibia start to allow GM crops to be cultivated locally - would therefore be far-fetched and irrational, given that these countries currently allows and historically allowed meat and meat products into their own domestic markets that already historically contained and currently contains GM ingredients (either directly or indirectly in the value chain/manufacturing). The GM crops/events that Namibia intends to cultivate, are also not new, but have been on the market for many years and are well-known, so no new or additional risks are to be introduced into the meat value chains that does not already exist (if any).

The ATF also indicated that the Meat Board of Namibia has confirmed that the export status to the European Union are not negatively influenced by the fact that Namibian animal feed already contains GM ingredients. No legal basis therefore exist that could restrict Namibian meat exports to the EU as a result of GMOs in animal feed. At most, it could be a marketing issue, linked to consumer preferences in specific markets. The latter is however only a voluntary standard, which every consumer is entitled to, and similar to the issue of consumer preference for fair trade or organic-produced products for example.

4.4.5 Biodiversity

It is argued that non-target and beneficial species are also affected in Bt crop fields, resulting in overall reduced biodiversity. Various investigations indicate that Bt crop fields have either no impact on non-target species (Pellegrino 2018) or even result in higher biodiversity than non-Bt fields sprayed with insecticides (NASEM 2019; Carpenter 2011). The literature review by Pellegrino (2018) found only Hymenoptera to be affected and specifically a parasitic wasp, *Macrocentrus cingulum*. However, since the main hosts for this wasp are stalk borers, a decrease in its presence is expected if there is a decrease in stalk borers as a result of the Bt maize.

Typical insecticides sprayed on non-Bt maize are not selective and orders other than Lepidoptera may also be harmed, as well as other classes of animals. Since Bt crops targets mainly Lepidopterans, increased biodiversity can realistically be expected in Bt crop fields. For example, all existing studies indicate that honey bees are not affected by Bt crops (Duan et al. 2008, Ricroch et al. 2018).

Weed diversity in glyphosate resistant crops, after spraying with glyphosate, seems to largely depend on the type of crop (NASEM 2019). In some instances weed diversity is lower and thus arthropod diversity is also lower. In general, in the United States of America, glyphosate resistant crops sprayed with glyphosate, had similar or increased weed diversity than non-GM fields.

In terms of biodiversity within different varieties of the same crop (crop diversity), limited studies are available. However, those that have been conducted do not indicate decreased genetic variety since GM crops were introduced (Carpenter 2011).

4.4.6 Bt Toxin Resistance

Organisms continuously evolve because of random mutations at genetic level and selection pressure. For example, trees, that because of a random mutation had thorny protrusions, were not preferred by herbivores for browsing (i.e. selection pressure). Since these trees had a higher chance of survival, they had a higher chance of cross-pollinating, and thus an increased chance of containing and expressing the genetics for thorny projections. In this way, the random mutation coupled with the selection pressure, resulted in the evolution of thorns for protection against herbivores. This is a very similar process to selective breeding applied by humans to produce certain traits in organisms.

Random mutations can also lead to resistance in insects against the active ingredients of insecticides (see Figure 4-3 for a schematic representation of the process). The best-known example is the resistance that developed in Anopheles mosquitos to dichlorodiphenyltrichloroethane (DDT), during the fight against malaria (Fossog et al. 2013). In addition to DDT resistance, Anopheles mosquitos have also developed resistance against pyrethroids and to some degree against carbamates (Wanjala et al. 2015). Insects that reproduce quickly, with large numbers of offspring, are more prone to developing resistance.

Similar to the insecticide resistance mentioned, insects can also become resistant to Bt toxins in Bt crops. When Bt crops were first approved for agriculture, the prediction by some scientists were, that insects will rapidly become resistant to Bt proteins. The reality was that although incidents of resistance in insect populations against Bt toxins have been described (van den Berg et al. 2013; van Rensburg 2007), it took much longer than initially predicted (Kunert et al. 2011).

Different strategies, which are mostly applicable to both GM crops and normal insecticide use, can delay evolution of resistance in insects. The first is by ensuring a high enough dose of the Bt toxin and / or more than one toxin is produced by the GM crop. In a population of insects, there will be individuals more susceptible to an insecticide, as well as those less susceptible. Spraying low dosages of an insecticide will only kill those more susceptible while the resistant individuals survive. A high dosage of an insecticide is more likely to kill less susceptible (resistant) individuals, thus delaying the evolution of resistance. Using multiple insecticides will also delay resistance, as it is more unlikely for an organism to be resistant to more than one insecticide. The same principle is true with GM crops. Those expressing more than one toxin and / or toxins of a higher dosage will delay evolution of resistance.

The second method used to delay resistance is to plant refuges of similar non-GM crops close to GM crop fields. A refuge of non-Bt maize will, for example, allow for the pests in question to feed and reproduce in the absence of a toxin and thus in the absence of a selection pressure. The population of insects sustained in the refuge will have a lower incidence of resistance. When these individuals mate with Bt toxin resistant individuals, it decreases the number of resistant offspring and delays the evolution of resistance.

Evidence suggest that the high dose / multiple toxins / refuge strategy can successfully delay development of resistance (NASEM 2019). The success will depend on the expression of toxins in the crop as well as appropriately sized refuges. Another factor to consider is that because Bt crops can reduce pest populations significantly, it may become feasible to plant only non-Bt crops in some years, thus further delaying the evolution of resistance.

It should be noted that resistance is possible to both traditional insecticides and Bt toxins. It is a matter of proper management and correct agricultural practices to delay the evolution of resistance. For example, planting of Bt maize and cotton should not completely negate the use of insecticides, but the two should be used together.

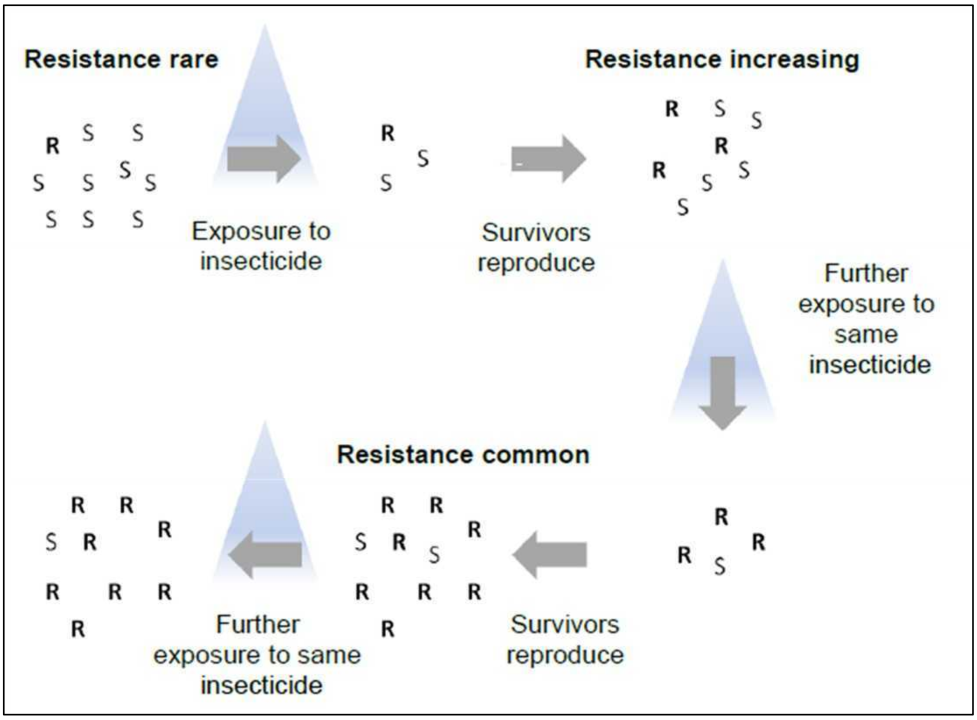

Figure 4-3 Schematic representation of pesticide resistance development (source: IRAC 2011)

4.4.7 Herbicide Resistance

All plants or weeds have the ability to become herbicide resistant / tolerant (Brookes and Barfoot 2018). Hundreds of weeds are herbicide resistant without the involvement of GM crops. These are listed on the International Survey of Herbicide Resistant Weeds website (http://www.weedscience.org) (Figure 4-4). Weeds have also evolved glyphosate resistance before the first herbicide tolerant GM crops were released. However, glyphosate resistance was also encountered where environmental release of glyphosate resistant crops occurred (NASEM 2019; Brookes and Barfoot 2018). Evolution of resistance is mostly similar to that of animals and so are the methods to delay resistance. Integrated weed management practices such as a combination of herbicides, manual hoeing or ploughing will delay evolution of resistance.

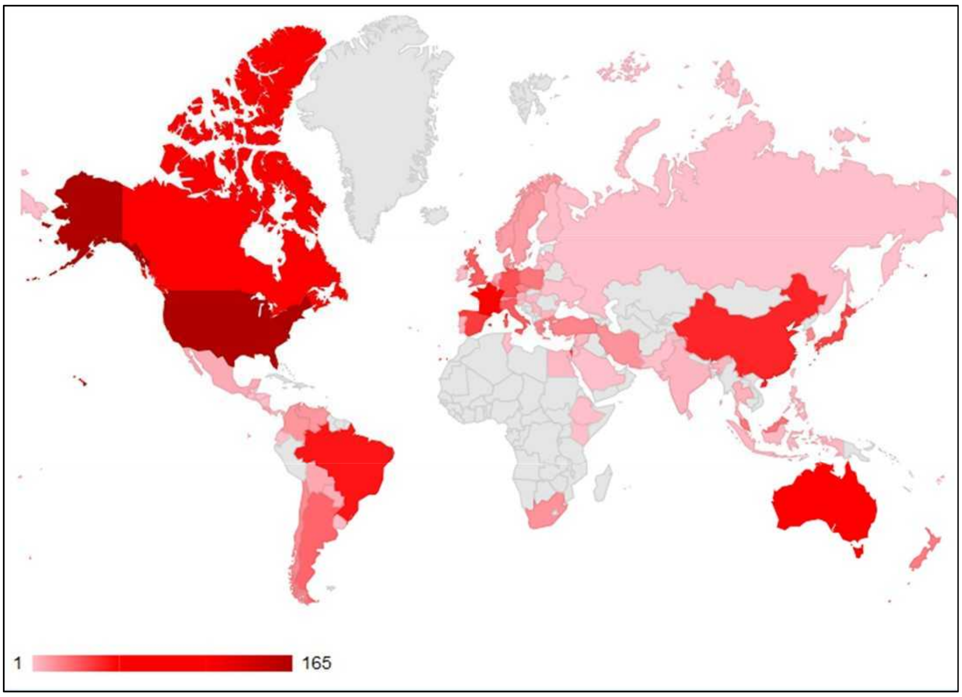

Figure 4-4 Global weed resistance (http://www.weedscience.org/Graphs/GeoChart.aspx)

4.4.8 Gene Flow

Concerns about the potential transfer of the modified gene sequences from a GM crop to closely related species or weeds through horizontal gene transfer (HGT) exist. Horizontal gene transfer is the transfer of genetic material, between single cell and / or multicellular organisms that did not originate from a parental donor. This is in contrast to vertical gene transfer, which is the transfer of genetic material from parent to offspring during reproduction. Horizontal gene transfer is a natural process and forms an important part of evolution. For example, hundreds of genes in humans appears to have originated from bacteria and through HGT they ended up in vertebrates, and ultimately in humans, at some point during vertebrate evolution (Heilig et. al. 2001). HGT is common in prokaryotes while HGT between eukaryotes are considered scarce due to numerous obstacles that have to be overcome to achieve successful HGT (Philips et al., 2022).

The concern with gene flow involving GMOs is that the genetic material inserted into a GM organism may be transferred to other organisms and have detrimental effects. Examples include the HGT of antibiotic resistance genes to pathogens (Bennett et al. 2004, Keese, 2008) and virus to virus gene transfer resulting in new diseases (Falk and Bruening 1994; Keese, 2008).

Horizontal gene transfer from a plant to other organisms is a very rare occurrence and is expected to be less frequent than normal background rates (Keese, 2008, WHO 2014, Philips et al., 2022). Furthermore, maize is categorised as low risk in terms of its probability for gene flow to occur (Viljoen and Chetty, 2011; Tsatsakis et al., 2017). Viljoen and Chetty (2011) calculated cross-pollination success over distance. They found that at 45 m the chance for cross-pollination to occur is between 1.0% and 0.1%, at 145 m between 0.1% and 0.01% and at 473 m between 0.01% to 0.001%. Cross-pollination success over distance for cotton also shows a rapid decline in cross-pollination success over distance (Llewellyn et al. 2007). The percentage of seeds testing positive for Cry1A and Cry2A in conventional cotton segregated from the Bt field by 1 m was 7.9%, at 12.6 m it was 1%, at 25.2 m it was 0.88% and at 48.6 m, 0.79%. Based on the results, Llewellyn et al. (2007) recommend a buffer between GM and conventional cotton of 20 m. Similar results were obtained by Sen et al. (2004) who indicated that as little as 8 to 9 m can provide good isolation. However, for both maize and cotton the success rate for cross-pollination is significantly influenced by external factors such as wind, topography, etc. Also for cotton, the presence of very high numbers of honey bees also increase cross-pollination at greater distances (Llewellyn et al., 2007).

Gene flow is considered to have negligible risks to humans and the environment (Keese, 2008; WHO, 2014) and no cases of adverse environmental effects as a result of HGT between GM crops and wild, related plants have been observed (NASEM, 2019) nor have any reports been made by 2022 of adverse impacts on human health or environmental safety due to HGT from GM plants (Philips et al., 2022).

4.4.9 GMOs as Food and Livestock Feed

Multiple arguments on the safety of GM food and feedstuffs and the risks they pose to humans and animals exist. A very long and detailed discussion falls outside of the scope of this assessment. However, a brief summary of various studies and literature reviews are presented below.

A general health concern is that the modified genes of a GM crop can be transferred to, and incorporated into the genome of, a consumer of a GM crop or its products. Potential adverse health effects may then result from this new genetic material. For example, the Cry1Ab fragments of Bt genes have been detected in animal organs (Mazza et al. 2005). The Bt gene as a whole was however not detected. It should be noted that with all food that is eaten, the fragments of genes can find its way into organs. It is not restricted to GM food only. Thus, should harmful effects realise because of gene fragments entering organs, it can occur with any of the food we eat. A second concern is that the specific protein that is expressed by the inserted gene(s), will be harmful when consumed and that allergens can be produced.

NASEM (2019), Vince et al. (2018) and de Vos et al. (2017) all reviewed existing literature on the health effects of GM feed on livestock. The conclusion reached by all three papers is that there is a lack of published evidence of adverse effects in livestock fed with GM feed. NASEM (2019) concluded: "*On the basis of detailed examination of comparisons of currently commercialized GE and non-GE foods in compositional analysis, acute and chronic animal-toxicity tests, long-term data on health of livestock fed GE foods, and human epidemiological data, the committee found no differences that implicate a higher risk to human health from GE foods than from their non-GE counterparts.*"

The conclusion makes sense since proteins, natural and GM, undergo the same process of denaturation into peptides (segments of amino acids) during the digestion process. Once denatured into amino acids, the characteristics of the original protein are no longer present.

Health impacts of glyphosate sprayed maize are also questioned. A significant contributor to people being sceptic about the health effects of eating glyphosate resistant maize stems from a 2012 study (Séralini et al. 2012). It presented data indicating that the long-term toxicity of glyphosate (specifically in Roundup®) and maize event NK603 (Roundup Ready®) on rats have severe health impacts. This resulted in large public outcry. However, the study was in the meantime retracted due to a lack of scientific accuracy, after the validity of the data was questioned and re-examined. Steinberg et. al., (2019) repeated a similar study and found that after two years of feeding rats NK603 maize, both treated with Roundup and untreated, no adverse health effects could be discerned.

Whereas no evidence of adverse health effects could be found, instances of health benefits are documented. Pellegrino et al. (2018) analysed long-term data on GM maize and stated that lower concentrations of mycotoxins (−28.8%), fumonisin (−30.6%) and thricotecens (−36.5%) are present in maize. NASEM (2019) concluded their review as follows: "*There is* *some evidence that GE insect-resistant crops have had benefits to human health by reducing insecticide poisonings and decreasing exposure to fumonisins.*"

4.5 GENETICALLY MODIFIED MAIZE AND COTTON IN SOUTH AFRICA

South Africa's GM maize and cotton cultivation is an example to consider in deciding the future of GM maize production in Namibia. It provides some information on the potential advantages, disadvantages and impacts. The following list summarises some of the findings in no specific order of importance:

Positive

- Twenty one years of GM maize cultivation and related studies show that actual yield of GM maize is 5.6% to 24.5% higher than their non GM counterparts (Pellegrino et. al. 2018). Yields for cotton are also higher (Morse et al., 2006).
- Higher yields and reduced pesticide use results in increased profit margins (Morse et al., 2006).
- Since the introduction and widespread cultivation of Bt maize in 1998 in South Africa, the volume of chemical insecticides used has reduced significantly (Kunert, 2011; Mwamahonje and Mrosso, 2016). The same was found for insecticide use on Bt cotton, with significantly less insecticides applied than on conventional cotton for the period 1997 to 2001 (Morse et al., 2006).
- GM maize kernels have 28.8% lower concentrations of toxic compounds naturally produced by fungi which can cause various adverse health effects in humans and livestock. Collectively these toxins are called mycotoxins, and of the mycotoxins, fumonisin is 30.6% less and thricotecens 36.5% less (Pellegrino et. al., 2018).
- Evidence point towards Bt toxins not affecting non-target organisms (Pellegrino et. al. 2018).
- The adoption of GM maize for cultivation in South Africa has led to the stabilisation in the growth rate of the wholesale maize price, thus reducing price risk (Abidoye and Mabaya, 2014).
- Smallholder farmers value the labour-saving benefit (mostly women and children) and increased yields (mostly men) of GM maize and GM cotton (Morse et al., 2008; Gouse, 2012; Gouse et al., 2016). Greater yields provide more income which in turn is spend on education of children, more investment in agriculture, and payment of debt (Morse et al., 2008).

Negative

- Some Bt resistance was detected in the African stalk borer in the Vaalharts irrigation scheme (van Rensburg, 2007). It seems that the lack or wrong implementation of refuges as well as the planting regime (late planting of maize as well as variance in time of planting) may have contributed to the evolution of resistance (van Rensburg, 2007; Kruger et. al., 2009).
- Lack of GM seed availability and cost to smallholder farmers may hamper the adoption of GM cropping in communal areas (Gouse et al., 2016).
- Cross pollination between GM and non-GM maize can occur where fields are near to each other (see Section 4.4.8) (Viljoen and Chetty, 2011).

Whereas most cotton plantations globally are of GM nature, there is a high, albeit small, demand for organic cotton in some niche markets. To exploit this possible opportunity, organic cotton research had been tested in South Africa in the past, but yields were not profitable, and as farmers are not subsidised as in other countries to farm organically, this venture never took off. Organic cotton production requires the use of non-GM (conventional) cottonseed, and since organic production is not commercially viable in South Africa, there is also no conventional cottonseed available. Thus, no organic cotton or conventional cotton are produced in South Africa (https://cottonsa.org.za/cotton-facts/).

Cotton GM varieties are as a result also all deregulated in South Africa, while all cottonseed sold in South Africa contains the Bt-gene. By-products, such as cottonseed oil and cottonseed oilcake that is used for animal feeding, are therefore also effectively genetically modified products.

5 ALTERNATIVES

Table 5-1 highlights the major advantages and disadvantages of traditional non-GM maize and cotton and various strains of GM maize and cotton.

Table 5-1 Alternative maize and cotton types for cultivation

Alternative	Advantages	Disadvantages	Preferred Option
Maize type			
Traditional non-GM maize and cotton	♦ Long established crops of which the positive and negative properties are well known ♦ Cheaper seeds ♦ Seeds easily available ♦ Can keep some harvested maize seed for next planting season	♦ Highly susceptible to crop damage by insects ♦ Reduced crop yields when significant pest outbreaks occur ♦ Maize is only broad leaf herbicide tolerant ♦ Cotton is only grass herbicide tolerant ♦ More labour intensive ♦ More spraying result in more fuel use and thus greenhouse gasses ♦ Increased water use due to need for dilution of insecticides	♦ Cultivation of GM maize and cotton with traditional maize and cotton as refuges. Planting a combination of GM maize and cotton events, or varying GM maize and cotton events between planting seasons, will contribute to delaying the onset of insect resistance.
MON 810	♦ Resistant to main pests like fall armyworm and African stalk borer ♦ Increased actual yields ♦ Reduced insecticide use ♦ Less labour intensive ♦ Less greenhouse gas emissions due to reduced fuel use for spraying ♦ Reduced water use due to less need for dilution of insecticides	♦ Only one BT toxin can potentially lead to more rapid insect resistance to Bt ♦ Seed is more expensive ♦ Seed is less easily obtainable ♦ Requires special knowledge and proper management to prevent potential negative impacts	
MON 89034 (Maize) **MON 15985 (Cotton)**	♦ Resistant to main pests like fall armyworm and African stalk borer ♦ Two Bt toxins has high efficiency and delay insect resistance ♦ Increased actual yields ♦ Reduced insecticide use ♦ Less labour intensive ♦ Less greenhouse gas emissions due to reduced fuel use for spraying	♦ Seed is more expensive ♦ Seed is less easily obtainable ♦ Requires special knowledge and proper management to prevent potential negative impacts	

Alternative	Advantages	Disadvantages	Preferred Option
	♦ Reduced water use due to less need for dilution of insecticides		
NK 603 (Maize) **MON 88913 (Cotton)**	♦ Easier weed control ♦ Increased actual yields	♦ Weeds can become resistant to glyphosate ♦ Requires special knowledge and proper management to prevent potential negative impacts	
Stacked events	♦ Both insect resistance and easier weed control ♦ Increased actual yields ♦ Reduced insecticide use ♦ Less labour intensive ♦ Less greenhouse gas emissions due to reduced fuel use for spraying ♦ Reduced water use due to less need for dilution of insecticides	♦ Pests and weeds can become resistant to Bt proteins and glyphosate ♦ Requires special knowledge and proper management to prevent potential negative impacts	

5.1 No Go Alternative

Maize and cotton production volumes on the existing cleared land for crop production will remain the same, or may even reduce in light of climate change, if the environmental release of GM maize and cotton are not allowed. Namibia will continue to rely heavily on maize imports (which also is GM maize) for most of the country's maize consumption. This results in a net cash outflow from the country. More land will need to be cleared to increase local maize and cotton production. Maize and cotton producers will remain vulnerable to pest outbreaks.

