



FEBRUARY 2023

POTATO PRODUCTION GUIDE FOR NAMIBIA - 2023





ACRONYMS

CM	Centimetre
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organisation
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GM	Gross Margin
HA	Hectare
IPM	Integrated Pest Management
KG	Kilograms
KM	Kilometre
KNO₃	Potassium Nitrate
LAN	Limestone Ammonium Nitrate
MAP	Mono Ammonium Phosphate
MD	Man Days
MSP	Market Share Promotion Scheme
NAB	Namibian Agronomic Board
NPK	Nitrogen Phosphorus Potassium
NSI	Namibian Standards Institution
PTM	Potato Tuber Moth
T	Tons
TFC	Total Fixed Cost
TVC	Total Variable Cost





FOREWORD



Agriculture directly contributes about 9.48% to the Gross Domestic Product (GDP), with potatoes being the number one horticulture product highly consumed in Namibia. The Government of the Republic of Namibia has underscored the importance of agriculture to the national economy through the Sixth National Development Plan (NDP 6) and Vision 2030, and the Namibia Agricultural Policy.

Potato (*Solanum tuberosum* L.) is an important cash crop and source of food in Namibia. It plays a key role in contributing to food and nutrition security, poverty eradication, and employment creation.

Potato consumption is growing and this is attributed to urbanisation and population growth and changing consumer tastes and preferences towards fresh potatoes.

However, the current productivity levels are low, averaging below 35 tons per ha vis-a-vis 60 tons per ha achievable under recommended agronomic practices in other countries, and local production is very low, as only 40% of the potatoes traded locally are produced in Namibia. Improvements in the production and use of certified seeds, optimization of the use of inputs, disease control, and improved storage and marketing have the potential to transform the subsector into a more competitive industry. Strategic interventions in the industry are also important in helping achieve the government's agenda of food and nutrition security.

The Potato Production Guide for Namibia was developed through a desktop review of different potato production manuals/guides of various countries and primary information was obtained from farmers. This publication provides insights into the background of potato production in Namibia, harvesting and post-harvest handling practices, pest and disease management, and potato marketing.

It is a tool that will help achieve one of the objectives of the Market Share Promotion (MSP) Scheme of improving local production and marketing of Namibian products. The document is expected to guide a farmer, entrepreneur, and any other stakeholder, including the youth, on how to go about the potato production business.

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PRODUCTION PRACTICES - SUMMARY

OPERATIONS	AGRONOMICS AND TIMING
Botanical	<p>Botanical name – Solanum Tuberosum, Family – Solanaceae</p> <p>Origin – South America (Peru – Bolivia area) and grown on a large scale all over the world</p>
Potato plant growth stages	There are five potato growth stages: sprout development, vegetative growth, tuber growth, tuber bulking, and maturation
Climate	Potatoes are susceptible to frost and extremely cold temperatures. The optimum average temperature for potatoes' growth is about 25°C, whereas, the temperature above 30°C may slow down or stop the accumulation of carbohydrate in tubes, resulting in yield reduction. The optimum temperature for the growth of potatoes ranges between 7°C and 20°C.
Site and soil	<p>Silt clay loam, loam, sandy loam, friable</p> <p>Good draining, level field, avoid ponding</p> <p>PH: 6.0 – 7.0; sub-acidic soil suitable, acidic soils not suitable</p> <p>Organic matter: Good content (2-4%)</p> <p>Salt content of < 4mS /cm</p> <p>A farmer should therefore, take soil samples 2-3 weeks before planting</p>
Cultivars	When choosing potato cultivars, pay special attention to their growing conditions, potato maturity types, disease resistance, type