6 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

The legislation and standards provided in Table 6-1 to Table 6-3 are relevant to the proposed environmental release of GM maize and cotton in Namibia.

Table 6-1 Namibian law applicable to GMOs

Law	Key Aspects	Applicability to Environmental Release of GM Maize
The Namibian Constitution	♦ Promote the welfare of people ♦ Incorporates a high level of environmental protection ♦ Incorporates international agreements as part of Namibian law	♦ Genetically modified maize can potentially provide increased food security, thus promoting the welfare of people ♦ Introduction of GMOs may have environmental impacts
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	♦ Defines the environment ♦ Promotes sustainable management of the environment and the use of natural resources ♦ Provides a process of assessment and control of activities with possible significant effects on the environment	♦ Introduction of GMOs is a listed activity requiring environmental assessment
Environmental Management Act Regulations Government Notice No. 28-30 of 2012	♦ Commencement of the Environmental Management Act ♦ List activities that requires an environmental clearance certificate ♦ Provide Environmental Impact Assessment Regulations	♦ Regulates the environmental assessment process
Biosafety Act Act No. 7 of 2006, Government Notice No. 223 of 2006	♦ Regulate activities involving the research, development, production, marketing, transport, application and other uses of genetically modified organisms and specified products derived from genetically modified organisms ♦ Prohibits planting of GMOs without registration ♦ Provides for formation of the Biosafety Council ♦ Government Notice No. 259 of 2018 declares certain products in Namibia as GMOs or GMO containing products. The schedule includes the maize events MON810, MON89034 and NK603 as well as stacked events of these	♦ Main legislation dealing with the environmental release of GM maize

Law	Key Aspects	Applicability to Environmental Release of GM Maize
Biosafety Act Regulations Government Notice No. 210	♦ Provide regulations for obtaining permits to place GMO Food and feedstuff on the market, for contained use of GMOs, and for field trials and environmental release ♦ Provides for risk assessment reports and risk management plans for GMO related activities ♦ Provides for regulations pertaining to handling, labelling, transport, accidental release, etc. of GMOs	♦ Regulates the environmental release of GM maize and incidental matters ♦ Regulates the environmental assessment process
Research, Science and Technology Act Act No. 23 of 2004, Government Notice No. 283 of 2004	♦ Provide for the promotion, co-ordination and development of research, science and technology in Namibia ♦ Establish the National Commission on Research, Science and Technology	♦ Establishes the National Commission on Research, Science and Technology
Agronomic Industry Act Act No. 20 of 1992, Government Notice No. 107 of 1992	♦ Governs the prohibition, restriction and permitting on the sale, import and export of controlled products	♦ Legislation pertaining to the agronomic industry who will cultivate GM maize
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act Act No. 36 of 1947, Government Notice No. 1239 of 1947	♦ Governs the registration, importation, sale and use of fertilizers, farm feeds, agricultural remedies and stock remedies ♦ Various amendments and regulations	♦ Genetically modified maize will ultimately form part of farm feeds
Seed and Seed Varieties Act Act No. 23 of 2018, Government Notice No. 368 of 2018	♦ Provides for restrictions on the importation, production and sale of seed ♦ Not in force yet	♦ Expected to control GM seed once enforced
Import and Export Control Act Act No. 30 of 1994, Government Gazette Notice No. 224 of 1994	♦ Controls imports into and exports from Namibia ♦ Provides for issuing of permits with respect to imports and exports	♦ Genetically modified seed imports and potential GM maize or GM maize containing food and feed exports
Soil Conservation Act Act No. 76 of 1969	♦ Law relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources in Namibia	♦ Genetically modified crops allow for easier implementation of conservation tillage (reduced erosion) and less pesticide use

Law	Key Aspects	Applicability to Environmental Release of GM Maize
Public Health Act Act No. 36 of 1919	♦ Provides for the protection of health of all people	♦ Potential health effects of consuming GMOs
Labour Act Act No 11 of 2007, Government Notice No. 236 of 2007	♦ Provides for Labour Law and the protection and safety of employees ♦ Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997)	♦ Application of herbicides on herbicide tolerant GM maize pose potential health impacts, but not more so than pesticide application on non-GM maize
National Agricultural Policy, 1995	♦ Aims to realize the national objectives of reviving and sustaining economic growth, creating employment opportunities, alleviating poverty and reducing inequalities in income ♦ Aims to maintain or increase levels of agricultural productivity	♦ Genetically modified maize can potentially contribute to reaching the aims of the policy by providing increased yields
Namibia Food Safety Policy, 2014	♦ Aims to ensure food safety for all consumers in Namibia, and provide sufficient food safety guarantees on all food products traded nationally, or exported to other countries ♦ This policy ensures that control standards are established and adhered to as regards food production safety, food product hygiene, animal health and welfare, plant health and preventing the risk of contamination from external substances ♦ It lays down conditions for regulations on appropriate labelling for these foodstuffs and food products	♦ Health concerns related to consumption of GMOs

Table 6-2 Relevant multilateral environmental agreements

Agreement	Key Aspects	Applicability to Environmental Release of GM Maize
Stockholm Declaration on the Human Environment, Stockholm 1972.	♦ Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment	♦ In agreement with the Namibian Constitution regarding enhancement of the human environment ♦ Genetically modified maize can potentially provide increased food security, thus promoting the welfare of people
United Nations Framework Convention on Climate Change (UNFCCC)	♦ The Convention recognises that developing countries should be accorded appropriate assistance to enable them to fulfil the terms of the Convention	♦ Genetically modified crop production can reduce greenhouse gas emissions through the reduced need for spraying pesticides and thus less exhaust gasses from farm implements
Convention on Biological Diversity, Rio de Janeiro, 1992	♦ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity	♦ Cultivation of GM crops can affect biodiversity through the reduction of pest species and onset of resistance in pests
Cartagena Protocol on Biosafety, 2000	♦ Adopted by the Convention on Biological Diversity in 2000 and came in force in 2003 ♦ Objective is to protect biological diversity from the potential risks posed by safe transfer, handling and use of Living Modified Organisms (LMOs)[GMOs] resulting from modern biotechnology ♦ Considers risks to human health	♦ Address GMOs directly
International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	♦ Promote conservation, exploration, collection, characterization, evaluation and documentation of plant genetic resources for food and agriculture ♦ Promote the sustainable use of plant genetic resources for food and agriculture	♦ Cultivation of GM crops can potentially affect plant genetic resources
International Plant Protection Convention, Rome, 1951	♦ Promote controlling pests and diseases of plants and plant products and preventing their introduction and spread across national boundaries	♦ Although not directly dealing with GMOs it established International Standards for Phytosanitary Measures (ISPMs) with applicability to GMOs (Table 6-3)
World Trade Organization (WTO)	♦ Global international organization dealing with the rules of trade between nations ♦ The primary purpose of the WTO is to open trade for the benefit of all	♦ The use of GMOs in the production of food and feedstuff may influence international trade

Agreement	Key Aspects	Applicability to Environmental Release of GM Maize
WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)	♦ Applies to all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade	♦ The use of GMOs in the production of food and feedstuff may influence international trade

Table 6-3 Standards or codes of practise

Standard or Code	Key Aspects	Applicability to Environmental Release of GM Maize
International Standards for Phytosanitary Measures (ISPMs)	♦ Compiled under the International Plant Protection Convention of 1951 ♦ Various standards related to GMOs that deals with plant pests	♦ Some GM plants may present a phytosanitary risk ♦ The potential of GM maize becoming a pest / invasive
Food and Agriculture Organization (FAO) / World Health Organization (WHO): Codex Alimentarius	♦ Provides international standards for all the principle foods, whether processed, semi-processed or raw, for distribution to the consumer ♦ Includes provisions in respect of food hygiene, food additives, residues of pesticides and veterinary drugs, contaminants, labelling and presentation, methods of analysis and sampling, and import and export inspection and certification.	♦ Provides: ○ standards for maize (CXS 153-1985) and whole maize meal (CXS-154-1985) ○ principles for the risk analysis of foods derived from modern biotechnology (CXG 44-2003) ○ guidelines on performance criteria and validation of methods for detection, identification and quantification of specific DNA sequences and specific proteins in foods (CXG 74-2010) ○ compilation of Codex texts relevant to the labelling of foods derived from modern biotechnology (CXG 76-2011) ○ guideline for the conduct of food safety assessment of foods derived from recombinant-DNA plants (CXG 45-2003)

7 IDENTIFIED IMPACTS

The following section provides a brief description of potential impacts (positive and negative) of cultivating GM maize and cotton and highlights the objective for each. The impacts are categorised according to economic, physical / chemical, biological and social impacts.

7.1 ECONOMIC

The financial feasibility of planting GM versus traditional crop cultivars will have to be considered for each farming unit. Ultimately, the goal of introducing GM crops is, among others, to increase profitability by increasing actual yields at times of pest outbreaks or by being able to plant crops in short planting seasons (i.e. late onset of rain in case of dry land cropping). Factors that can decrease profitability include administrative costs related to permitting, more expensive seeds, lower tonnage price for GM vs non-GM crops, additional expenses incurred to ensure GM crops remains contained and segregated from non-GM variants, and possible insurance costs to cover GM crop related events such as product spills during transport, costs for coexistence with neighbours planting non-GM crops, and resistance management. In case of incidents pertaining to GM crops (e.g. non-GM and GM crop contamination), there may be additional costs incurred, for example for decontamination, product withdrawals, compensation or legal costs.

7.1.1 Employment

Objective: To promote sustainable employment.

Planting of certain GM crops, such as Round-Up Ready maize, can lead to reduced labour requirements to perform certain tasks (e.g. manual hoeing of weeds). A lesser component of mostly seasonal and/or temporary workforce may result in the cultivation of such a variant. However, the introduction of GM cotton for cultivation in Namibia may entice more farmers to start planting cotton. To harvest cotton, many farmers will rely on seasonal and/or temporary employees to handpick the cotton, thereby increasing the seasonal and/or temporary workforce component of operations. Furthermore, diversification of farming activities by cultivating GM crops, may increase the overall sustainability of the farm and allow for the time and resources to pursue additional revenue streams. This may offset possible job losses resulting from the planting of GM crops. Many of the farming units in Namibia, have diverse agricultural production units which include agronomy, livestock farming, charcoal production and tourism.

Actions

Enhancement:

- Opportunities for additional income generating activities to be investigated in order to sustain employment.
- Employment of local and Namibians first. Where feasible, employment of the same seasonal and/or temporary workforce year on year.
- Adhere to all the requirements of the Labour Act.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Keep in good standing with Social Security Commission.
- Updated employment records and contracts on file.

7.1.2 Economic Resilience

Objective: Contribution to local and national treasury as well sustaining a stable earning potential for employees and industry.

The impact is based on the assumption that the net economic benefit of GMO cultivation (on a specific farm and in general), will exceed the net benefit of non-GMO cultivation. The assumption is required as the net economic benefit may in some instances not realise (e.g. when no significant pests are present). Should the assumption be correct, the benefit will be experienced greatly by the Proponent, where after multiplier effects will result in increased economic resilience in the regional and national agricultural sectors. Planting of the GMO crops will require less input in terms of pesticide application (including fuel and water) and labour, depending on the GM events planted. Therefore, producers will make time available for additional revenue generating activities to be considered. More successful harvests translates into a more sustainable flow of revenue per agricultural unit, resulting in an increase in the stability of revenue flow.

Cultivation of especially GM maize will reduce the risk to harvest failure and or losses. An indirect impact of the increased economic resilience will see increased planning ability for socio-economic aspects such as health and education.

Actions
Prevention:
- Prior to embarking on the cultivation of GM maize and cotton, each farmer must do feasibility calculations taking specific local conditions into consideration.
- Where feasible and possible, economic gains should be invested into the local agricultural sector and related communities.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Feasibility reports on file

7.1.3 Yield and Revenue

Objective: To increase maize and cotton yields and thus revenue generation at all levels i.e. employee, employer, supplier, processor and national treasury.

At present, there is no difference in the potential yield between conventional maize and cotton and GM variants. However, actual yields for GM variants may be higher due to decreased insect damage, especially during a heavy infestation or plague, and competition with weeds. Coupled to this is the potential for increased profit margins if reduced volumes of pesticides are used, which also mean less fuel and water consumption. GM seed are typically more expensive and crop producers will likely consider the financial benefits of GM maize and cotton vs. conventional maize and cotton in deciding which to plant. Refer to Appendix B and Appendix C for examples of cost guide figures.

Actions
Mitigation:
- Prior to embarking on the cultivation of GM maize or cotton, each farmer must do feasibility calculations taking specific local conditions into consideration.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Feasibility reports on file.

7.1.4 Meat Exports

Objective: No impact on producers of meat for export purposes.

Concerns were raised that international markets may be closed if Namibian livestock consumes GMO containing feed. The reality is that feed produced in, or imported to, Namibia have for a long time contained GM ingredients. The Meat Board of Namibia also confirmed that meat exports to the EU are not negatively influenced because of livestock consuming GMO containing feed (ATF 2019).

Actions

Prevention:

- Continue to adhere to the regulations and legislation pertaining to the agricultural industry which may impose certain restrictions on crops that may be cultivated or how crops are utilized.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Legal register

7.2 Physical / Chemical

7.2.1 Pesticides in Soil and Groundwater

Objective: No or minimal impact on soil and groundwater as a result of pesticide use.

Pesticides can enter soil, and where porosity is high with shallow groundwater, can reach the water table. Unless organic farming is practiced, pesticide use will persist in both non-GM and GM cropping. As discussed earlier, evidence shows that the volumes of pesticides used are in fact lower for GM crops, especially for insecticides. In terms of herbicides, the concern is that where glyphosate resistant maize or cotton are planted, excessive volumes of glyphosate will be applied to combat weeds. Apart from the additional costs involved with excessive herbicide spraying, the regulations for herbicide use are the same, regardless of the choice of crop (GM vs non-GM). It will therefore be in the best interest of the farmer to maintain a pest management program that is sensible, with reduced potential impacts.

Actions

Prevention:

- Limit herbicide application as far as is practically possible.
- Application of glyphosate herbicide as per the prescribed concentration and application procedures.
- Prevent spray drift by applying herbicides during calm weather conditions.
- Proper training of operational personnel.

Responsible Body:

- Proponent; HSE Officer.

Data Sources and Monitoring:

- Keep record of all instances of herbicide application.

7.2.2 Soil Erosion

Objective: No or minimal soil erosion.

Globally, millions of tons of soil is lost through erosion each year. A significant portion of this is because of poor farming practices and tillage. Tilling is often employed to uproot weeds prior to planting of fields. This ensures all broad leaf and grassy weeds are removed. By planting glyphosate resistant maize and cotton the need for tillage is made redundant and conservation agriculture can be practiced since post emergent weeds among crops can be controlled. By practicing conservation tillage, there is less likelihood of soil loss due to water runoff and wind.

Actions

Prevention:

- Implement conservation tillage practises.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- None

7.3 BIOLOGICAL

7.3.1 Pesticides Resistance

Objective: To delay, or ideally prevent, the onset of pesticide resistance in insects and weeds.

In GM crop fields, pesticide resistance has been reported in insects (against Bt proteins) and weeds (against glyphosate). This is however no different from pesticide resistance reported in non-GM crop fields. Over reliance on the use of glyphosate and the lack of crop and herbicide rotation by farmers, in some regions, contribute to the development of weed resistance. In order to address this problem and maintain good levels of weed control, farmers have increasingly adopted more integrated weed management strategies incorporating a mix of herbicides, other herbicide tolerant crops and cultural weed control measures. These include, using other herbicides with glyphosate rather than solely relying on glyphosate; using herbicide tolerant crops that are tolerant to other herbicides, such as glufosinate; and using cultural practices such as mulching. These add cost to the GM herbicide tolerant production systems compared to about 10–15 years ago, although relative to the current conventional alternative, the GM herbicide tolerant technology continues to offer important economic benefits.

Actions

Prevention:

- Develop and implement an insect and weed resistance management plan in collaboration with the seed supplier.
- The plan should among others include:
    - all farmers must adhere to the refuge strategy as stipulated by the GM seed supplier.
    - as part of the insect resistance management plan, intermittently apply insecticides to kill any pest insects that may have developed Bt resistant traits.
    - application of glyphosate herbicide as per the prescribed concentration (i.e. not lower or higher concentrations as this may be ineffective) and application procedures.
    - weed control prior to planting which should include herbicides of alternative active ingredients to allow killing of weeds that may have developed resistance to glyphosate.
    - weed control prior to its production of viable seeds.
    - cleaning of farm implements to prevent distribution of potential resistant weeds.
    - crop rotation.

Responsible Body:

- Proponent; HSE Officer; seed supplier

Data Sources and Monitoring:

- Insect and weed resistance management plan.
- Regular inspection of all fields to ensure early detection of extraordinary damage to crops that would indicate Bt resistance.
- If Bt resistance is expected, implement the insect resistance management plan and notify the NCRST and seed supplier.
- Inspection of all fields after application of glyphosate to ensure early detection of surviving weeds that may indicate resistance.
- If glyphosate resistance is expected, implement the weed resistance management plan and notify the NCRST and seed supplier.
- Keep record all instances of suspected insect or weed resistance. Note at least the species, date, extent and measures taken.
- Keep record of all instances of insecticide and herbicide application as a measure to combat weeds or to prevent / delay resistance in insects and weeds. Note at least the date, insecticide and/or herbicide used, concentration of active ingredients as applied, and the reason for application.

7.3.2 Biodiversity / Non-Target Species

Objective: To prevent or minimize impacts on biodiversity and non-target species.

Pesticides by nature are harmful to the environment. Since typical insecticides are not species specific, they affect many non-target species. Planting Bt crops that targets specifically Lepidopterans, reduce the need for spraying insecticides. Using less insecticides are overall more beneficial for the environment and results in increased biodiversity as compared to fields treated with traditional insecticides.

The aim with weed control is to rid the crop fields of all weeds. Therefore, whether it is achieved by spraying a broad-spectrum herbicide like glyphosate, or by using a combination of manual and chemical control, the result is the same. The only instance where non-target species will be affected by herbicide application, is where spray drift occurs. Spray drift can be prevented by applying pesticides during calm conditions.

Actions

Prevention:

- Limit pesticide application as far as is practically possible.
- Application of pesticides as per the prescribed concentration and application procedures.
- Prevent spray drift by applying pesticides during calm weather conditions.
- Proper training of operational personnel.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Keep record of all instances of insecticide and herbicide application. Note at least the date, insecticide and/or herbicide used, concentration of active ingredients as applied, and the reason for application.

7.3.3 GM Crops Becoming Invasive

Objective: No GM maize establishing outside of farmland.

Concerns have been raised regarding the possibility of GM crops establishing themselves outside of farmland with the potential of becoming invasive. After decades of planting traditional maize and cotton, no instances of this have been recorded and it is highly unlikely that the GM cultivars will be any different. Neither maize nor cotton has any closely related species occurring naturally within Namibia, thus further decreasing the possibility of them establishing and becoming invasive.

Actions

Prevention:

- Contain GM seeds and prevent spillages during transport.
- Spill clean-up plan where accidental spills occur during transport.
- Prevent theft of GM crop seeds.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Spill management plan.
- Record all spills and include maize strain, date, location and spill clean-up measures with photo records.
- Submit the spill report to the NCRST.

7.3.4 Horizontal Gene Transfer

Objective: No health impacts as a result of horizontal gene transfer and no conflict with organic or non-GMO farmers.

As discussed in this report, HGT is considered to have negligible risks to humans and the environment and no cases of adverse environmental effects as a result of HGT between GM crops and wild, related plants have been observed.

Actions

Prevention:

- Communicate the intention to plant GM variants to neighbours indicating buffer and/or isolation zones to neighbours who do not plant GM variants,
- Maintain a buffer and/or isolation zone of 800 m (or a distance as directed by the seed supplier) between GM and non-GM fields.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Seed supplier guidelines and contractual obligations of farmer.
- Keep record of any potential cross-contamination events and report to NCRST.

7.4 SOCIAL

Evaluating social aspects associated with the cultivation of GM produce, are complex and sensitive at times. Impacts range from feelings about the subject (and related future aspirations) to demographic change processes such as seasonal migration of a workforce. Community structures and belief systems are different on a local, regional and even sometimes, national scale. Therefore, the local context of every producer will have to be considered during individual assessments on a microeconomic scale. The assessment should consider the specific crop or trait, or the combination, which may be important as to determine which indicators to measure / evaluate. Aspects to be covered should include the following during their assessment: benefits to society, economically linked prosperity, health and welfare, freedom of choice, food supply, cultural heritage, safety, biodiversity and environmental services. The first two aspects also form part of the economic considerations of the his report while the latter two are included in the biophysical considerations. Of importance is to note that there is very little information or research done considering the social impact of GMOs in Namibia.

For this report the following main aspects, are broadly covered:

- Feelings and aspirations for the future,
- Social cohesion,
- Community health, and
- Cultural aspects.

If more sustainable employment realises in the agricultural sector, migration of workers to rural farming areas (limited to geographical areas which support maize and cotton production) may occur as workers search for employment. Increased migration to farming units may increase the integration of various cultural groups. Integration of culture and increased migration of labourers may increase the spread of HIV/AIDS. It is expected that possible migration to rural areas will not significantly affect the current migration trend in Namibia which has seen increased rates of urbanization.

7.4.2 Feelings and Aspiration for the Future

Objective: To achieve optimal consensus regarding the cultivation of GM crops and promote the positive aspects in terms of agricultural markets.

Concerns about the use and cultivation of GM variants, mainly maize, permeates certain communities and action groups throughout the world. In Namibia, concerns have also been raised on a national scale and include perceived threats to the Namibian beef export markets as well as community health concerns in consuming related food. Aspiration for the future are bleak and negatively perceived as it is anticipated that GM cultivation will affect the meat trade and the overall health economy of Namibia negatively. Camped in with these concerns, are those questions related to the possible economic harm of non-GMO farmers. Cross pollination organic non-GM crops and GM crops, as well as the risk of pesticide spray drift are issues which have been raised. For the latter, there is no difference in the risk between fields of non-GM and GM crops near organic fields. The potential for cross-pollination in maize and cotton decrease relatively quickly with increased distances between fields. Trials by Viljoen and Chetty (2011) on maize indicated a maximum distance of 650 m at which cross-pollination occurred under South African conditions. The use of buffers and/or isolation zones between non-GM and GM maize can prevent cross-pollination. This may however not be feasible where farms are small and near each other. It will be the responsibility of the GM maize farmer to establish the buffer and/or isolation zones as contractually agreed with the seed supplier.

An opposing view, concerning the cultivation of GM variants, reflects positive aspirations for the Namibian agricultural sector with increased local food production for human and animal use. Successful cultivation of GM maize and cotton is considered to increase the stability of markets through more reliable yield and harvest expectations. The aspiration focusses on increased food security in Namibia with secondary spin-offs such as improved soil conservation and reduced greenhouse gas emissions, etc. Improved security of supply is considered to affect the markets favorably. Both views towards GM cultivation are applicable on a National, regional and local scale.

Farmers will continue to have a choice between farming systems and choice of crop. Cultivation of GM maize in Namibia will remain optional, as is organic or non-GM cropping / farming. With increasing GM crop production, a positive spinoff for organic producers is the creation of a niche market, targeting a sector of the community who are willing to pay more for food perceived as healthier (organic).

Actions

Prevention / Enhancement:

- Education and dissemination of accurate, scientific, information pertaining to the cultivation of GMOs.
- Maintain a buffer and/or isolation zone of 800 m (or a distance as directed by the seed supplier) between GM and non-GM fields.

Responsible Body:

- Proponent
- Consultants

Data Sources and Monitoring:

- Seed supplier guidelines and contractual obligations of farmer.
- Keep record of any potential cross-contamination events and report to NCRST.

7.4.3 Social Cohesion

Objective: To achieve optimal coexistence between GMO and non-GMO cultivating farmers and consumers.

Social change processes which could affect community cohesion, mostly on a local scale, include changes in social structure of a community, conflicts and community adaptability. Criteria for measurement of the aspect are too complex for a national scale, however, well achievable for local evaluations. For example, an increased potential for conflicts between neighbouring farmers, (which cannot easily be separated from the overall effects of conventional agriculture). An increased potential conflict risk may result between neighbouring farmers, should coexistence measures not be applied properly (by either), or if fear of contamination increases. These conflicts could lead to serious community rifts, especially in small rural communities were people depend, to some extent, on each other (e. g. neighbourly help, shared machinery). Such conflicts could be amplified by a change in social structure due to negative economic effects. For example, if a non GMO farmer's fields are contaminated by GMO crops, the non GMO farmer may sustain economic losses which could affect their role in the community and related structure.

In contrast to the above, farming communities who share the same position towards the cultivation of GMO's, could be unified and have increased levels of community cohesion, corporation and collaboration. For the purposes of this report, both possibilities and related mitigation and or enhancement measures have been included.

Actions

Prevention/Enhancement:

- Education and dissemination of accurate, scientific, information pertaining to the cultivation of GMOs during community meetings.
- Communication of plans and intentions to cultivate GMO crops.
- Agreements on the specific GMO management measures such as the setting and adherence to buffer and/or isolation zones, contamination contingency plans (inclusive of remuneration for losses / insurance etc.).
- Agreement, prior cultivation of GMOs, on conflict remediation measures to be taken.
- Sharing, where feasible, information and challenges with local neighbours in addressing concerns prior to them becoming unresolvable.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Communication record kept on file.
- Any neighbour agreements kept on file.

7.4.4 Community Health and Welfare

Objective: To reduce environmental contamination, increase food security and livelihoods.

Although there are points of view that the consumption of GMO produce have detrimental health effects, there are many independent research articles which refutes this. The matter will not be discussed within the scope of this report as it ties in with the feelings towards GMO cultivation. Rather, community health and welfare will be considered in a broader sense, looking at aspects such as food security, labour (income) and environmental degradation.

GMO cultivation has the potential to safeguard crops against pests, thereby increasing the overall yield. Cumulatively, this could (considering GMO maize), increase the amount of food available locally, if and when such crops are plagues by pests. The overall gain would be an increase in food security which could be beneficial for the largest segment of the Namibian population. An increase in food security, affects the overall community health, especially for those living in poverty. An increase in production of GMOs might however also see a reduced availability of non-GMO produce, thereby reducing the food choices available to those who are against its cultivation and / or consumption.

Changed labour conditions may result in the cultivation of GM variants. Labour and remuneration directly affect households and related communities. Seasonal labour is considered as one of the groups which may be affected the most. Increased employment opportunities in for example the cultivation of cotton, may increase earning potential of the seasonal workforce, which are also employed during harvesting of many other vegetables such as onions, potatoes, pumpkins, table grapes, etc. Increased labour requirements could also result in a change in regional migration patterns. The opposite is true for those instances where reduced employment opportunities realise (such in the case of Round-Up ready maize). In such case, the probability of poverty/vulnerability increases. Therefore, community health could be negatively impacted.

An overall cultivation plan includes the aim to reduce the use of pesticides on crops (Bt crops) while also enabling less reliance on tillage. Both of these fundamental approaches in agriculture, contribute to overall global conservation efforts. Reducing reliance on chemical pesticides, reduces the risks of contamination though over application of pesticides, while safeguarding non-target species such as bees. Finally, the reduced use of pesticides, especially for BT maize and cotton, will reduce human contact with chemicals. There would thus be a decrease in potential medically important consequences of exposure to pesticides and chemicals.

The greatest risks related to environmental health, however still include the misuse or over application of herbicides such as Round-Up; and the build up of chemical resistance in target species. The former is not directly related to the GMO product, but rather to the individual using the product. Chemical mismanagement is not only linked to GMO producers, but can also occur on non-GM crop producing farms. Unlike non GMO producers though, GMO farmers have a strict reporting regime in efforts to kibosh chemical mismanagement and related affects. Should resistance in insects develop, for example with BT maize and cotton, an application of an alternative pesticide will be required to eliminate such resistance. It should be noted that resistance may also develop where GM crops are not involved, such as the well documented case of resistance in mosquitos to insecticides (Riveron et al. 2016).

In Namibia, conservation agriculture was identified as one of vices to combat soil degradation. Eliminating or even just reducing tillage, reduces Namibia's greenhouse gas emission rate which is linked to the reduced rate of tractor use. Since planting of glyphosate tolerant GM crops makes it easier to practise conservation tillage, it could, if done responsibly, contribute positively to Namibia's overall soil conservation and climate change strategies.

Actions

Prevention/Enhancement:

- Keep to cultivation plan of GM variants and report any resistance development according to reporting requirements.
- Identify technically and financially feasible pollution prevention and control techniques to avoid or minimize adverse impacts on human health and the environment.
- Where applicable (located close to communities), avoid or minimize the potential for community exposure to hazardous materials (chemicals) and substances that may be released through cultivation.
- Ensure that appropriate mitigation and management measures are taken to address risks and potential impacts on community health and safety arising from an influx of project-related workers (for example, ensure adequate water and sanitation is available to all seasonal employees).
- Promote the preservation of water quality, along with integrated pest management and integrated soil fertility management to minimize the use of agrochemicals and ensure that wastewater is properly treated before it is discarded.
- A pest management plan must be developed when the use of a significant volume of pesticides is foreseen.
- When required to be used to reduce probability of insect or weed resistance, hazards of pesticide must be carefully considered, and the least toxic pesticides must be selected that are: (i) known to be effective; (ii) have minimal effects on non-target species and the environment; and (iii) minimize risks and impacts associated with the development of resistance in pests.
- Measures must be taken to avoid or minimize adverse impacts on ecosystem services from project activities. Any risks or potential adverse impacts on ecosystem services that may be exacerbated by climate change, should be identified and an mitigation plan provided, (for example over abstraction of groundwater for crop cultivation).
- Provide safety and health training, including on the proper use and maintenance of machinery and personal protective equipment.
- Employ local and Namibians first.
- Where implementable, use of technologies, practices and models that generate more and better employment opportunities (both directly and indirectly) for men and women equally, including the youth.
- Adhere to all requirements of the Labour Act and the Environmental Health Act.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Pesticide use register.
- Keep all records if any resistance reporting was conducted.
- Keep records of employment.
- Keep records of health and safety training.
- Keep records of soil and water (quality sampling).

7.4.5 Cultural Aspects

Objective: Conserve and coexist with cultural tradition related to conventional and traditional crop cultivation.

In considering the preservation of cultural heritage in terms of agriculture, reference is made to the traditional practises as well as the autonomy of local populations. The former refers to traditional production techniques or the use of specific crop variants, whereas the latter refers to the freedom of the population to decide on GMO-free production or GMO-free areas. Additional heritage or archaeological resources will be subject to standard chance-find-procedures.

Maize and cotton are not crops which are traditionally grown in the rural areas of Namibia. Nonetheless, the Namibian Government has set up various projects in assisting farmers in producing crops for commercial and own use. Some of these are irrigation based projects which aim at increasing the contribution of agriculture to the country's gross domestic product and to simultaneously achieve the social development and upliftment of communities, located within areas suitable for crop farming. The bulk of maize production in Namibia is however achieved through commercial farming techniques, driven by the availability and traditional use of existing implements and seed available. The bulk of producers use conventional tillage and planting techniques of non-GMO maize, some planted as dryland crops and some under irrigation (mainly pivot irrigation systems). Recent years have seen an increase in irrigation based production, which in itself, signifies a change in the traditional methods of cultivation. Cultivation of GMO maize will both impact conventional crop production techniques (of those who plant it) as well as the traditional label of Namibia, being a GMO maize producing country.

Introduction of GMO maize and related cultivation methods. have the potential to overshadow GMO-free / organic production leading to reduced sustainability of such cultivation.

Actions
Prevention:

- Education and dissemination of accurate, scientific, information pertaining to the cultivation of GMOs.
- Should any aspect of the cultivation, utilize cultural heritage, including knowledge, innovations or practices of local communities (specifically) to benefit the project or for commercial purposes, communities should be informed of: (i) their rights under national law; (ii) the scope and nature of the proposed use; and (iii) the potential consequences.
- The public consultation process should include groups affected by the project, main users, custodians, local communities, relevant government authorities and interested NGOs.
- For archaeological resources, about the chance find procedures for the preservation of such resources.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Keep consultation record

8 PERMIT APPLICATION

The approval of EIAs for the cultivation of GMOs, and subsequent issuing of a clearances, does not automatically allow farmers to import seeds to cultivate GM maize. An application for environmental release has to be submitted to the Biosafety Council, NCRST, by each farmer. This application must among others be accompanied by the SEA and its SEMP and an emergency response plan. Standard procedures for importation of seeds continue to apply, except that more stringent regulations are in place for its transport and handling.

Typically, environmental release of a GMO for agricultural purposes is preceded by field trials. For the proposed GM maize and cotton events and their stacks, sufficient evidence is available in the form of scientific literature spanning two decades and more of GM maize and cotton cultivation in South Africa, as well as various other countries worldwide. During this period some lessons were learned, specifically for example the importance of pest management plans to prevent development of resistance. This information is now freely available. The need for field trials are therefore considered to be redundant in the Namibian context.

9 CONCLUSION

Members of the APA intends to apply for the registration of GM maize (MON 810, MON 89034, NK 603 and stacks thereof) and GM cotton (MON88913 and MON88913 × MON15985) for purposes of environmental release in Namibia. These events provide for crops with insect resistance, glyphosate resistance as well as a combination of insect and glyphosate resistance. In general terms, GMOs are ideally placed to support the Namibian economy and the Namibian Government in its endeavours to ensure food security and food self-sufficiency. With less and less resources available due to climate change, more frequent droughts and outbreaks of pests and diseases, the negative effect of chemicals and pesticides on the Namibian fauna and flora, it is more than opportune to introduce GM crops for cultivation into Namibia. Such a step could turn otherwise marginal agronomic areas into profitable production areas and assist in the alleviation of hunger and poverty for those small-scale farmers that produce for household food security.

A large part of the population objects to the idea of genetic engineering and the consumption of GM foods. While some of the objections are based on moral and ethical beliefs, other objections stem from being misinformed or being selective in the sourcing of literature to support anti-GMO campaigns. Some objections, however, do warrant caution as is the concern about development of resistance in pests. Resistance in pests is however not restricted to GM crops, but results from poor pest management practises in both non-GM and GM crop cultivation.

In a country like Namibia, with mostly marginal agronomic potential, and likely to be significantly affected by climate change, it makes sense to diversify agronomic practices by introduction GM crops into the system. Based on extensive literature reviews as touched on in this report, there is no concrete evidence that GM maize and cotton's negative impacts are such that it should not be allowed for environmental release. That being said, it remains important for farmers to be obligated to follow the regulations and recommendations prescribed for each specific GM event. This includes the management plan prepared as part of the environmental impact assessment. Furthermore, GMOs pose very little threat to organic initiatives, as these can co-exist in the same country, as already proven in many other countries that have adopted both organic and GM production systems. The US for example has the biggest organic market in the world and it is growing at an impressive rate, despite the US also being one of the biggest producers and exporters of GM crops (FiBL & IFOAM – Organics International, 2018).

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Appendix A: Newspaper Clippings

Vrydag 24 Januarie 2020 Republikein SPORT 3

SA pensioengeld 'weg' in SME-plundery

Catherine Sasman

'n Bedrag van N$60 miljoen, wat aan die Nasionale Voorsorgfonds van die Suid-Afrikaanse Munisipale Werkersunie (Samwu) behoort, is maar net een van die sogenaamde beleggings wat in die SME Bank-plundery verdwyn het.

Die *Mail & Guardian* het onlangs berig die bedrag van N$60 miljoen is by 'n SME-rekening inbetaal sonder die pensioenfonds se skriftelike toestemming.

Volgens beëdigde verklarings voor die hooggeregshof afgelê, het die voormalige uitvoerende hoof van die SME Bank, die Zimbabwiër mnr. Tawanda Mumvuma, op 12 Oktober 2016 die besturende direkteur van JM Busha Asset Managers aangesê om die N$60 miljoen na die Namibiese bank oor te plaas.

Dié bedrag is die volgende dag na die SME Bank vanuit 'n VBS Mutual Bank-rekening oorgeplaas.

Op dieselfde dag het Mumvuma 'n promesse in JM Busha se guns onderteken, en sodoende aanspreeklikheid vir die N$60 miljoen vir die SME Bank aan JM Busha Asset Managers geskep.

'BELEGGING' GEWAARBORG

Die *Mail & Guardian* het berig dat, ten spyte van die SME Bank wat nou gelikwideer word, mnr. Joseph Busha, die beleggingsfonds se uitvoerende hoof, volhou die N$60 miljoen kan weer met rente verhaal word.

Busha het in 'n onderhoud met die SME Bank se likwidateurs, mnre. David Bruni en Ian McLaren, verlede jaar in Oktober aangevoer hy is deur Mumvuma bedrieg.

Die hoofbeampte van die Suid-Afrikaanse pensioenfonds, mnr. Themba Mfeka, het aan die *Mail & Guardian* gesê deel van die fonds se "belegging" in die SME Bank is deur die Namibiese regering en fondsdirekteurs gewaarborg.

Mfeka het verder beweer daar is regsaksie teen die SME Bank-direkteurs.

'n Anonieme bron het Mfeka se aantygings ontken.

Me. Tania Pearson, die SME Bank se voormalige regsverteenwoordiger wat met die likwidasieproses in die hof moes help, sê in hofstukke die JM Busha-"belegging" en ander was pogings om die plundering weg te steek.

Finansiële rekords en bankstate toon minstens N$247,6 miljoen is tussen Desember 2013 en Januarie 2017 uit die SME Bank se rekeninge by Standard Bank en FNB Namibia aan die vermeende ontvangers van die gesteelde geld betaal.

Baie van hierdie onwettige betalings is as fondse vir rekenaarhardeware of boukostes verdoesel, en toe buitengewoon groot bedrae moeilik geraak het om te verduidelik, het die bedrieërs dit "beleggings" begin noem.

In Junie 2016 het die SME Bank se eksterne ouditeur (BDO Namibia) 'n aantal transaksies bevraagteken en afskrifte van onder meer beleggingsooreenkomste versoek.

Die goewerneur van die Bank of Namibia (BoN), mnr. Iipumbu Shiimi, het ook onraad begin vermoed, maar het geen terugvoering van die SME Bank ontvang nie.

Toenemende druk op die bank het Mumvuma, mnr. Mauwane Kotane van Mamepe Capital (waarin SME Bank glo 'n aantal beleggings gemaak het), en mnr. Andile Ramavhunga, uitvoerende hoof van die South African VBS Mutual Bank, 'n komplot laat bedink om bedrae elders te kry om terug in die SME Bank se rekeninge te betaal.

Só is onder meer die Suid-Afrikaanse Munisipale Pensioenfonds vir N$60 miljoen gemelk.

Pearson het gesê Mumvuma, Kotane en Ramavhunga het in November 2016 dokumente opgestel om aan "allerlei" voor te lê dat N$57 miljoen aan die SME Bank uit 'n sogenaamde "belegging" terugbetaal is, wat die SME Bank by VBS Mutual Bank gehad het.

"In werklikheid het hulle verdere aanspreeklikheid vir die SME Bank geskep, naamlik 'n bedrag van N$60 miljoen wat aan JM Busha Asset Managers verskuldig is," het Pearson gesê.

– catherine@republikein.com.na

Die nou verlate SME Bank. FOTO MARC SPRINGER

Reusepeste slaan toe

Die herfskommandowurm rig gewasse grootskaalse skade aan. FOTO'S FAO

» Noordelike, sentrale gebiede geraak

Kommandowurms, wat boere se weiding en gewasse kan verwoes, het in van die streke kop uitgesteek.

Elvira Hattingh

Die herfskommandowurm het sy opwagting in Namibië se Zambezi-, Oshana- en Oshikotostreek gemaak.

Terselfdertyd het die Afrika-kommandowurm in die Oshana-, Oshikoto- en Omusatistreek uitgebroei.

Die ministerie van landbou, water en bosbou het gister 'n mediaverklaring uitgereik om die uitbreking van die peste te bevestig en voeg by verskeie hektaar grond is reeds geraak.

Intussen sê kommersiële boere in die Mieliedriehoek hulle loop reeds drie weke lank onder die herfskommandowurm deur, terwyl gerugte die ronde doen dat klein groepe van die Afrika-kommandowurm ook in die Outjo- en Otavi-gebied uitgebroei het.

Volgens die ministerie is die herfskommandowurm op 6 Januarie op Sibbinda, Kongola, Ngoma, Bukalo, Itomba, Nsundwa, Kasheshe en Musanga in die Zambezistreek opgemerk.

"Die gewasse is tans in verskillende groeistadiums, van die ontkieming- tot blomstadium, en is uiters kwesbaar vir peste soos die herfs- en Afrika-kommandowurm," het die ministerie se uitvoerende direkteur, mnr. Percy Misika, in die verklaring gesê.

Misika het ook bevestig streke wat pesdoders beskikbaar het, moet met bespuitingsprogramme begin sodat die peste nie verder moet versprei nie.

Intussen het mnr. Klaas Malan, 'n akkerbouer uit Namibië se Mieliedriehoek, bevestig boere in dié omgewing voer drie weke lank al 'n stryd teen die herfskommandowurm.

Hy sê hulle moet voortdurend pesdoders spuit en hy doen dit snags wanneer voordelige insekte soos bye nie rondvlieg nie, sodat hy hulle nie ook doodmaak nie.

Malan sê die herfskommandowurm beskadig mieliekoppe, wat beteken boere kry swakker graderings vir mielies wat hulle wil verkoop.

Die ministerie verduidelik die herfskommandowurm, wat sy oorsprong in Amerika het, is die eerste keer in die 2016-'17-seisoen in Namibië opgemerk.

Boonop het dié pes die ongewone vermoë om vinnig te versprei en is dit 'n uitdaging om dit te beheer omdat dit weerstandig teen verskeie pesdoders is.

Dit volg nadat CropLife SA se dr. Gerhard Verdoorn onlangs gewaarsku het dié twee peste kan in Namibië uitbreek ná Namibiërs onder erge motplae gebuk gegaan het.

Hy en sy kollegas het gesê die motte is moontlik dié van die Afrika-kommandowurm.

Verdoorn het toe gesê weerstoestande is ideaal vir die uitbroei van peste, met die warm tropiese, vogtige lug wat uit Wes-Afrika, die Kongo en Zaïre oor Suider-Afrika beweeg.

"Die Afrika-kommandowurm is 'n baie ernstige pes wat jou veld groot skade kan aanrig. Dit teer hoofsaaklik op weiding en sal soms ook gewasse invaar," het hy gesê.

Hy sê die Afrika-kommandowurm is endemies aan Suider-Afrika, wat beteken dit kom natuurlik hier voor, maar reën en vog veroorsaak dat dit in groot getalle uitbroei.

– elvira@republikein.com.na

Zambezi farmers face fall armyworm outbreak

2019-02-26 John Muyamba

RUNDU - The Ministry of Agriculture, Water and Forestry has confirmed there is an outbreak of fall armyworms in the Zambezi Region after it was reported on February 14 to have attacked crops in various areas – and considering the poor rain prospects this will affect the harvest immensely. According to the ministry the outbreak poses a significant threat to smallholder farmers, mainly maize farmers. and has become a threat to food security.

In the 2016/2017 cropping season approximately 50 000 hectares of maize and millet were estimated to have been damaged by these worms that adversely affected 27 000 households. The fall armyworms were spotted in Sachona, Kongola, Ngoma, Bukalo, Kasheshe and Musanga. "Following these reports the Ministry of Agriculture, Water and Forestry took assessment missions in the affected areas on 18 and 19 February which confirmed that over 100 hectares of farmland are adversely affected by the worms. Crops in these areas are at different growth stages, from vegetative to flowering stage which is highly susceptible to fall armyworms," Margaret Kalo, spokesperson for the agriculture ministry said.

Research shows that the fall armyworms prefer maize, but can also feed on more than 80 additional species of crops, including rice, sorghum, millet, sugarcane, vegetable crops and cotton.

Fall armyworms were initially detected in Central and Western Africa in early 2016 and they quickly spread across virtually all of Sub-Saharan Africa. In July 2018 it was also confirmed in India and Yemen. Because of trade and the moth's strong flying ability, it has the potential to spread further.

Farmers will need great support through integrated pest management to sustainably manage the pest in their cropping systems. The lifespan of the fall armyworm from egg to larva to moth lasts from one to three months, and it is during the larva stage that it creates the most crop damage. Research also shows the moth can fly up to 100 km per night and the female moth can lay up to a total of 1 000 eggs in her lifetime

This reporter has learned on the website of the Food and Agriculture Organization (FAO) of the United Nations that FAO have developed a mobile phone app which can aid farmers to monitor fall armyworms in their crop fields here in Africa and farmers can research it and see how it can assist them.

There are a number of ways to try to manage this pest in maize and other crops, but because it is a new pest to Africa, none of them are guaranteed to be effective and research is going on to develop more effective solutions.

However, there are some cultural and manual practices that can help reduce their effectiveness like the use of intercropping, and crop rotation with non-grass species such as cassava can reduce crop damage.

Handpick and destroy egg masses and larvae, or collect and drop larvae in hot water. Killing one caterpillar prevents the appearance of more than 1500-2000 new caterpillars within less than four weeks, while using good quality seeds can increase plant vigour and potentially reduce damage, farmers are advised.

2019-02-26 John Muyamba

Worms engulf Namibia

Home / Worms engulf Namibia

By Southern Times -- Jan24,2020 -- 0 Comments

Timo Shihepo

Windhoek - After a prolonged period of drought, Namibian farmers have yet another problem to tackle in the form of fall army worms and African army worms which are currently attacking their crops.

The areas most affected by the fall army worms and African army worms outbreak are in the Zambezi, Oshana and Oshikoto regions.

"Following these reports, this confirmed the several hectares of farmland are adversely affected by the worms. The crops in these areas are at different growth stages, from germination, vegetative to flowering stages, which is highly susceptible to fall army worms and African army worms," said Ministry of Agriculture, Water and Forestry executive director, Percy Misika.

The fall army worm is a pervasive agricultural pest native to south and central America that ruthlessly worked its way across the African continent, after arriving in West Africa and hitting Nigeria in 2016.

The agricultural ministry said the worms then made their way to south of the Sahara and into Namibia in 2016/2017 cropping season.

"The fall army worm has spread quickly due to its short reproductive cycle and ability to travel long distance quickly during its adult (moth) stage," said Misika.

The fall army worm's lifespan from egg to larva to moth lasts from one to three months. It is during the larva stage that it creates the most crop damage. The agricultural ministry said that the fall army worm is difficult to control because it reproduces fast and in larger numbers and can migrate long distances, hides within growing leaves and is also resistant to several pesticides.

"Okapuka (worms) is in abundance here. I think we might need to buy seeds and replant again because they are really causing havoc," Kambwali, a farmer in Oshikoto region, told *The Southern Times*.

In an effort to help the farmers, the Ministry of Agriculture, Water and Forestry has directed the regions with pesticides to start the spraying programme with immediate effect in order to contain the pests in areas where they have been reported.

"In addition, all the crop growing regions were directed to intensify awareness campaigns through the local radio service in order to educate farmers on the identification, ecology and control of the pest. The Ministry will continue with surveillance, using pheromone traps in areas which are not yet reported to be affected by the pest to ensure timely control of the fall army worm and African worm outbreak," said Misika.

Appendix B: Cost Guide Figures for Bt Maize and non-GMO maize

Non-GM White Maize Dryland

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	White Maize (GM-free) (Ton)
Maize (White - GM-free) - Dryland	Winter 2023	2023-07-15	5.50

Income					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
White Maize (GM-free)	5.50	Ton	3 420.00	R/ton	R18 810
Gross Production Value					R18 810

Expenses					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (White Maize GM-free)	25 000.00	Kernels/ha	0.05	R/pip	R1 250
Fertiliser - Macro elements	1.00	Ha	4 630.26	R/ha	R4 630
Fertiliser - Micro elements	1.00	Ha	126.50	R/ha	R127
Fuel (Diesel)	63.15	L/ha	19.51	R/l	R1 232
Herbicide	1.00	Ha	699.19	R/ha	R699
Insecticide	1.00	Ha	2 376.94	R/ha	R2 377
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	0.00	R/ha	R0
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	18 810.00	Rand	2.00	%	R376
Harvester Maize - Dryland	1.00	Ha	675.00	R/ha	R675
Transport	5.50	Ton	165.00	R/ton	R908
Mechanization - Repair and Maintenance	1.00	Ha	749.78	R/ha	R750
Safex Hedging Cost	5.50	Ton	3.00	R/ton	R17
Total Direct Cost					R14 851

Interest					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	6 188.04	Rand	12.00	%	R743

Total Production Cost	R15 594
Margin Above Cost	R3 216
Breakeven Yield/Ha	4.56
Breakeven Price/Ton	R2 835

Sensitivity Analysis							
Crop Yield (t/ha)	R3 120	R3 220	R3 320	R3 420	R3 520	R3 620	R3 720
2.50	-R7 794	-R7 544	-R7 294	-R7 044	-R6 794	-R6 544	-R6 294
3.50	-R4 674	-R4 324	-R3 974	-R3 624	-R3 274	-R2 924	-R2 574
4.50	-R1 554	-R1 104	-R654	-R204	R246	R696	R1 146
5.50	R1 566	R2 116	R2 666	R3 216	R3 766	R4 316	R4 866
6.50	R4 686	R5 336	R5 986	R6 636	R7 286	R7 936	R8 586
7.50	R7 806	R8 556	R9 306	R10 056	R10 806	R11 556	R12 306
8.50	R10 926	R11 776	R12 626	R13 476	R14 326	R15 176	R16 026

Fertiliser (Macro Elements)		
N	107.5	Kg/ha
P	21.5	Kg/ha
K	20.0	Kg/ha
Ca	3.4	Kg/ha
Mg	6.3	Kg/ha
S	12.0	Kg/ha

GM White Maize Dryland

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	White Maize (Ton)
Maize (White - GM) - Dryland	Winter 2023	2023-07-15	5.50

Income

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
White Maize	5.50	Ton	3 420.00	R/ton	R18 810
Gross Production Value					**R18 810**

Expenses

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (White maize)	25 000.00	Kernels/ha	0.07	R/pip	R1 750
Fertiliser - Macro elements	1.00	Ha	4 630.26	R/ha	R4 630
Fertiliser - Micro elements	1.00	Ha	126.50	R/ha	R127
Fuel (Diesel)	63.15	L/ha	19.51	R/l	R1 232
Herbicide	1.00	Ha	699.19	R/ha	R699
Insecticide	1.00	Ha	1 802.59	R/ha	R1 803
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	0.00	R/ha	R0
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	18 810.00	Rand	2.00	%	R376
Harvester Maize - Dryland	1.00	Ha	675.00	R/ha	R675
Transport	5.50	Ton	165.00	R/ton	R908
Mechanization - Repair and Maintenance	1.00	Ha	749.78	R/ha	R750
Safex Hedging Cost	5.50	Ton	3.00	R/ton	R17
Total Direct Cost					**R14 777**

Interest

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	6 157.06	Rand	12.00	%	R739

Total Production Cost	R15 516
Margin Above Cost	R3 294
Breakeven Yield/Ha	4.54
Breakeven Price/Ton	R2 821

Sensitivity Analysis

Crop Yield (t/ha)	R3 120	R3 220	R3 320	R3 420	R3 520	R3 620	R3 720
2.50	-R7 716	-R7 466	-R7 216	-R6 966	-R6 716	-R6 466	-R6 216
3.50	-R4 596	-R4 246	-R3 896	-R3 546	-R3 196	-R2 846	-R2 496
4.50	-R1 476	-R1 026	-R576	-R126	R324	R774	R1 224
5.50	R1 644	R2 194	R2 744	R3 294	R3 844	R4 394	R4 944
6.50	R4 764	R5 414	R6 064	R6 714	R7 364	R8 014	R8 664
7.50	R7 884	R8 634	R9 384	R10 134	R10 884	R11 634	R12 384
8.50	R11 004	R11 854	R12 704	R13 554	R14 404	R15 254	R16 104

Fertiliser (Macro Elements)

N	107.5	Kg/ha
P	21.5	Kg/ha
K	20.0	Kg/ha
Ca	3.4	Kg/ha
Mg	6.3	Kg/ha
S	12.0	Kg/ha

Non-GM White Maize Irrigation

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	White Maize (GM-free) (Ton)
Maize (White - GM-free)	Winter 2023	2023-07-15	13.00

Income					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
White Maize (GM-free)	13.00	Ton	3 420.00	R/ton	R44 460
Gross Production Value					R44 460

Expenses					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (White Maize GM-free)	90 000.00	Kernels/ha	0.05	R/pip	R4 500
Fertiliser - Macro elements	1.00	Ha	12 448.02	R/ha	R12 448
Fertiliser - Micro elements	1.00	Ha	1 205.39	R/ha	R1 205
Fuel (Diesel)	69.15	L/ha	19.51	R/l	R1 349
Herbicide	1.00	Ha	909.98	R/ha	R910
Insecticide	1.00	Ha	3 027.79	R/ha	R3 028
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	89.00	R/ha	R89
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	44 460.00	Rand	2.00	%	R889
Harvester Maize	1.00	Ha	1 350.00	R/ha	R1 350
Transport	13.00	Ton	165.00	R/ton	R2 145
Irrigation - Escom	690.00	mm/ha	8.09	R/mm	R5 582
Irrigation - Water Board	690.00	mm/ha	1.99	R/mm	R1 373
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	787.89	R/ha	R788
Pivot Cost - Repair and Maintenance	1.00	Ha	1 133.00	R/ha	R1 133
Safex Hedging Cost	13.00	Ton	3.00	R/ton	R39
Total Direct Cost					R38 754

Interest					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	16 147.49	Rand	12.00	%	R1 938

Total Production Cost							R40 692
Margin Above Cost							R3 768
Breakeven Yield/Ha							11.90
Breakeven Price/Ton							R3 130
Sensitivity Analysis							
Crop Yield (t/ha)	R3 120	R3 220	R3 320	R3 420	R3 520	R3 620	R3 720
10.00	-R9 492	-R8 492	-R7 492	-R6 492	-R5 492	-R4 492	-R3 492
11.00	-R6 372	-R5 272	-R4 172	-R3 072	-R1 972	-R872	R228
12.00	-R3 252	-R2 052	-R852	R348	R1 548	R2 748	R3 948
13.00	-R132	R1 168	R2 468	R3 768	R5 068	R6 368	R7 668
14.00	R2 988	R4 388	R5 788	R7 188	R8 588	R9 988	R11 388
15.00	R6 108	R7 608	R9 108	R10 608	R12 108	R13 608	R15 108
16.00	R9 228	R10 828	R12 428	R14 028	R15 628	R17 228	R18 828

Fertiliser (Macro Elements)		
N	286.0	Kg/ha
P	52.0	Kg/ha
K	80.0	Kg/ha
Ca	10.0	Kg/ha
Mg	10.0	Kg/ha
S	25.0	Kg/ha

GM White Maize Irrigation

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	White Maize (Ton)
Maize (White - GM)	Winter 2023	2023-07-15	13.00

Income					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
White Maize	13.00	Ton	3 420.00	R/ton	R44 460
Gross Production Value					R44 460

Expenses					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (White maize)	90 000.00	Kernels/ha	0.07	R/pip	R6 300
Fertiliser - Macro elements	1.00	Ha	12 448.02	R/ha	R12 448
Fertiliser - Micro elements	1.00	Ha	1 205.39	R/ha	R1 205
Fuel (Diesel)	69.15	L/ha	19.51	R/l	R1 349
Herbicide	1.00	Ha	909.98	R/ha	R910
Insecticide	1.00	Ha	2 453.44	R/ha	R2 453
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	89.00	R/ha	R89
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	44 460.00	Rand	2.00	%	R889
Harvester Maize	1.00	Ha	1 350.00	R/ha	R1 350
Transport	13.00	Ton	165.00	R/ton	R2 145
Irrigation - Escom	690.00	mm/ha	8.09	R/mm	R5 582
Irrigation - Water Board	690.00	mm/ha	1.99	R/mm	R1 373
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	787.89	R/ha	R788
Pivot Cost - Repair and Maintenance	1.00	Ha	1 133.00	R/ha	R1 133
Safex Hedging Cost	13.00	Ton	3.00	R/ton	R39
Total Direct Cost					R39 980

Interest					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	16 658.17	Rand	12.00	%	R1 999

Total Production Cost	R41 979
Margin Above Cost	R2 481
Breakeven Yield/Ha	12.27
Breakeven Price/Ton	R3 229

Sensitivity Analysis							
Crop Yield (t/ha)	R3 120	R3 220	R3 320	R3 420	R3 520	R3 620	R3 720
10.00	-R10 779	-R9 779	-R8 779	-R7 779	-R6 779	-R5 779	-R4 779
11.00	-R7 659	-R6 559	-R5 459	-R4 359	-R3 259	-R2 159	-R1 059
12.00	-R4 539	-R3 339	-R2 139	-R939	R261	R1 461	R2 661
13.00	-R1 419	-R119	R1 181	R2 481	R3 781	R5 081	R6 381
14.00	R1 701	R3 101	R4 501	R5 901	R7 301	R8 701	R10 101
15.00	R4 821	R6 321	R7 821	R9 321	R10 821	R12 321	R13 821
16.00	R7 941	R9 541	R11 141	R12 741	R14 341	R15 941	R17 541

Fertiliser (Macro Elements)		
N	286.0	Kg/ha
P	52.0	Kg/ha
K	80.0	Kg/ha
Ca	10.0	Kg/ha
Mg	10.0	Kg/ha
S	25.0	Kg/ha

Non-GM Yellow Maize Dryland

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Maize (BT-free) - Dryland (Ton)
Maize (Yellow - GM-free) - Dryland	Winter 2023	2023-07-15	5.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Maize (BT-free) - Dryland	5.50	Ton	3 450.00	R/ton	R18 975
Gross Production Value					**R18 975**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Maize BT-free)	25 000.00	Kernels/ha	0.05	R/pip	R1 250
Fertiliser - Macro elements	1.00	Ha	4 630.26	R/ha	R4 630
Fertiliser - Micro elements	1.00	Ha	126.50	R/ha	R127
Fuel (Diesel)	63.15	L/ha	19.51	R/l	R1 232
Herbicide	1.00	Ha	699.19	R/ha	R699
Insecticide	1.00	Ha	2 376.94	R/ha	R2 377
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	0.00	R/ha	R0
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	18 975.00	Rand	2.00	%	R380
Harvester Maize - Dryland	1.00	Ha	675.00	R/ha	R675
Transport	5.50	Ton	165.00	R/ton	R908
Mechanization - Repair and Maintenance	1.00	Ha	749.78	R/ha	R750
Safex Hedging Cost	5.50	Ton	3.00	R/ton	R17
Total Direct Cost					**R14 855**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	6 189.42	Rand	12.00	%	R743

Total Production Cost	R15 597
Margin Above Cost	R3 378
Breakeven Yield/Ha	4.52
Breakeven Price/Ton	R2 836

Sensitivity Analysis

Crop Yield (t/ha)	R3 150	R3 250	R3 350	R3 450	R3 550	R3 650	R3 750
2.50	-R7 722	-R7 472	-R7 222	-R6 972	-R6 722	-R6 472	-R6 222
3.50	-R4 572	-R4 222	-R3 872	-R3 522	-R3 172	-R2 822	-R2 472
4.50	-R1 422	-R972	-R522	-R72	R378	R828	R1 278
5.50	R1 728	R2 278	R2 828	R3 378	R3 928	R4 478	R5 028
6.50	R4 878	R5 528	R6 178	R6 828	R7 478	R8 128	R8 778
7.50	R8 028	R8 778	R9 528	R10 278	R11 028	R11 778	R12 528
8.50	R11 178	R12 028	R12 878	R13 728	R14 578	R15 428	R16 278

Fertiliser (Macro Elements)		
N	107.5	Kg/ha
P	21.5	Kg/ha
K	20.0	Kg/ha
Ca	3.4	Kg/ha
Mg	6.3	Kg/ha
S	12.0	Kg/ha

GM Yellow Maize Dryland

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Maize (BT) - Dryland (Ton)
Maize (Yellow - GM) - Dryland	Winter 2023	2023-07-15	5.50

Income					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Maize (BT) - Dryland	5.50	Ton	3 450.00	R/ton	R18 975
Gross Production Value					R18 975

Expenses					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (Maize BT)	25 000.00	Kernels/ha	0.07	R/pip	R1 750
Fertiliser - Macro elements	1.00	Ha	4 630.26	R/ha	R4 630
Fertiliser - Micro elements	1.00	Ha	126.50	R/ha	R127
Fuel (Diesel)	63.15	L/ha	19.51	R/l	R1 232
Herbicide	1.00	Ha	699.19	R/ha	R699
Insecticide	1.00	Ha	1 802.59	R/ha	R1 803
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	0.00	R/ha	R0
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	18 975.00	Rand	2.00	%	R380
Harvester Maize - Dryland	1.00	Ha	675.00	R/ha	R675
Transport	5.50	Ton	165.00	R/ton	R908
Mechanization - Repair and Maintenance	1.00	Ha	749.78	R/ha	R750
Safex Hedging Cost	5.50	Ton	3.00	R/ton	R17
Total Direct Cost					R14 780

Interest					
Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	6 158.44	Rand	12.00	%	R739

Total Production Cost							R15 519
Margin Above Cost							R3 456
Breakeven Yield/Ha							4.50
Breakeven Price/Ton							R2 822
Sensitivity Analysis							
Crop Yield (t/ha)	R3 150	R3 250	R3 350	R3 450	R3 550	R3 650	R3 750
2.50	-R7 644	-R7 394	-R7 144	-R6 894	-R6 644	-R6 394	-R6 144
3.50	-R4 494	-R4 144	-R3 794	-R3 444	-R3 094	-R2 744	-R2 394
4.50	-R1 344	-R894	-R444	R6	R456	R906	R1 356
5.50	R1 806	R2 356	R2 906	R3 456	R4 006	R4 556	R5 106
6.50	R4 956	R5 606	R6 256	R6 906	R7 556	R8 206	R8 856
7.50	R8 106	R8 856	R9 606	R10 356	R11 106	R11 856	R12 606
8.50	R11 256	R12 106	R12 956	R13 806	R14 656	R15 506	R16 356

Fertiliser (Macro Elements)		
N	107.5	Kg/ha
P	21.5	Kg/ha
K	20.0	Kg/ha
Ca	3.4	Kg/ha
Mg	6.3	Kg/ha
S	12.0	Kg/ha

Non-GM Yellow Maize Irrigation

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Maize (BT-free) (Ton)
Maize (Yellow - GM-free)	Winter 2023	2023-07-15	13.00

Income

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Maize (BT-free)	13.00	Ton	3 450.00	R/ton	R44 850
Gross Production Value					R44 850

Expenses

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Seed (Maize BT-free)	90 000.00	Kernels/ha	0.05	R/pip	R4 500
Fertiliser - Macro elements	1.00	Ha	12 448.02	R/ha	R12 448
Fertiliser - Micro elements	1.00	Ha	1 205.39	R/ha	R1 205
Fuel (Diesel)	69.15	L/ha	19.51	R/l	R1 349
Herbicide	1.00	Ha	909.98	R/ha	R910
Insecticide	1.00	Ha	3 027.79	R/ha	R3 028
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	89.00	R/ha	R89
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	44 850.00	Rand	2.00	%	R897
Harvester Maize	1.00	Ha	1 350.00	R/ha	R1 350
Transport	13.00	Ton	165.00	R/ton	R2 145
Irrigation - Escom	690.00	mm/ha	8.09	R/mm	R5 582
Irrigation - Water Board	690.00	mm/ha	1.99	R/mm	R1 373
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	787.89	R/ha	R788
Pivot Cost - Repair and Maintenance	1.00	Ha	1 133.00	R/ha	R1 133
Safex Hedging Cost	13.00	Ton	3.00	R/ton	R39
Total Direct Cost					R38 762

Interest

Product Name	Product Quantity	Measure Unit	Price	Measure Unit	Product Cost
Interest	16 150.74	Rand	12.00	%	R1 938

Total Production Cost	R40 700
Margin Above Cost	R4 150
Breakeven Yield/Ha	11.80
Breakeven Price/Ton	R3 131

Sensitivity Analysis

Crop Yield (t/ha)	R3 150	R3 250	R3 350	R3 450	R3 550	R3 650	R3 750
10.00	-R9 200	-R8 200	-R7 200	-R6 200	-R5 200	-R4 200	-R3 200
11.00	-R6 050	-R4 950	-R3 850	-R2 750	-R1 650	-R550	R550
12.00	-R2 900	-R1 700	-R500	R700	R1 900	R3 100	R4 300
13.00	R250	R1 550	R2 850	R4 150	R5 450	R6 750	R8 050
14.00	R3 400	R4 800	R6 200	R7 600	R9 000	R10 400	R11 800
15.00	R6 550	R8 050	R9 550	R11 050	R12 550	R14 050	R15 550
16.00	R9 700	R11 300	R12 900	R14 500	R16 100	R17 700	R19 300

Fertiliser (Macro Elements)

N	286.0	Kg/ha
P	52.0	Kg/ha
K	80.0	Kg/ha
Ca	10.0	Kg/ha
Mg	10.0	Kg/ha
S	25.0	Kg/ha

GM Yellow Maize Irrigation

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Maize (BT) (Ton)
Maize (Yellow - GM)	Winter 2023	2023-07-15	13.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Maize (BT)	13.50	Ton	3 450.00	R/ton	R46 575
Gross Production Value					**R46 575**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Maize BT)	90 000.00	Kernels/ha	0.07	R/pip	R6 300
Fertiliser - Macro elements	1.00	Ha	12 449.69	R/ha	R12 450
Fertiliser - Micro elements	1.00	Ha	1 205.39	R/ha	R1 205
Fuel (Diesel)	69.15	L/ha	19.51	R/l	R1 349
Herbicide	1.00	Ha	909.98	R/ha	R910
Insecticide	1.00	Ha	2 453.44	R/ha	R2 453
Fungicide	1.00	Ha	1 291.34	R/ha	R1 291
Other Chemicals	1.00	Ha	89.00	R/ha	R89
Aeroplane	2.00	Applications	260.00	R/ha	R520
Insurance - Maize	46 575.00	Rand	2.00	%	R932
Harvester Maize	1.00	Ha	1 350.00	R/ha	R1 350
Transport	13.50	Ton	165.00	R/ton	R2 228
Irrigation - Escom	690.00	mm/ha	8.09	R/mm	R5 582
Irrigation - Water Board	690.00	mm/ha	1.99	R/mm	R1 373
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	787.89	R/ha	R788
Pivot Cost - Repair and Maintenance	1.00	Ha	1 133.00	R/ha	R1 133
Safex Hedging Cost	13.50	Ton	3.00	R/ton	R41
Total Direct Cost					**R40 108**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	16 711.50	Rand	12.00	%	R2 005

Total Production Cost	**R42 113**
Margin Above Cost	**R4 462**
Breakeven Yield/Ha	12.21
Breakeven Price/Ton	R3 119

Sensitivity Analysis							
Crop Yield (t/ha)	R3 150	R3 250	R3 350	R3 450	R3 550	R3 650	R3 750
10.50	-R9 038	-R7 988	-R6 938	-R5 888	-R4 838	-R3 788	-R2 738
11.50	-R5 888	-R4 738	-R3 588	-R2 438	-R1 288	-R138	R1 012
12.50	-R2 738	-R1 488	-R238	R1 012	R2 262	R3 512	R4 762
13.50	R412	R1 762	R3 112	R4 462	R5 812	R7 162	R8 512
14.50	R3 562	R5 012	R6 462	R7 912	R9 362	R10 812	R12 262
15.50	R6 712	R8 262	R9 812	R11 362	R12 912	R14 462	R16 012
16.50	R9 862	R11 512	R13 162	R14 812	R16 462	R18 112	R19 762

Fertiliser (Macro Elements)		
N	286.1	Kg/ha
P	52.0	Kg/ha
K	80.1	Kg/ha
Ca	10.0	Kg/ha
Mg	10.0	Kg/ha
S	25.0	Kg/ha

Appendix C: Cost Guide Figures for GM Cotton: Dry-land vs. Irrigated

GM Cotton Dry-land – Summer

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Cotton - Dryland (Ton)
Cotton - Dryland	Summer 2022/23	2022-10-15	1.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Cotton - Dryland	1.50	Ton	11 870.00	R/ton	R17 805
Gross Production Value					**R17 805**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Cotton)	5.00	Kg/ha	138.07	R/kg	R690
Fertiliser - Macro elements	1.00	Ha	2 669.25	R/ha	R2 669
Fertiliser - Micro elements	1.00	Ha	344.45	R/ha	R344
Fuel (Diesel)	69.59	L/ha	23.62	R/l	R1 644
Diesel (Picker)	10.00	L/ha	23.62	R/l	R236
Herbicide	1.00	Ha	528.00	R/ha	R528
Insecticide	1.00	Ha	755.40	R/ha	R755
Fungicide	1.00	Ha	0.00	R/ha	R0
Other Chemicals	1.00	Ha	248.50	R/ha	R249
High Boy sprayer	6.00	Applications	200.00	R/ha	R1 200
Insurance - Cotton	17 805.00	Rand	9.00	%	R1 602
Cotton picker - Dryland	1.00	Ha	3 750.00	R/ha	R3 750
Packaging - Plastic (Cotton)	0.65	Bales	680.00	R/bale	R439
Transport Cotton	1.50	Ton	310.00	R/ton	R465
Mechanization - Repair and Maintenance	1.00	Ha	1 293.71	R/ha	R1 294
Marketing Cost Cotton - statutorily & Nakpo	1.50	Ton	110.00	R/ton	R165
Total Direct Cost					**R16 031**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	6 679.43	Rand	11.00	%	R735

Total Production Cost							**R16 765**
Margin Above Cost							**R1 040**
Breakeven Yield/Ha							1.41
Breakeven Price/Ton							R11 177
Sensitivity Analysis							
Crop Yield (t/ha)	R11 120	R11 370	R11 620	R11 870	R12 120	R12 370	R12 620
0.75	-R8 425	-R8 238	-R8 050	-R7 863	-R7 675	-R7 488	-R7 300
1.00	-R5 645	-R5 395	-R5 145	-R4 895	-R4 645	-R4 395	-R4 145
1.25	-R2 865	-R2 553	-R2 240	-R1 928	-R1 615	-R1 303	-R990
1.50	-R85	R290	R665	R1 040	R1 415	R1 790	R2 165
1.75	R2 695	R3 132	R3 570	R4 007	R4 445	R4 882	R5 320
2.00	R5 475	R5 975	R6 475	R6 975	R7 475	R7 975	R8 475
2.25	R8 255	R8 817	R9 380	R9 942	R10 505	R11 067	R11 630

Fertiliser (Macro Elements)		
N	31.0	Kg/ha
P	12.0	Kg/ha
K	16.0	Kg/ha
Ca	0.0	Kg/ha
Mg	0.0	Kg/ha
S	2.3	Kg/ha

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GM Cotton Dry-land -Winter

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Cotton - Dryland (Ton)
Cotton - Dryland	Winter 2023	2023-04-15	1.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Cotton - Dryland	1.50	Ton	11 950.00	R/ton	R17 925
Gross Production Value					**R17 925**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Cotton)	5.00	Kg/ha	138.07	R/kg	R690
Fertiliser - Macro elements	1.00	Ha	2 172.63	R/ha	R2 173
Fertiliser - Micro elements	1.00	Ha	323.23	R/ha	R323
Fuel (Diesel)	69.59	L/ha	20.81	R/l	R1 448
Diesel (Picker)	10.00	L/ha	20.81	R/l	R208
Herbicide	1.00	Ha	528.00	R/ha	R528
Insecticide	1.00	Ha	755.40	R/ha	R755
Fungicide	1.00	Ha	0.00	R/ha	R0
Other Chemicals	1.00	Ha	248.50	R/ha	R249
High Boy sprayer	6.00	Applications	200.00	R/ha	R1 200
Insurance - Cotton	17 925.00	Rand	11.00	%	R1 972
Cotton picker - Dryland	1.00	Ha	2 125.00	R/ha	R2 125
Packaging - Plastic (Cotton)	0.65	Bales	680.00	R/bale	R439
Transport Cotton	1.50	Ton	290.00	R/ton	R435
Mechanization - Repair and Maintenance	1.00	Ha	1 404.08	R/ha	R1 404
Marketing Cost Cotton - statutorily & Nakpo	1.50	Ton	110.00	R/ton	R165
Total Direct Cost					**R14 114**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	5 880.76	Rand	12.00	%	R706

Total Production Cost	R14 820
Margin Above Cost	R3 105
Breakeven Yield/Ha	1.24
Breakeven Price/Ton	R9 880

Sensitivity Analysis							
Crop Yield (t/ha)	R11 200	R11 450	R11 700	R11 950	R12 200	R12 450	R12 700
0.75	-R6 420	-R6 232	-R6 045	-R5 857	-R5 670	-R5 482	-R5 295
1.00	-R3 620	-R3 370	-R3 120	-R2 870	-R2 620	-R2 370	-R2 120
1.25	-R820	-R507	-R195	R118	R430	R743	R1 055
1.50	R1 980	R2 355	R2 730	R3 105	R3 480	R3 855	R4 230
1.75	R4 780	R5 218	R5 655	R6 093	R6 530	R6 968	R7 405
2.00	R7 580	R8 080	R8 580	R9 080	R9 580	R10 080	R10 580
2.25	R10 380	R10 943	R11 505	R12 068	R12 630	R13 193	R13 755

Fertiliser (Macro Elements)		
N	31.0	Kg/ha
P	12.0	Kg/ha
K	16.0	Kg/ha
Ca	0.0	Kg/ha
Mg	0.0	Kg/ha
S	2.3	Kg/ha

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GM Cotton Irrigated - Summer

Cost Guide Figures

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Sub Crop	Publications	Pricing Date	Cotton (Ton)
Cotton	Summer 2022/23	2022-10-15	5.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Cotton	5.50	Ton	11 870.00	R/ton	R65 285
Gross Production Value					**R65 285**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Cotton)	12.00	Kg/ha	138.07	R/kg	R1 657
Fertiliser - Macro elements	1.00	Ha	16 512.36	R/ha	R16 512
Fertiliser - Micro elements	1.00	Ha	785.90	R/ha	R786
Fuel (Diesel)	72.43	L/ha	23.62	R/l	R1 711
Diesel (Picker)	40.00	L/ha	23.62	R/l	R945
Herbicide	1.00	Ha	528.00	R/ha	R528
Insecticide	1.00	Ha	4 157.40	R/ha	R4 157
Fungicide	1.00	Ha	0.00	R/ha	R0
Other Chemicals	1.00	Ha	1 468.25	R/ha	R1 468
High Boy sprayer	6.00	Applications	200.00	R/ha	R1 200
Insurance - Cotton	65 285.00	Rand	9.00	%	R5 876
Cotton picker	1.00	Ha	4 500.00	R/ha	R4 500
Packaging - Plastic (Cotton)	2.37	Bales	680.00	R/bale	R1 608
Transport Cotton	5.50	Ton	310.00	R/ton	R1 705
Irrigation - Escom	800.00	mm/ha	6.82	R/mm	R5 456
Irrigation - Water Board	800.00	mm/ha	1.91	R/mm	R1 528
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	1 284.69	R/ha	R1 285
Pivot Cost - Repair and Maintenance	1.00	Ha	771.00	R/ha	R771
Marketing Cost Cotton - statutorily & Nakpo	5.50	Ton	110.00	R/ton	R605
Total Direct Cost					**R52 412**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	26 205.93	Rand	11.00	%	R2 883

Total Production Cost	R55 295
Margin Above Cost	R9 990
Breakeven Yield/Ha	4.66
Breakeven Price/Ton	R10 054

Sensitivity Analysis

Crop Yield (t/ha)	R11 120	R11 370	R11 620	R11 870	R12 120	R12 370	R12 620
4.00	-R10 815	-R9 815	-R8 815	-R7 815	-R6 815	-R5 815	-R4 815
4.50	-R5 255	-R4 130	-R3 005	-R1 880	-R755	R370	R1 495
5.00	R305	R1 555	R2 805	R4 055	R5 305	R6 555	R7 805
5.50	R5 865	R7 240	R8 615	R9 990	R11 365	R12 740	R14 115
6.00	R11 425	R12 925	R14 425	R15 925	R17 425	R18 925	R20 425
6.50	R16 985	R18 610	R20 235	R21 860	R23 485	R25 110	R26 735
7.00	R22 545	R24 295	R26 045	R27 795	R29 545	R31 295	R33 045

Fertiliser (Macro Elements)		
N	180.0	Kg/ha
P	50.0	Kg/ha
K	110.0	Kg/ha
Ca	18.0	Kg/ha
Mg	15.0	Kg/ha
S	24.0	Kg/ha

Page 1 of 1

GM Cotton Irrigated Winter

Cost Guide Figures

profarmer

Sub Crop	Publications	Pricing Date	Cotton (Ton)
Cotton	Winter 2023	2023-04-15	5.50

Income					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Cotton	5.50	Ton	11 950.00	R/ton	R65 725
Gross Production Value					**R65 725**

Expenses					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Seed (Cotton)	12.00	Kg/ha	138.07	R/kg	R1 657
Fertiliser - Macro elements	1.00	Ha	13 527.69	R/ha	R13 528
Fertiliser - Micro elements	1.00	Ha	765.78	R/ha	R766
Fuel (Diesel)	72.43	L/ha	20.81	R/l	R1 507
Diesel (Picker)	40.00	L/ha	20.81	R/l	R832
Herbicide	1.00	Ha	528.00	R/ha	R528
Insecticide	1.00	Ha	4 157.40	R/ha	R4 157
Fungicide	1.00	Ha	0.00	R/ha	R0
Other Chemicals	1.00	Ha	1 468.25	R/ha	R1 468
High Boy sprayer	6.00	Applications	200.00	R/ha	R1 200
Insurance - Cotton	65 725.00	Rand	11.00	%	R7 230
Cotton picker	1.00	Ha	4 250.00	R/ha	R4 250
Packaging - Plastic (Cotton)	2.37	Bales	680.00	R/bale	R1 608
Transport Cotton	5.50	Ton	290.00	R/ton	R1 595
Irrigation - Escom	800.00	mm/ha	8.09	R/mm	R6 472
Irrigation - Water Board	800.00	mm/ha	1.93	R/mm	R1 544
Irrigation - Scheduling	1.00	Ha	114.00	R/ha	R114
Mechanization - Repair and Maintenance	1.00	Ha	1 392.95	R/ha	R1 393
Pivot Cost - Repair and Maintenance	1.00	Ha	1 133.00	R/ha	R1 133
Marketing Cost Cotton - statutorily & Nakpo	5.50	Ton	110.00	R/ton	R605
Total Direct Cost					**R51 588**

Interest					
Product Name	**Product Quantity**	**Measure Unit**	**Price**	**Measure Unit**	**Product Cost**
Interest	25 793.75	Rand	12.00	%	R3 095

Total Production Cost	R54 683
Margin Above Cost	R11 042
Breakeven Yield/Ha	4.58
Breakeven Price/Ton	R9 942

Sensitivity Analysis

Crop Yield (t/ha)	R11 200	R11 450	R11 700	R11 950	R12 200	R12 450	R12 700
4.00	-R9 883	-R8 883	-R7 883	-R6 883	-R5 883	-R4 883	-R3 883
4.50	-R4 283	-R3 158	-R2 033	-R908	R217	R1 342	R2 467
5.00	R1 317	R2 567	R3 817	R5 067	R6 317	R7 567	R8 817
5.50	R6 917	R8 292	R9 667	R11 042	R12 417	R13 792	R15 167
6.00	R12 517	R14 017	R15 517	R17 017	R18 517	R20 017	R21 517
6.50	R18 117	R19 742	R21 367	R22 992	R24 617	R26 242	R27 867
7.00	R23 717	R25 467	R27 217	R28 967	R30 717	R32 467	R34 217

Fertiliser (Macro Elements)		
N	180.0	Kg/ha
P	50.0	Kg/ha
K	110.0	Kg/ha
Ca	18.0	Kg/ha
Mg	15.0	Kg/ha
S	24.0	Kg/ha

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Appendix D: Consultant's Curriculum Vitae

ENVIRONMENTAL SCIENTIST **André Faul**

André entered the environmental assessment profession at the beginning of 2013 and since then has worked on more than 2300 Environmental Impact Assessments including assessments of the petroleum industry, harbour expansions, irrigation schemes, township establishment and power generation and transmission. André's post graduate studies focussed on zoological and ecological sciences and he holds a M.Sc. in Conservation Ecology and a Ph.D. in Medical Bioscience. His expertise is in ecotoxicological related studies focussing specifically on endocrine disrupting chemicals. His Ph.D. thesis title was The Assessment of Namibian Water Resources for Endocrine Disruptors. Before joining the environmental assessment profession he worked for 12 years in the Environmental Section of the Department of Biological Sciences at the University of Namibia, first as laboratory technician and then as lecturer in biological and ecological sciences.

CURRICULUM VITAE ANDRÉ FAUL

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	ANDRÉ FAUL
Profession	:	Environmental Scientist
Years' Experience	:	23
Nationality	:	Namibian
Position	:	Environmental Scientist
Specialisation	:	Environmental Toxicology
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Zoology/Biochemistry	:	University of Stellenbosch, 1999
B.Sc. (Hons.) Zoology	:	University of Stellenbosch, 2000
M.Sc. (Conservation Ecology)	:	University of Stellenbosch, 2005
Ph.D. (Medical Bioscience)	:	University of the Western Cape, 2018

First Aid Class A	EMTSS, 2017; OSH-Med 2022
Basic Fire Fighting	EMTSS, 2017; OSH-Med 2022

PROFESSIONAL SOCIETY AFFILIATION:
Environmental Assessment Professionals of Namibia (Practitioner)

AREAS OF EXPERTISE:
Knowledge and expertise in:
- Water Sampling, Extractions and Analysis
- Biomonitoring and Bioassays
- Biodiversity Assessment
- Toxicology
- Restoration Ecology

EMPLOYMENT:

2013-Date	:	Geo Pollution Technologies – Environmental Scientist
2005-2012	:	Lecturer, University of Namibia
2001-2004	:	Laboratory Technician, University of Namibia

PUBLICATIONS:

Publications:	5
Contract Reports	+230
Research Reports & Manuals:	5
Conference Presentations:	1

Appendix D: Tree Information

Trees recorded in quarter degree squares 1917BC (Curtis & Mannheimer, 2005)

Name	**Common Name**	**Notes**
Acacia ataxacantha	Flame-thorn	
Acacia erioloba	Camel-thorn	Protected by forestry legislation.
Acacia fleckii	Sand-veld Acacia	
Acacia hebeclada subsp hebeclada	Candle-pod Acacia	
Acacia hereroensis	Mountain-thorn	
Acacia luederitzii var luederitzii	Kalahari Acacia	
Acacia mellifera subsp detinens	Blue-thorn Acacia	Aggressive invasive.
Acacia nilotica subsp kraussiana	Scented-pod Acacia	
Acacia reficiens subsp reficiens	Red-thorn	Very aggressive invader.
Acacia tortilis	Umbrella Thorn	
Acacia tortilis subsp heteracantha	Umbrella-thorn	
Acacia tortilis subsp spirocarpa	Umbrella-thorn	
Albizia anthelmintica	Worm-cure Albizia; Aru	The low numbers of young trees recorded are a concern, as is the number of dead trees in some areas. It is Protected by forestry legislation.
Bauhinia petersiana subsp macrantha	White Bauhinia	
Berchemia discolor	Bird Plum	Protected by forestry legislation, as well as by traditional Owambo cultures for its fruit and shade. The population does not appear to be in any real danger at the moment, but communities could be encouraged to plant this species.
Boscia albitrunca	Shepherd's Tree	Although widespread and hardy, it is heavily utilised by people and animals. The difficulty that young plants have in becoming established is a concern, but fortunately there appears to be a healthy and widespread population of young plants. Protected by forestry legislation.
Burkea africana	Burkea	Excessive fire may be compromising recruitment by destroying seeds. Overharvesting for timber may also be of concern in future. Protected by forestry legislation.
Caesalpinia rubra	Purple Caesalpinia	

Catophractes alexandri	Trumpet-thorn; Rattlepod	Invasive in some areas.
Cissus nymphaeifolia	Wild Grape	
Combretum apiculatum subsp apiculatum	Kudu-bush	
Combretum apiculatum subsp leutweinii	None	
Combretum hereroense subsp hereroense	Mouse-eared Combretum	
Combretum imberbe	Leadwood	Although heavily utilized by people, regrowth is good and growth of young trees is vigorous. Because of its religious importance and many uses, it is protected locally. Old specimens warrant protection as monuments. Protected by forestry legislation.
Combretum psidioides	Peeling-twig Combretum	
Combretum zeyheri	Large-fruited Combretum	
Commiphora africana	Hairy Corkwood; Poison-grub Commiphora	
Commiphora angolensis	Sand Corkwood	
Commiphora glandulosa	Tall Common Corkwood; Tall firethorn Corkwood	
Commiphora glaucescens	Blue-leaved Corkwood	
Commiphora pyracanthoides	Fire Thorn Corkwood; Small Common Corkwood	
Commiphora tenuipetiolata	Satin-bark Corkwood	
Croton gratissimus	Lavender Croton; Lavender fever berry	
Croton gratissimus var gratissimus	Lavender Croton	
Croton gratissimus var subgratissimus	None	
Croton menyhartii	Rough-leaved Croton	

Cyphostemma juttae	Blue Kobas, Namibian grape, Wild grape	Endemic with very small population and threatened with pachycaul trade. Least concern according to IUCN criteria. Protected by Nature Conservation Ordinance. Protected by forestry legislation.
Dichrostachys cinerea subsp africana	Kalahari Christmas Tree; Sickle-bush	Of concern because of its effects on other species (invasive).
Distephanus divaricatus	Golden Bitter-tea	
Dombeya rotundifolia	Wild Pear	Two varieties rotundifolia and velutina. Velutina is endemic and classified as least concern.
Ehretia alba	White-puzzle Bush	
Ehretia namibiensis s namibensis	Namibian Puzzle-bush	
Elephantorrhiza schinziana	Otavi Elephant-root	Endemic and rare with restricted distribution. Worthy of conservation.
Elephantorrhiza suffruticosa	Skew-leaved Elephant Root	
Erythrina decora	Namib Coral-tree	Endemic to Namibia and very uncommon throughout its range. Worthy of Protection. Very few young trees. Protected by forestry legislation.
Euclea undulata var myrtina	Common Guarri; Mountain Ebony	
Euphorbia guerichiana	Paper-bark Euphorbia	CITES Appendix II.
Euphorbia monteroi subsp monterio	None	
Ficus cordata subsp cordata	Namaqua Rock-fig	Protected by forestry legislation.
Ficus ingens	Red-leaved Fig	Only 2 records.
Ficus thonningii	Common wild Fig; Stranglerfig	
Flueggea virosa subsp virosa	White-berry Bush	
Fockea multiflora	Python Vine	
Gomphocarpus tomentosus	None	
Grewia bicolor var bicolor	Two-coloured Raisin-bush	
Grewia flava	Velvet Raisin	

Grewia flavescens	Sandpaper Raisin	
Grewia schinzii	Shaggy Raisin; Rusty-haired Raisin	
Grewia subspathulata	Mupundukaina	
Grewia villosa var villosa	Mallow Raisin	
Gymnosporia senegalensis	Confetti Spikethorn	
Gyrocarpus americanus	Propeller Tree	
Heteromorpha stenophylla	Karstveld Wild-parsley	
Hibiscus caesius var caesius	River Hibiscus	
Hibiscus calyphyllus	Wild stock-rose; Large Yellow Hibiscus	
Hibiscus dongolensis	Dongola Hibuscus	
Ipomoea verbascoidea	None	
Kirkia acuminata	Common Kirkia	
Lannea discolor	Live-long	Protected by forestry legislation.
Lantana rugosa	None	
Montinia caryophyllacea	Wild Clove-bush	
Moringa ovalifolia	Moringa; Phantom Tree	Potentially threatened by pachycaul trade. Damaged by elephants in Etosha National Park. Protected by Nature Conservation Ordinance. Near endemic to Namibia extending into southern Angola. Protected by forestry legislation.
Mundulea sericea	Silverbush	
Obetia carruthersiana	Angola Nettle	
Ochna pulchra	Peeling-bark Ochna	
Opilia campestris var campestris	None	
Osyris lanceolata-quadripartita	African sandalwood	
Otoptera burchellii	None	
Ozoroa crassinervia	Namibian Resin-tree	Near-endemic stretching into the Richtersveld.
Ozoroa insignis	Africa Resin-tree	

Ozoroa paniculosa	Common Resin-bush	
Pachypodium lealii	Bottle Tree	Vulnerable to pachycaul trade. Lack of young trees is a concern. Protected by nature conservation ordinance. Listed on CITES Appendix II. Near-endemic extending into extreme southern areas of Angola. Protected by forestry legislation.
Pavetta zeyheri	Small-leaved Bride's-bush	May be declining.
Peltophorum africanum	Muparara	
Philenoptera nelsii subsp nelsii	Kalahari Omupanda; Kalahari Apple-leaf	
Rhigozum brevispinosum	Simple-leaved Rhigozum	
Searsia ciliata	Sour Karee	
Searsia lancea	Willow Rhus	May be affected by a disease. Protected by forestry legislation. Previously Rhus lancea.
Searsia marlothii	Bitter Karee	
Searsia pyroides var dinteri	None	
Searsia tenuinervis var tenuinervis	Kalahari Currant	
Sclerocarya birrea	Marula	Protected locally by communities that use them. Protected by forestry legislation.
Securidaca longepedunculata	Violet-tree	
Spirostachys africana	Tamboti	Protected by forestry legislation.
Steganotaenia araliacea var araliacea	Carrot-tree	
Tarchonanthus camphoratus	Camphor Bush	
Terminalia prunioides	Purple-pod Terminalia	
Terminalia sericea	Silver Cluster-leave	
Tetradenia riparia	River Ginger-bush; Wild Ginger	
Tetragonia schenkii	None	
Tinnea rhodesiana	Maroon Bells	May be overlooked.

Tylosema esculentum	Gemsbok bean; Marama bean; Moroma bean	
Vangueria infausta subsp infausta	Velvet Wild-medlar	
Vangueriopsis lanciflora	False-medlar	Rare in Namibia.
Ximenia americana var microphylla	Blue Sourplum	
Ximenia caffra var caffra	Large Sourplum	
Ziziphus mucronata	Buffalo-thorn	Protected by forestry legislation.

Appendix E: Proof of Public Consultation

Notified IAPs

Name	Organisation
M Murangi	Namwater
F Enkali	Oshikoto Regional Council
P Ipinge	Oshikoto Regional Council
J Lopes	Nabis FMB/00587 (Damara Dik Dik Lodge)
P Nambahu	Oasis FMB/00786/00002
W Spoelstra	Mosbach FMB/00589
P Grobler	Maieberg FMB/00790
P Hangala	Ombanje FMB/00787
J Brits	Danevis FMB/00785
J van der Merwe	Mafoi FMB/00785
R Johanes	Namibian Organic Association (NOA)
M Aufderheide-Voigts	Namibian Organic Association (NOA)
E Förtsch	Namibian Organic Association (NOA)
V Corry	Namibian Organic Association (NOA)
Manager: Biotechnology	National Commission on Research, Science and Technology (NCRST)

Notification Letter

TEL.: (+264-61) 257411 ♦ FAX.: (+264) 88626368
CELL.: (+264-81) 1220082
PO BOX 11073 ♦ WINDHOEK ♦ NAMIBIA
E-MAIL: gpt@thenamib.com

To: **Interested and / or Affected Party** **19 June 2024**

Re: **Environmental Scoping Assessment and Environmental Management Plan for Irrigation-Based Agricultural Activities and the Environmental Release of Genetically Modified Maize on the Farm Emilienhof FMB/00588, Oshikoto Region**

Dear Sir/Madam

Geo Pollution Technologies (Pty) Ltd was appointed by the Van Druten Family Trust to undertake an environmental assessment for irrigation-based agricultural activities and the environmental release of genetically modified (GM) maize on farm Emilienhof FMB/00588 in the Oshikoto Region (see location map on page 2). The assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Project: Environmental Scoping Assessment and Environmental Management Plan for Irrigation-Based Agricultural Activities and the Environmental Release of Genetically Modified Maize on Farm Emilienhof, Oshikoto Region

Proponent: Van Druten Family Trust

Environmental Assessment Practitioner: Geo Pollution Technologies (Pty) Ltd

The Proponent has a total area of 54 ha of which 52 ha is under centre pivot irrigation systems, 2 ha is under drip irrigation, and 1 ha under sprinklers, irrigation is from boreholes. The main crops cultivated are maize, potatoes, onions and butternuts. In order to improve productivity, the Proponent wishes to replace the traditional maize cultivars, as employed in Namibia, with insect and/or roundup resistant GM.

The environmental scoping assessment will include all activities pertaining to the transport, storage and planting of GM maize seeds, the management of the crops during the growing period, the application of pesticides to the crops, harvesting of the crops, and the handling and transport of the harvested maize to the markets. Groundwater is abstracted from production boreholes for irrigation purposes via centre pivot irrigation systems. Fuel for farm vehicles is stored in aboveground diesel tanks. General operations also include activities such as electricity supply, waste handling and sewage disposal.

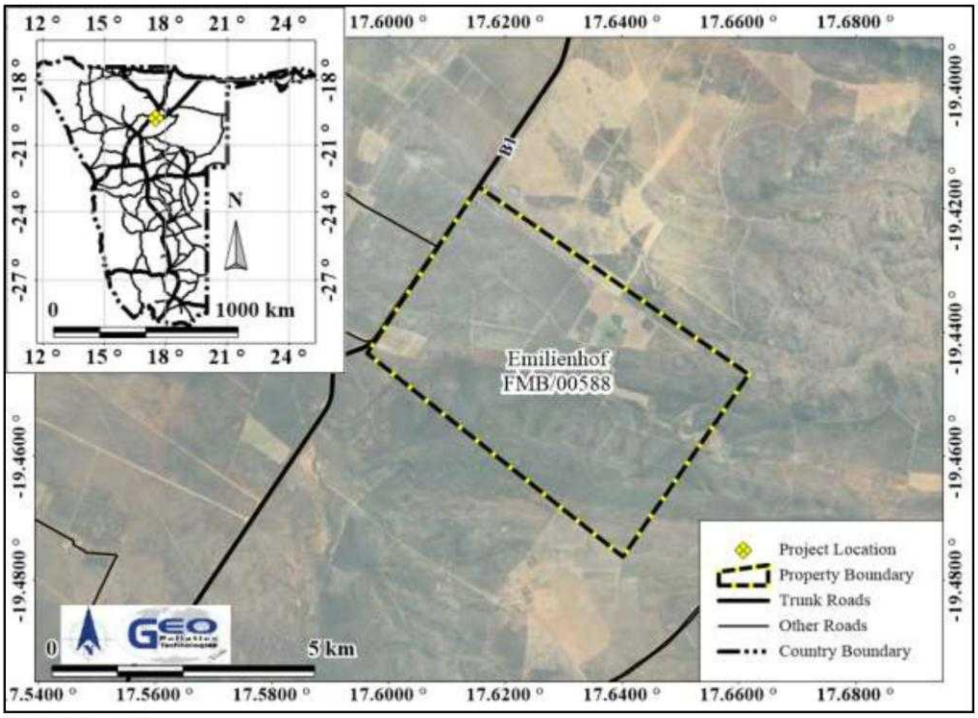
Interested and affected parties or neighbours are invited to register with the environmental consultant, to receive further documentation and communication regarding the project, or to provide comments related to the project, for inclusion in the assessment. Please register or submit comments at:

Fax: 088-62-6368 or **E-Mail:** emilienhof@thenamib.com

Should you require any additional information please contact Geo Pollution Technologies at telephone 061-257411.

Sincerely,
Geo Pollution Technologies

Quzette Bosman
Social and Environmental Assessment Practitioner



Project Location

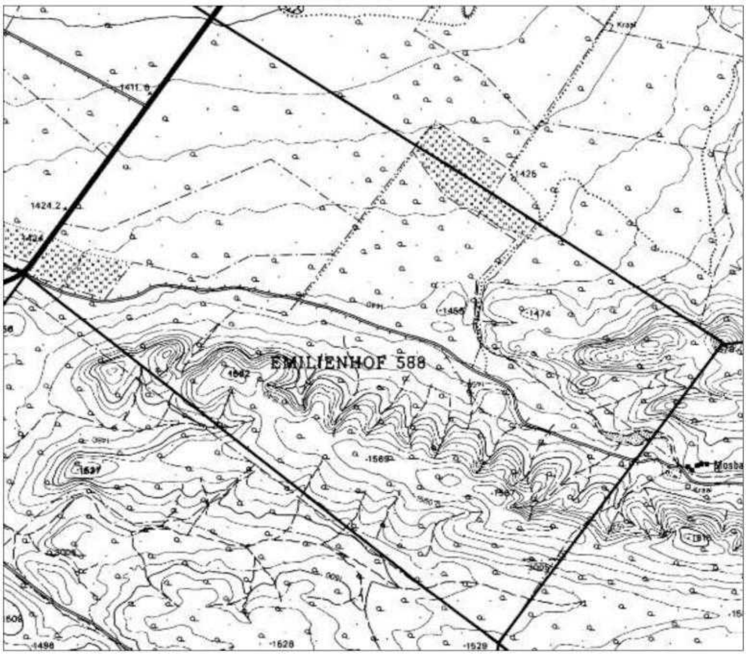
Page 2 of 2

Geo Pollution Technologies (Pty) Ltd

Background Information Document

ENVIRONMENTAL SCOPING ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN FOR IRRIGATION-BASED AGRICULTURE ACTIVITIES AND THE ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE ON FARM EMILIENHOF, OSHIKOTO REGION

BACKGROUND INFORMATION DOCUMENT



Prepared by:

Geo Pollution Technologies

Prepared for:

Van Druten Family Trust

June 2024

1 INTRODUCTION

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by the van Druten Family Trust (the Proponent) to undertake an environmental assessment for irrigation-based agriculture activities and the environmental release of genetically modified maize on farm Emilienhof FMB/00588 in the Oshikoto, Region (Figure 1-1). The total area currently under irrigation by the Proponent is 54 ha of which 52 ha is under centre pivot irrigation systems and 2 ha is under drip irrigation, and 1 ha under sprinklers irrigation is from boreholes. The main crops cultivated are maize, potatoes, onions and butternuts. In order to improve productivity, the Proponent wishes to replace the traditional maize cultivars with insect and/or roundup resistant GM strains.

An environmental clearance certificate (ECC) for the operations is required as per the Environmental Management Act No. 7 of 2007 (EMA). A scoping environmental assessment report (SR) and an environmental management plan (EMP) are proposed to be submitted to the Ministry of Environment, Forestry and Tourism's Department of Environmental Affairs (DEA) in support of an application for an ECC. The environmental assessment will include all operational activities associated with the agricultural activities of the Proponent.

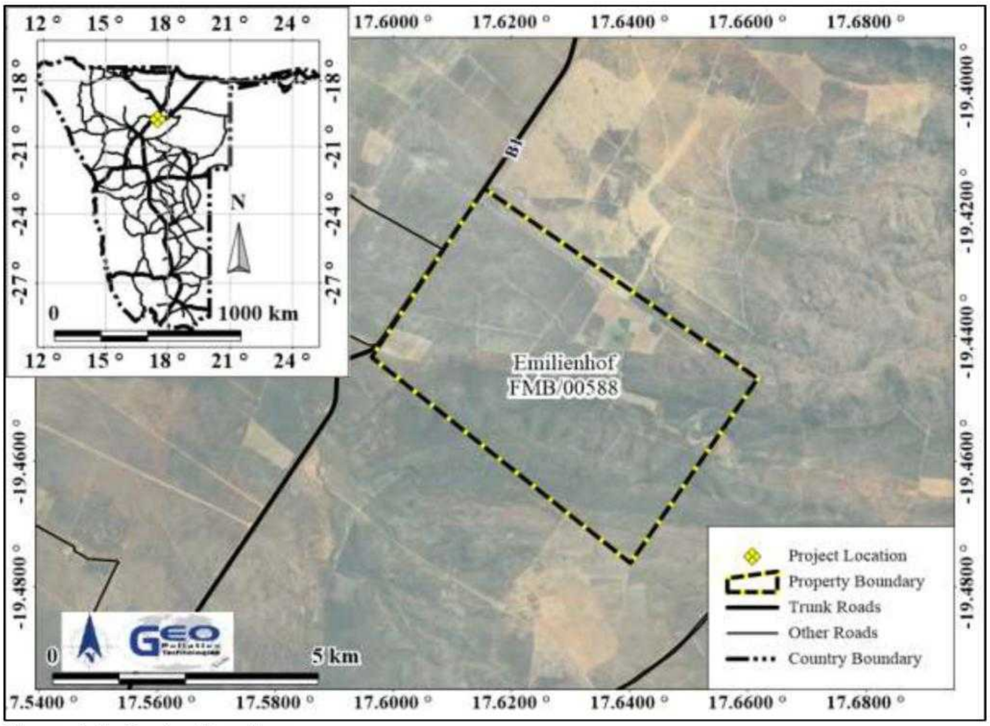


Figure 1-1 Project location

2 PURPOSE OF THE BID

With this background information document (BID), GPT aims to provide interested and affected parties (IAPs) with information about the project and interact with them regarding it. All IAPs are therefore invited to register with GPT for the project in order to:

- Provide GPT with additional information which should be taken into account in the assessment of impacts;
- Share any comments, issues or concerns related to the project; and
- Review and comment on the reports (SR and EMP).

3 PROJECT DESCRIPTION

Activities associated with the project have been divided into the following phases: planning, maintenance/construction, operational and the decommissioning phase. A brief outline of expected activities for each phase is detailed below.

3.1 PLANNING PHASE

While planning for operations, construction / maintenance activities and decommissioning of the farm, it is the responsibility of the Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management measures are in place prior to and during all phases, to ensure potential impacts and risks are minimised. Typical planning activities include:

- Obtain permits and approvals from local and national authorities including Ministry of Agriculture, Water and Land Reform.
- Make provisions to have a health, safety and environmental coordinator to implement the EMP.
- Ensure provisions for a fund to cater for environmental incidents (e.g. pollution) and ecological restoration are made.
- Ensure all appointed contractors and employees enter into agreements which include the EMP.
- Establish and/or maintain a reporting system to report on aspects of construction activities, operations and decommissioning as outlined in the EMP.

3.2 CONSTRUCTION AND MAINTENANCE PHASE

Some construction activities will form part of the continuous development of the farm. Maintenance and upgrades continues on a daily basis and may also include some construction activities. Maintenance include minor repairs to infrastructure, general upkeep of buildings, servicing of vehicles, etc.

3.3 OPERATIONAL PHASE

Genetically modified crops have the potential to increase profitability by mainly reducing input costs related to pest control. The two main traits in the GM maize cultivars proposed to be planted are insect and RoundUp resistance.

Insect resistance is achieved by the insertion of certain gene segments of the *Bacillus thuringiensis* bacterium which produces a protein that is toxic to target pests of the insect order Lepidoptera (moths and butterflies). Specifically the larvae stages (caterpillars) are targeted as they die when eating the crops, therefore breaking the life cycle of the pest species.

RoundUp is the trade name of a systemic herbicide containing the active ingredient glyphosate. RoundUp resistance in crops has, among others, the advantage of a reduced need for mechanical weed control in fields. Also, often fields are prepared for planting by first allowing the weeds to germinate and grow, then spraying such weeds with herbicides, and once dead, planting of crops can commence. During short growing seasons, this is not always possible and by planting RoundUp resistant crops, you can immediately start planting and then spray while both the weeds and crops are on the field. RoundUp resistance is achieved by inserting gene segments from the bacteria *Agrobacterium* sp. strain CP4. It produces an enzyme that is tolerant to glyphosate, thus allowing the GM crop to grow in the presence of glyphosate.

The following is a list of the GM maize cultivars (or events) proposed for environmental release.

GM Event	Crop Type	Trait
MON 810	Maize	Insect Resistance
MON 89034	Maize	Insect Resistance
NK 603	Maize	RoundUp Resistance
MON 89034 × NK 603	Maize	Insect Resistance and RoundUp Resistance

GM Event	Crop Type	Trait
NK 603 × MON 810	Maize	Insect Resistance and RoundUp Resistance

The main operational activities that will be addressed in the SR pertain to the transport, storage and planting of GM maize seeds, the management of the crops during the growing period, the application of pesticides to the crops, harvesting of the crops, and the handling and transport of the harvested maize to the markets. Groundwater is abstracted from production boreholes for irrigation purposes via centre pivot irrigation systems. General operations also include activities such as electricity supply, waste handling and domestic effluent disposal. Livestock farming forms part of the operations on the farm.

3.4 Decommissioning Phase

In the context of GM crop cultivation, decommissioning refers to the termination of cultivation of any GM crop. Such decommissioning is not foreseen during the validity of the ECC. Decommissioning will however be assessed. Should decommissioning occur at any stage, aftercare will be required to ensure no GM maize remain on the cultivated fields and that regrowth be controlled by chemical and/or mechanical means.

Decommissioning of selected infrastructure may occur and will also be assessed. Should decommissioning occur at any stage, rehabilitation of the area may be required. Decommissioning will entail the complete removal of all infrastructure including buildings and underground infrastructure. Pollution present on the site, if any, must then be remediated.

3.5 Preliminary Identified Impacts

During the environmental assessment all components of the environment will be considered, however only those components which are being impacted on significantly, or are deemed to be sensitive, will be assessed. These include the following:

- Health and safety risks
- Soil and groundwater pollution
- Over abstraction of groundwater
- Fire risks
- Waste and effluent generation and disposal
- Traffic
- Noise
- Visual impact
- Ecosystem and biodiversity impacts
- Socio-economic contributions
- Cross Pollination of GM and non-GM crops

4 PUBLIC CONSULTATION

GPT invites all IAPs to provide in writing, any issues and suggestions regarding the development. This correspondence must include:

- Name and surname,
- Organization represented or private interest,
- Position in the organization,
- Contact details, and
- Any direct business, financial, personal or other interest which you may have in the approval or refusal of the application.

All contributions become public knowledge and will be circulated along with the reports as per the EMA requirements. The comments, inputs and suggestions will also be submitted to the DEA along with how any issues have been addressed in the SR. The public participation process will remain

Press Notice: The Namibian Sun 1 and 8 July 2024

Sun

MONDAY 1 JULY 2024 NEWS | 3

nance, and N$64 million for capital expenditures.

He added that the council's self-funded capital projects - amounting to N$51 million - focus on key priorities such as new extensions layout, and the replacement of prepaid meters for water and electricity.

The council plans to establish two recreational parks, construct open markets in Blocks E and B, install street lights, upgrade ICT infrastructure and replace transformers.

An additional N$7 million is also earmarked for the rehabilitation of oxidation ponds, courtesy of the ministry of urban and rural development, while the Roads Fund Administration pledged N$4 million for road maintenance and construction within the town.

During the meeting, some residents proposed the establishment of a community think tank to contribute ideas and proposals for enhancing the local economy, reflecting their commitment to active civic engagement.

- JEMIMA BEUKES

Television, Shiimi said Namibia was geared to earn up to 65% of the oil proceeds, while international oil companies such as Shell, TotalEnergies and, more recently, Galp - which have since 2022 announced mega finds - stand to walk away with up to 35% return on their investments.

This is despite Namibia's low free-carried interest equity stakes in the Graff-1, Venus X-1 and Mopane wells through the National Petroleum Corporation of Namibia (Namcor).

"If you look at the Act and other legislation that is going to manage these resources, we believe Namibia is going to get the majority of the cake. In fact, we think, at the moment, 65% of the cake will remain in Namibia, so investors will only be left with 35%," he said.

Tax legislation explained

In terms of Namibia's current tax legislation regarding revenue from petroleum operations, auditing firm PwC Namibia explained in a oil tax guide.

"Licence holders are required to pay annual charges for the benefit of the State Revenue Fund, calculated by multiplying the number of square kilometres included in the block or blocks by the amounts provided for in Section 67 of the Petroleum Act. In the case of exploration licences, the charge is calculated as follows: During the first four years, N$60 per square kilometre; during the next two years, N$90 per square kilometre; during the subsequent two years, N$120 per square kilometre. Thereafter, it is N$150 per square kilometre. In the case of production licences, the fee is N$1 500 per square kilometre," PwC said.

Billions in revenue

Shiimi emphasised that while the government stood to earn significant oil revenue in the form of

According to an assessment by the University of Cape Town, Namibia's recent oil discoveries in the Orange Basin are estimated to generate about N$443 billion in investment and N$53 billion in revenues from taxes and royalties.

Meanwhile, opposition leader McHenry Venaani in the past voiced his stern opposition to Namibia's interest in discovered oil and gas resources. He described government's stake in the oil finds as 'meagre', adding that such negotiations are an example of the state having negotiated in bad faith.

The Popular Democratic Movement (PDM) leader further emphasised that incorrectly structured oil exploration agreements have far-reaching consequences.

"If we conclude agreements that are not favourable to the developmental objectives of the country, our oil resources will not benefit Namibians," he said.

PUBLIC PARTICIPATION NOTICE
ENVIRONMENTAL IMPACT ASSESSMENTS FOR AGRICULTURE AND ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE FOR CULTIVATION

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by the Proponents: Heidelberg **291 CC, Emilienhof Investments CC, Edible Sunflow Oils CC, HD Farming, and Ondundu Farming Enterprises CC,** to undertake environmental assessments for agricultural activities and the environmental release of genetically modified (GM) maize for cultivation on their respective farms in the Otjozondjupa and Oshikoto Regions, as indicated in the below map. Additional information about the respective Proponents' farms and farming activities can be obtained from GPT or viewed at: ***http://www.thenamib.com/projects/projects.html***

The environmental assessments will be conducted according to the Environmental Management Act of 2007 and its regulations published in 2012. Depending on the respective Proponents' individual farming activities, aspects related to cultivation of GM maize and cotton, water abstraction, fuel storage and hospitality and tourism facilities, will be included.

All interested and affected parties are invited to register with GPT. By registering you are provided with the opportunity to share any comments, issues or concerns related to the projects, for consideration in the environmental assessments. Additional information can be requested from GPT: Tel: +264-61-257411; Fax: +264-88626368; E-Mail: gmo3@thenamib.com

Ms Quzette Bosman, Geo Pollution Technologies

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Sun

No.	Erf no:	Name(s) of the applicant	Zoning	Size (m^2)	Purchase price (N$)	Township & extension
1.	653	Sylvia Kanhemo Nghidengwa	Residential	352m²	N$ 10 560.00	Engela-Omafo extension 2
2.	327	Toini Timoteus	Residential	695m²	N$ 12 150.00	Engela-Omafo extension 1
3.	277	Paulus Indila Kapenda	Residential	1575m²	N$ 133 875.00	Ohangwena proper
4.	631	Charmine Bianca Nuguris	Residential	377m²	N$ 11 310.00	Engela-Omafo extension 2
5.	61	Openipawa Fikameni	Business	625m²	N$ 23 575.00	Oshikango proper
6.	62	Openipawa Fikameni	Business	625m²	N$ 23 575.00	Oshikango proper
7.	1224	Hafeni Shiponeni	Business	837m²	N$ 51 015.15	Oshikango proper

2. Notice is hereby given in terms of Section 63(2)(b) of the Local Authorities Act, 1992 (Act 23 of 1992), that the Town Council of Helao Nafidi intends to lease by way of private transaction a portion of the farm Helao Nafidi townlands No. 997 to the following applicant:

Erf No.	Name of applicant	Township	Size	Zoning	Duration of lease	Monthly lease fee
Temp erf 254	Rauna Peuyonyol Ndahekelekwa Shindele	Omafo extension 11	814m²	Residential	7 years	N$ 75.00/ month

All written objections must be lodged with the office of the Chief Executive Officer of Helao Nafidi Town Council at Private Bag 503, Ohangwena on or before 22nd July 2024.

ENQUIRIES: Penehafo Mwatukange (Property Officer) - 065-261900/081 128 3601.

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ed water to both countries is on the cards. We have phased this project into three phases: SS1 is desalinated water for the West Coast. The cabinet has approved that project. The feasibility study has been done. The funding has been secured. Hopefully, we will start implementing it in December," he said.

He explained that SS2 is related to supplying desalinated water to the central areas.

"We are still in the process of evaluating whether the provision of desalinated water is cost-effective in comparison to making all our dams and providing water from other sources."

SS3, which might be the last phase as the programme can be extended, is where the pipeline comes in for Namibia - Botswana.

"We have created a joint committee that is looking into the legal aspects and usage aspects of how that infrastructure is actually going to be maintained and built, among others. The committee is going to be brought back at the next meeting so that we can move on to the next step, which is a complete feasibility study."

Press Notice: Die Republikein 1 and 8 July 2024

2 NUUS | Republikein | Maandag 1 Julie 2024

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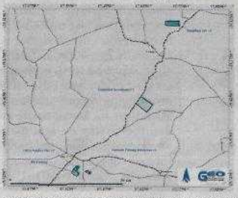

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Namibië sal glo meerderheid van olie-inkomste geniet

VAN BL. 1

BELASTINGWETGEWING VERDUIDELIK

Ingevolge Namibië se huidige belastingwetgewing met betrekking tot petroleumbronne, word tantième bereken as 5% van die bruto inkomste.

Tantième is gewoonlik kwartaalliks betaalbaar en word bereken deur die markwaarde van die ruolie te gebruik.

Daarbenewens word petroleuminkomstebelasting gehef teen 35% van belasbare inkomste en 'n bykomende winsbelasting wat gehef word op die netto kontantvloei uit petroleumbedrywighede ná belasting, het die ouditeursfirma PWC Namibia in 'n olie- en belastinggids verduidelik.

"Daar word van lisensiehouers verwag om jaarlikse heffings ten bate van die fonds vir staatsinkomste te betaal.

"Dit word bereken deur die aantal vierkante kilometer wat in die blok of blokke ingesluit is, te vermenigvuldig met die bedrae waarvoor in Artikel 67 van die Petroleumwet voorsiening gemaak word.

"In die geval van eksplorasielisensies word die heffing soos volg bereken: gedurende die eerste vier jaar, N$60 per vierkante kilometer; gedurende die volgende twee jaar, N$90 per vierkante kilometer; gedurende die daaropvolgende twee jaar, N$120 per vierkante kilometer; daarna, N$150 per vierkante kilometer. In die geval van die produksielisensies is die heffing N$1 500 per vierkante kilometer," het PWC gesê.

'NAMIBIËRS DEEL OOK IN OPBRENGS'

Shiimi het beklemtoon hoewel die regering aansienlike olie-inkomste in die vorm van belasting en tantième sal verdien, kan gewone Namibiërs ook direk in die opbrengs deel.

"Dit hang ook af van hoe ons die vaardighede gaan opbou, want om as Namibiërs deel te kan neem moet ons meer Namibiërs op die olieplatforms sien. Die inkomste gaan dus ook direk na individuele Namibiërs," het hy gesê.

Die internasionale energiekonsultantfirma, Wood Mackenzie, raam dat Namibië se onlangse olie-ontdekkings in die Oranjekom ongeveer US$3,5 miljard se beleggings verteenwoordig, sowat N$527,8 miljard teen die heersende wisselkoers, en US$3,5 miljard (N$63,7 miljard) se inkomste uit belasting en tantième jaarliks vir die regering sal genereer.

Wood Mackenzie het vroeër vanjaar egter gemaan dat die ontginning van olie en gas in die Oranjekom waarskynlik met uitdagings gepaard sal gaan omdat die bronne so diep is.

Nie een van die internasionale oliereuse wat betrokke is by aflandige eksplorasie aan die kus van Namibië het reeds besluit dat hul ontdekkings kommersieel ontginbaar is nie.

PDM LEWER KRITIEK

Die leier van die Popular Democratic Movement (PDM), McHenry Venaani, het in die verlede sy streng teenkanting teen Namibië se belangstelling in ontdekte olie- en gasbronne uitgespreek.

"Dit is as sodanig 'n groot kommer dat 'n eksplorasieblok wat in die buiteland van Namibië geleë is, in blok 2913B waarin TotalEnergies se Venus-1X-boorgat 'n 40%-werkbelang, saam met QatarEnergy (30%), Impact Oil and Gas (20%) geniet, die regering met 'n skamele 10%-belang laat," het Venaani betreur.

Hy meen sulke onderhandelinge is 'n voorbeeld van die regering "wat in swak geloof onderhandel het".

Venaani het verder beklemtoon dat verkeerd gestruktureerde olie-eksplorasie-ooreenkomste verreikende gevolge het, en bygevoeg dat sulke onetiese praktyke selfs groter geword het in die mate dat dit dreig om ontwikkeling en groei binne die land en die vasteland te belemmer.

"Korrupsie heers in Namibië en as ons ooreenkomste sluit wat nie gunstig is vir die ontwikkelingsdoelwitte van die land nie, sal ons oliebronne nie Namibiërs bevoordeel nie," het Venaani gesê.

– republikein@republikein.com.na

Maandag 8 Julie 2024 | Republikein | NUUS 3

Deveral koud vir die pasiënte van die Katutura-staatshospitaal wat tans tydelik in 'n veldhospitaal gehuisves word wat voorheen vir Covid-

vloer vuil is en vuil linne in 'n bondel op die vloer lê. Mediese afval word glo ook enkele meters van die veldhospitaal se ingang gehou.

taal nie.

"Pasiënte in die veldhospitaal is stabiel. Ek is tans in Swakopmund en moet die superintendent betrek. Alles was dalk nie 'n oorsaaklike verband nie. Ons moes iewers mense huisves, want die hospitaal word opgeknap. As jy in my skoene was, wat

binnekom. Daarbenewens het pasiënte by die Katutura-staatshospitaal aangevoer dat sommige toiletgeriewe onbruikbaar is weens 'n watertekort.

Die staatshospitaal ondergaan tans uitgebreide opknappings- en herstelwerk op verskeie verdiepings, wat beteken pasiënte moet tydelik uit die betrokke sale verskuif word. Die gesondheidsminister, dr. Kalumbi Shangula, het in die Nasionale Vergadering verseker dat slegs stabiele pasiënte tydelik na die veldhospitaal oorgeplaas is wat tydens die Covid-19-pandemie naby die staatshospitaal opgerig is.

ANDER GERIEWE STAAN LEEG

Langs die tydelike veldhospitaal waarin staatspasiënte nou gehuisves word, is 'n moderne Covid-19-hospitaal wat leeg staan. Die hekke is gesluit en twee sekuriteitswagte is aan diens. Volgens

Die Covid-19-hospitaal is nou gereserveer vir isolasiegevalle van aansteeklike siektes. FOTO HENDELINA NGHITIWA

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IAP Comments

Comments and Responses Report: Comments from the Namibian Organic Association Received: 27 September 2024 via Email
Comment 1 27 September 2024 Subject: Response to the Environmental Impact Assessment by Geo Pollution Technologies for the cultivation of genetically-modified maize on Farms Askevold and Naueis Interested and Affected Party: Namibian Organic Association (NOA) NOA Board members: Mareike Voigts (Chairperson) Eckhart Förtsch (Vice Chairperson) Sanet Brundyn (Treasurer) Vera Corry (Secretary) Selma Nasheya Jacobina Lumambo Johannes Negongo Dirk Bockmühl To whom it may concern, Please find attached here some comments and queries with regard to the Environmental Impact Assessment for the cultivation of genetically modified maize on farms Askevold and Naueis. Attached also is a position paper by the Namibian Organic Association from April 2023 in response to the importation of genetically modified feed by AGRA.
Response 1: The response is well received and the position paper by the Namibian Organic Association from April 2023, in response to the importation of genetically modified feed by AGRA, is noted.
Comment 2 *Background* The Namibian Organic Association is a membership-based voluntary association that was founded in 2009 by producers and consumers passionate about healthy, sustainably produced food. The organization's mandate is to grow the organic sector in Namibia, thereby increasing the accessibility of local, healthy, nutritious food to all Namibians. This is done through awareness raising campaigns, training workshops, offering certification for organically produced food for the local market, and more recently, by engaging with government through the establishment of a Technical Working Group on Organic Agriculture and Agroecology which will form part of the Food Security Working Group under the Office of the Prime Minister (OPM). Standing with organic movements across the globe, NOA and its members are guided by the four principles of organic agriculture, namely: Health, Ecology, Fairness and Care (as defined by the International Federation of Organic Agriculture Movements, IFOAM – Organics International), as well as by the 13 principles of Agroecology. These principles guide management practices across the value chain of the food system and contribute directly to multiple Sustainable Development Goals (SDGs): - SDG 1: Eradication of poverty - SDG 2: Eradication of hunger - SDG 4: Ensuring quality education - SDG 5: Achieving gender equality - SDG 6: Increasing water-use efficiency - SDG 8: Promoting decent jobs - SDG 12: Ensuring sustainable consumption and production - SDG 13: Building climate resilience - SDG 15: Halting the loss of biodiversity. NOA stands for food sovereignty through sustainable food production that is practiced through crop diversity, seed saving and seed sharing, using seeds adapted to local environments as well as conventional crop breeding methods to enhance production within local environments. Capacity

building within the country through supporting farmers – subsistence, small-scale and commercial – is a main focus for NOA. With regard to the cultivation of genetically modified organisms (GMOs), NOA calls for: - Transparent processes and full public participation - Fully independent research trials/studies - Risk assessments for GMOs to include herbicide/pesticide impacts - All GMO products to be clearly labelled to inform consumers. NOA would also like to point to the study by Noack et al. (2024), which highlights that while much of the literature focus on yields of GM crops, there is very little focus on the social and environmental impacts of GMO cultivation. This is also highlighted in a report by the African Centre for Biodiversity, which NOA urges all decision-makers, environmental impact assessors and farmers to familiarize themselves with, as well as the references therein: • Africa Centre for Biodiversity. 2020. GMOs in South Africa 23 years on: Failures, biodiversity loss and escalating hunger
Response 2: Background introduction is noted.
Comment 3 *Queries/comments on the Environmental Impact Assessment (EIA):* 1. GM Maize that is herbicide resistant (event NK603) is cultivated in conjunction with the herbicide 'Roundup', the active ingredient of which is glyphosate. While this product is still available in Namibia on the shelves, it is well documented that this chemical is carcinogenic (OEHHA, 2019) and has been linked to several chronic diseases, such as non-Hodgkin lymphoma, with exposure to glyphosate increasing the chance of cancer by 40% (Zhang, et al., 2019). Furthermore, the "adjuvants" (chemical additives) that are used in the formulation of Roundup make it even more toxic than glyphosate alone, which is largely unknown to the public and decision- makers (Mesnage et al., 2015). The EIA does not deal sufficiently with the impacts of glyphosate (the active ingredient in Round up) on the health of humans and animals.
Response 3: The authors of the EIA are well aware of the inherent dangers of not only an herbicide like glyphosate (and RoundUp), but also many other commonly used pesticides, including those used by the laymen around their own homes and gardens. Many of these have not received the attention of glyphosate, as they are not linked to GM crops. They are however used on crops we buy in our stores on a regular basis. In an ideal world, we think it is safe to assume that, all other things being equal, no single person will willingly choose a crop grown with pesticides over a crop grown without any. Unfortunately, reality is quite different from idealism, and factors like the price of organic vs non-organic foods influence this decision, especially in a country where a large portion of population lives below the poverty line. The above being said, the debate on the carcinogenicity of glyphosate is ongoing. However, a critical analysis of the Zangh et al. (2019) paper by the US EPA, found various flaws in the Zhang et al. study and concluded that the study by Andreotti et al. (2018) remains the largest, best-designed high quality study, and their categorization of glyphosate as "*not likely to be carcinogenic to humans*" remains. The very detailed review of GM crops by the National Academies of Sciences, Engineering, and Medicine (2016) had to conclusions on cancer incidence linked to GM crops: *FINDING: The incidence of a variety of cancer types in the United States has changed over time, but the changes do not appear to be associated with the switch to consumption of GE foods. Furthermore, patterns of change in cancer incidence in the United States are generally similar to those in the United Kingdom and Europe, where diets contain much lower amounts of food derived from GE crops. The data do not support the assertion that cancer rates have increased because of consumption of products of GE crops.* *FINDING: There is significant disagreement among expert committees on the potential harm that could be caused by the use of glyphosate on GE crops and in other applications. In determining the risk from glyphosate and formulations that include glyphosate, analyses must take into account both marginal exposure and potential harm.* It may be worthwhile studying the National Academies of Sciences, Engineering, and Medicine (2016) document.

Ultimately, it remains crucial that farmers apply RoundUp, as with all other pesticides, according to the prescribed instructions and in a responsible manner. References: Andreotti G, Koutros S, Hofmann JN, Sandler DP, Lubin, JH, Lynch CF, Lerro CC, De Roos AJ, Parks CG, Alavanja MC, Silverman DT. 2018. Glyphosate use and cancer incidence in the Agricultural Health Study. JNCI: Journal of the National Cancer Institute. 110(5): 509–516. doi:10.1093/ jnci/djx233. National Academies of Sciences, Engineering, and Medicine. 2016. Genetically Engineered Crops: Experiences and Prospects. Washington, DC: The National Academies Press. doi: 10.17226/23395.
Comment 4 2. Given that there are several movements in the EU and the US to ban this chemical for use in the agricultural sector, NOA would like to raise the question as to whether it is imperative to set up a cultivation system that is totally reliant on the use of this herbicide? What would the economic implications be if this chemical is banned in the EU (and the US) where many of Namibia’s beef exports are destined to?
Response 4: Most of, if not all, animal feed used to supplement cattle’s diets, especially now during drought conditions, already contain GMOs. Also, as indicated in the specialist study, the Meat Board of Namibia has confirmed that the export status to the European Union are not negatively influenced by the fact that Namibian animal feed already contains GM ingredients, inclusive of RoundUp Ready Maize. It is also not an irreversible cultivation system. Permits for planting of GM crops needs to be renewed on an annual basis.
Comment 5 3. It is often argued that the cultivation of herbicide resistant GM maize leads to a decrease in herbicide use. There are, however, studies showing the exact opposite (Perry, et al., 2016). Not only does herbicide use remain the same as before, or even increase, but because herbicide resistance does develop in weeds, more herbicide is used, or even more toxic herbicide alternatives are being used, e.g. glufosinate, dicamba, 2-D (REFERENCE). Bayer recommends overlapping use of residual herbicides with glyphosate, the examples of which that are given are partly already banned in the EU or in the process of being banned (e.g. Atrazine, Simazine, Metribuzin, Metachlor). Is the cultivation of herbicide-resistant (‘Roundup Ready’) GM maise then a sensible and sustainable system to invest into?
Response 5: Likewise, there are studies indicating that there are no definitive proof that herbicide use increase. See the National Academies of Sciences, Engineering, and Medicine (2016) report. Furthermore, herbicide resistance in weeds is not a concern in GM crops only. It also develops under traditional crop farming where weeds are sprayed prior to planting of fields. The same argument can therefore be made for non-GM crops.
Comment 6 4. Pg. 21: It is argued here that GM crops need to be used because the use of herbicides (on non-GM crops) leads to weed resistance. This statement is problematic since it is also the use of herbicides in GM herbicide-resistant crops that leads to weed resistance (Heap and Duke, 2018; even highlighted in a report by Bayer on glyphosate), perhaps even more so as farmers that use herbicide-resistance GM crops start to rely on only one herbicide, rather than an Integrated Pest Management approach which entails a more holistic approach to pest management and thereby reduces the risk of herbicide or pesticide resistance developing.
Response 6: Noted. Throughout the EIA and specialist report it is clearly stated that weed resistance to herbicides can occur in both non-GM and GM crops. However, the statement referred to has been rephrased to better express the argument. It now reads: *Some weeds have developed resistance to some herbicides, leading to a need to* *rotate both crops and herbicide groups in order to keep crops weed-free. Where broad-leafed weeds developed resistance, glyphosate tolerant GM maize may be beneficial as such weeds can still be eliminated on post-emergent maize.* Ultimately, it is thus equally important to have adequate pest management systems for both GM and non-GM crops.
Comment 7

5. Further to the previous point, a reduced use of pesticides is typically only reported in cultivation systems that are already using significant amounts of agro-chemicals (IAAASTD Report, Pg 45). In this light, it is questionable whether the cultivation of Bt and herbicide-resistant maize in Namibia on a farm where the amount of chemical use might not have been monitored continuously, would realistically lead to a reduction in pesticide use.
Response 7: It is logical that the largest reduction in pesticide use would be in systems making use of a lot of agro-chemicals (pesticides). Subsistence farmers for example, seldom use pesticides at all. The National Academies of Sciences, Engineering, and Medicine (2016) report highlights numerous studies, all indicating reduced use in insecticides on GM crops. In fact their conclusion is: *FINDING: In all cases examined, use of Bt crop varieties reduced application of synthetic insecticides in those fields. In some cases, the use of Bt crop varieties has also been associated with reduced use of insecticides in fields with non-Bt varieties of the crop and other crops.* Furthermore, it is unlikely, especially in Bt maize, that farmers will willingly use expensive insecticides if they are not needed.
Comment 8 6. Maize is a wind-pollinated plant, which is not mentioned in the EIA report. Therefore, the risk of cross-pollination is very real as pollen can be carried across substantial distances by wind. This would impact those neighbours that want to grow non-GM crops, and could also impact their aspirations for organic certification which would directly impact their economic resilience/status. Contrary to what the EIA states, contamination of non-GM crops on neighbouring farms have impacted these farmers' ability to pursue organic certification (Paull, 2019).
Response 8: Having reviewed the Paull 2019 article, of which he is the only author, it is safe to say that from the tone of the article, and the fact that the author is an advocate of organic agriculture, there is great bias towards organic agriculture. This also stems from his lack of including positive aspects of GM crops, which there definitely are. Nevertheless, the EIA report indicates a buffer (isolation zone) of 800 m between GM and non-GM fields, or as directed by the seed supplier. A counter argument can also be made by farmers intending to plant GM crops. Many farmers have indicated losses of millions of dollars as a result of fall and African armyworms. If they are not allowed to plan GM crops to counter these losses, due to a nearby organic farmer, their own economic resilience is also impacted.
Comment 9 7. More difficult growing conditions can be expected in the future due to climate change, increased temperatures and unpredictable weather patterns. Resilience lies within crop diversity, which is more apparent in local varieties than in GMO crops.
Response 9: The statement *"More difficult growing conditions can be expected in the future due to climate change, increased temperatures and unpredictable weather patterns."* directly supports the idea of planting GM crops as it provides a level of flexibility not offered by non-GM crops. For example, with dry-land non-GM crops, farmers have to time field preparation and weed control based on weather predictions. Should the rain arrive too late in the planting window, farmers will either risk investing a lot of money by planting without good rains, or not plant at all. With herbicide tolerant GM crops, planting can occur much later in the planting window, as no weed control is required prior to planting, since weed control can be performed post emergent. New GM traits are continuously investigated, with a strong focus on drought tolerance. Such a trait can play a crucial role in food security in dry African countries which already suffers food shortages. Local varieties will still be planted as refuges when GM-crops are planted.
Comment 10 8. There are currently only 24 countries in the world that allow growing of GM crops (Paull, 2019), with most countries having strict rules and regulations in place that require food stuffs to be clearly labelled to contain GMOs, which highlights consumers reluctance to consuming GMOs.
Response 10: 27 countries planted GM crops by 2023and the area under GM crop cultivation, globally, has increased from 170.1 million hectares to 206.3 million hectares. Directly linking the number of countries planting GM crops to consumer reluctance, i.e. consumer reluctance causes

fewer countries to plant GM crops, is inaccurate. There are numerous other factors to consider, among them the lengthy and cumbersome processes to follow in order to get approval for environmental release of GM crops. It therefore does not necessarily represent the populations' sentiment. This is also supported by the fact that many more countries, including Namibia, import GM crops for food and feed.

The luxury to refuse to eat food containing GM products, may be an affordable option in for example certain European countries. The reality of most developing countries is however very different. The following screen capture is just a single example that highlights this difference:


OPINION COMMENTARY Follow

We May Starve, but at Least We'll Be GMO-Free

Unlike the Europeans we copied, Zimbabwe can't afford such an unscientific ideological luxury.

By Nyasha Mudukuti

March 10, 2016 6:51 pm ET

From: https://www.wsj.com/articles/we-may-starve-but-at-least-well-be-gmo-free-1457653915

Comment 11

9. The EIA shows that insect and weed resistance needs to be monitored. How does the farmer undertake this, and is it a realistic actionable measure that the farmer is able and willing to continue to do? Who will regulate this? What happens when resistance is recorded? NOA cautions that once resistance has developed it cannot be undone. The proponent will be responsible for ensuring that resistance does not occur through implementing alternative pesticides, but how is this controlled and enforced?

Response 11: As stated earlier, weed and insect resistance to pesticides can occur in cultivation of both GM and non-GM crops. The advantage of GM crops is that there at least is legislation and controls in place to prevent and detect this, whereas with non-GM crops there are none. Ultimately the Biosafety Council under the National Commission on Research Science and Technology, Ministry of Higher Education, Technology and Innovation is mandated to prescribe regulations pertaining to the cultivation of GM crops, if permits for this are issued.

Comment 12

10. Given the stringent management plans and regulations/control of various aspect pertaining to the cultivation of GM maize (e.g. planting of refugia, avoiding crosspollination, use of herbicides, etc.) for which not only the proponent is responsible for, but also the environmental regulators/health & safety inspectors, NOA raises the question as to whether the relevant authorities actually have the expertise and capacity to regulate and control such a highly contentious cultivation scheme. This was also highlighted in a report for South Africa by the African Centre for Biodiversity in relation to GMO cultivation in the country (ACBio, 2020). Given that many Namibian farmers already seem to be illegally cultivating GM maize, it is questionable if the government institutions responsible for regulating and overseeing the legal cultivation of GMO crops in the country have the capacity and resources to do, to ensure that there is no contamination and cross-pollination.

Response 12: The application process for the planting GMO's is substantial. Apart from this EIA process, any applicant should also apply to the Biosafety Council under the NCRST. The requirements for this application include emergency response plans for both transport and cultivation of GM crops. Approved and legal cultivation of GM crops will be better controlled, with checks and balances in place.

Comment 13

11. The EIA/proponent argues that the cultivation of GM maize will lead to more employment opportunities and an increase in technical expertise in the country. The same can, however, be

argued for adopting or integrating a more sustainable agricultural system as offered through organic agricultural and agroecological practices – both creating employment opportunities and improving technical expertise in the country as these farming systems are based on a foundation of a very good understanding of ecology, the environment, markets, etc., in order to flourish, while at the same time safeguarding the environment and producing food that is clean and nutritious. A report by the United Nations found that organic agriculture promotes job creation, providing for more than 30% more jobs per hectare than non-organic farms (De Schutter, 2011).
Response 13: The EIA report does not claim that that the cultivation of GM maize will lead to more employment opportunities and more technical expertise than organic agricultural and agroecological practices. It simply highlights potential benefits of this project. Naturally a farm making use of for example manual labour to eliminate weeds, will have to employ more people than when insecticides are applied. It however comes at significant cost which may ultimately be carried over to the consumer. As stated earlier, the Namibian population, save for a small niche market, cannot afford the prices that accompanies organic food production. A visit to the weekly biomarket in Windhoek presents a clear indication of this when the number and demographic of patrons are considered. Furthermore, the higher production costs can also reduce the feasibility of crop production to such a level where farmers stop producing crops, especially if pests continually result in significant losses.
Comment 14 12. Research has shown that there is already resistance that has developed in fall army worm and stem borer to the Bt toxin (Huang et al., 2014; Kruger et al., 2011). Furthermore, a study conducted in 2020, showed that despite initial reductions in pesticide use, farmers use more pesticides today compared to before the introduction of Bt cotton (Kranthi & Stone, 2020). Once resistance has developed, even if only after a few years, farmers need to start using insecticides again – resistance cannot be undone.
Response 14: This concern has already been addressed in previous points above and the specific case as discussed by Kruger et al. (2011) was presented in the specialist report (page 22 0f 71).
Comment 15 13. *Bt toxin* a. Bt from plants can remain in the soil for over 2 months (Strain & Lidy, 2015; Feng et al. 2015) – the EIA does not address the long-term impacts of this toxin in the soil, especially on soil life. *b*. The potential impact on higher tropic levels have also not been addressed.
Response 15: The same study by Strain & Lidy (2015) states: "The Bt proteins are highly specific and only lethal upon ingestion, limiting the scope of toxicity to target insects. However, concern of exposure to non-target organisms and negative public perceptions regarding Bt crops has caused controversy surrounding their use." Literature overwhelmingly reiterates that the Bt proteins are very species specific. No evidence could be found of Bt proteins being toxic in higher trophic levels. The conclusion therefore remains that Bt maize are less harmful in ecosystems than traditional insecticide application.
Comment 16 14. Another worthwhile read is the 2022 publication "Pesticide Atlas" of a consortium of different organisations under the leadership of the Heinrich Böll Stiftung, with statistics proving that GMO cultivation and the associated use of pesticides has been a failure and carries grave consequences for human health and the global environment (https://eu.boell.org/sites/default/files/2023-04/pesticideatlas2022_ii_web_20230331.pdf). This publication not only lists facts and statistics, but also reflects on the European public's resistance to GMO and harmful chemicals. Europe is the most important market for Namibian agricultural exports.
Response 16: The focus of the Pesticide Atlas is pesticides in general and not GM crops. In science, ideas are never entirely proven or disproven. Instead, they are accepted or rejected based on supporting and opposing evidence, with conclusions subject to revision when new evidence or perspectives emerge. The evidence presented in the Pesticide Atlas to "[proof]that GMO cultivation and the associated use of pesticides has been a failure and carries grave consequences for human health and the global environment" is weak and highly correlative. Furthermore, this concern has been addressed in the points above.

Comment 17 15. Pg. 51: The risk of biodiversity loss should be categorized as 'highly probable'. The following paragraph is relevant here, taken from the ACBio 2020 report: *'GMOs are central to the industrialised version and vision of agriculture punted across the globe. Expanding monocrops and GMOs severely affect global ecological functions through deforestation (specifically the large grain producers of the world) and encroachment into natural habitats, polluting soils and waterways by highly toxic chemicals. There is an overall reduction in the nutrition of food through the creation of nutritionally depleted soils (Schjoerring et al., 2019). The environmental and social toll of industrial agriculture has been recognised widely, with many experts calling for an urgent shift towards biodiverse agroecological production systems (De Schutter, 2010; HLPE, 2019; IPES-Food, 2016).'* If Namibia now allows GMO cultivation, it follows the trap of many industrialised countries of depleting soils and reducing productivity of their agricultural system.
Response 17: Refer to section 4.4.5 of the specialist report. Scientific studies have shown that biodiversity can actually improve under GM crop cultivation. The problem as illustrated in the concern is not directly correlated with GM crop cultivation, but goes hand in hand with industrialised agriculture, of which GM crop cultivation may be part of, but so is non-GM crop cultivation. Maize, whether GM or non-GM, remains a monoculture. That is why crop rotation is important, and is practiced by most Namibian farmers. Furthermore, in the Namibian setting, as far as commercial farming where GM crops will mainly be cultivated is concerned, "slash-and-burn agriculture" is not practiced. Thus, the statement "*Expanding monocrops and GMOs severely affect global ecological functions through deforestation" is not valid.*
Comment 18 16. NOA would like to raise the concern that the 'road back' from GM maize cultivation is even more difficult than converting to organic/agroecological systems now. For example, once herbicide resistant weeds have developed through incorrect and overuse of herbicides, we cannot simply undo this development. Furthermore, once soil health is destroyed due to the use of herbicides and other chemicals, it will become increasingly difficult to cultivate this land.
Response 18: As stated earlier, the same risks exist with non-GM crops cultivated under traditional methods of pesticide use. To try and achieve an agricultural industry where no pesticides are used at all, is, even though ideal, unrealistic.
Comment 19 17. NOA would like to highlight that the wording in the document does not reflect an entirely objective voice and could easily influence the reader: when talking about the risks of GM maize cultivation, the writer uses the words 'it **may** lead to XYZ', whereas when highlighting the potential benefits of GM maize cultivation, the writer uses the words 'it **will** lead to XYZ'.
Response 19: It is not the intention to be subjective. Examples include: • In the sentence "Increased **potential** yields in maize crops, through the cultivation of GM maize, will improve the economic resilience of the farm by offsetting losses that may periodically be incurred in other income streams" it is stated that it is potential increased yields, and it is true that increased yields generate more income. • Various potential and definite impacts **will** emanate from the operations, maintenance/construction and decommissioning phases. • The use of GMO maize **is expected** to increase the success rate and nett economic benefit of operations. **However,** due to the variability of GMO seed prices, input costs etc, the nett benefit **will vary** year on year. It is nonetheless **foreseen**, based on historic cultivation of GMO in other developing countries, that the overall revenue generation capacity **will** be increased, contributing to the sustainability of operations and related employment.

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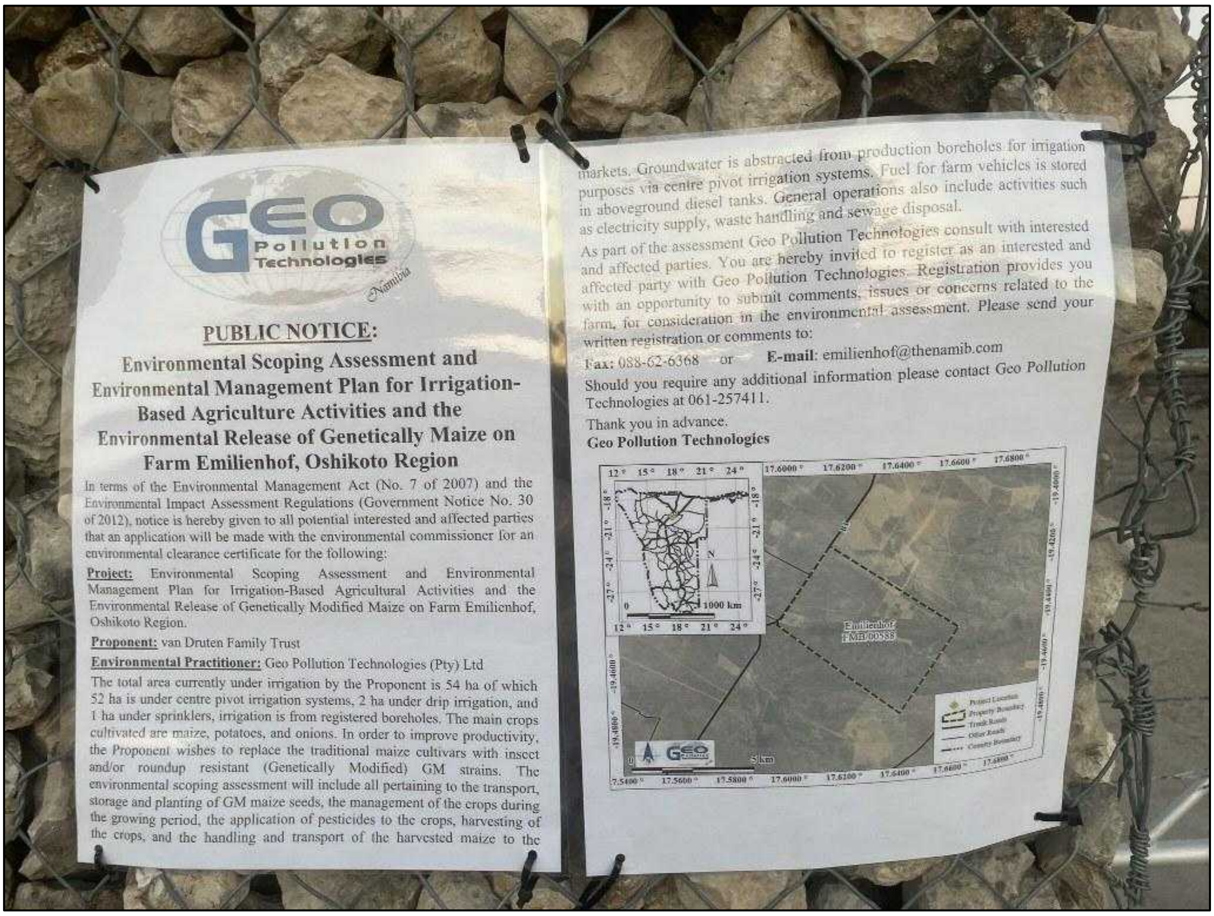
Geo Pollution Technologies
Namibia
PUBLIC NOTICE:
Environmental Scoping Assessment and Environmental Management Plan for Irrigation-Based Agriculture Activities and the Environmental Release of Genetically Maize on Farm Emilienhof, Oshikoto Region
In terms of the Environmental Management Act (No. 7 of 2007) and the Environmental Impact Assessment Regulations (Government Notice No. 30 of 2012), notice is hereby given to all potential interested and affected parties that an application will be made with the environmental commissioner for an environmental clearance certificate for the following:
Project: Environmental Scoping Assessment and Environmental Management Plan for Irrigation-Based Agricultural Activities and the Environmental Release of Genetically Modified Maize on Farm Emilienhof, Oshikoto Region.
Proponent: van Druten Family Trust
Environmental Practitioner: Geo Pollution Technologies (Pty) Ltd
The total area currently under irrigation by the Proponent is 54 ha of which 52 ha is under centre pivot irrigation systems, 2 ha under drip irrigation, and 1 ha under sprinklers, irrigation is from registered boreholes. The main crops cultivated are maize, potatoes, and onions. In order to improve productivity, the Proponent wishes to replace the traditional maize cultivars with insect and/or roundup resistant (Genetically Modified) GM strains. The environmental scoping assessment will include all pertaining to the transport, storage and planting of GM maize seeds, the management of the crops during the growing period, the application of pesticides to the crops, harvesting of the crops, and the handling and transport of the harvested maize to the
markets. Groundwater is abstracted from production boreholes for irrigation purposes via centre pivot irrigation systems. Fuel for farm vehicles is stored in aboveground diesel tanks. General operations also include activities such as electricity supply, waste handling and sewage disposal.
As part of the assessment Geo Pollution Technologies consult with interested and affected parties. You are hereby invited to register as an interested and affected party with Geo Pollution Technologies. Registration provides you with an opportunity to submit comments, issues or concerns related to the farm, for consideration in the environmental assessment. Please send your written registration or comments to:
Fax: 088-62-6368 or E-mail: emilienhof@thenamib.com
Should you require any additional information please contact Geo Pollution Technologies at 061-257411.
Thank you in advance.
Geo Pollution Technologies
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Appendix F: Consultants' Curriculum Vitae

ENVIRONMENTAL ASSESSMENT PRACTITIONER **Quzette Bosman**

Quzette Bosman has 16 years' experience in the Impact Assessment Industry, working as an Environmental Assessment Practitioner and Social Assessment practitioner mainly as per the National Environmental Legislation sets for South Africa and Namibia. Larger projects have been completed in terms of World Bank and IFC requirements. She studied Environmental Management at the Rand Afrikaans University (RAU) and University of Johannesburg (UJ), including various Energy Technology Courses. This has fuelled a passion towards the Energy and Mining Industry with various projects being undertaken for these industries. Courses in Sociology has further enabled her to specialize in Social Impact Assessments and Public Participation. Social Assessments are conducted according to international best practise and guidelines. Work has been conducted in South Africa, Swaziland and Namibia.

CURRICULUM VITAE QUZETTE BOSMAN

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	QUZETTE BOSMAN
Profession	:	Social Impact Assessor / Environmental Assessment Practitioner
Years' Experience	:	16
Nationality	:	South African
Position	:	Senior Environmental Consultant
Specialisation	:	ESIA & ESMP; SIA
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent German –speaking, reading - fair
First Aid Class A		EMTSS, 2017
First Aid LSM		OSH-Med International 2022
Basic Fire Fighting		EMTSS, 2017
Basic Industrial Fire Fighting		OSH-Med International 2022

EDUCATION AND PROFESSIONAL STATUS:

BA	Geography & Sociology	:	Rand Afrikaans University, 2003
BA	(Hons.) Environmental Management	:	University of Johannesburg, 2004

PROFESSIONAL SOCIETY AFFILIATION:
Namibian Environment and Wildlife Society
International Association of Impact Assessors South Africa (IAIA SA)
Member 2007 - 2012
Mpumalanga Branch Treasurer 2008/2009

OTHER AFFILIATIONS
Mkhondo Catchment Management Forum (DWAF): Chairperson 2008-2010
Mkhondo Water Management Task Team (DWAF): Member 2009

AREAS OF EXPERTISE:
Knowledge and expertise in:
- environmental impact assessments
- project management
- social impact assessment and social management planning
- community liaison and social monitoring
- public participation / consultation, social risk management
- water use licensing
- environmental auditing and compliance
- environmental monitoring
- strategic environmental planning

EMPLOYMENT:

2015 - Present	:	Geo Pollution Technologies – Senior Environmental Practitioner
2014-2015	:	Enviro Dynamics – Senior Environmental Manager
2010 - 2012	:	GCS – Environmental Manager (Mpumalanga Office Manager)
2007 - 2009	:	KSE-uKhozi - Technical Manager: Environmental
2006 -2007	:	SEF – Environmental Manager
2004 - 2005	:	Ecosat – Environmental Manager

PUBLICATIONS:

Contract reports	: +190
Publications	: 1

ENVIRONMENTAL ASSESSMENT PRACTITIONER Johann Strauss

Johann Strauss holds an B.A degree in Geography with Psychology and Environmental Management from the Northwest University (NWU) South Africa. He is currently in the process of pursuing his honours degree in environmental management from the University of South Africa (UNISA). He entered the environmental assessment profession at the end of 2022 and since then has worked on various Environmental Impact Assessments including assessments of the petroleum industry, irrigation schemes, tourism and transport industry.

CURRICULUM VITAE JOHANN STRAUSS

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	Johann Strauss
Profession	:	Environmental Assessment Practitioner
Years' Experience	:	2
Nationality	:	Namibian
Position	:	Environmental Consultant
Specialisation	:	Environmental Impact Assessments
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

EDUCATION AND PROFESSIONAL STATUS:

B.A Geography with Psychology and Environmental Management	:	North West University, 2021

AREAS OF EXPERTISE:

Knowledge and expertise in:

- Environmental impact assessments
- Environmental management plans
- Environmental monitoring
- Environmental auditing and compliance
- Manifold (GIS)

EMPLOYMENT:

2022-Date	:	Geo Pollution Technologies – Environmental Consultant

PUBLICATIONS:

Contract reports : 19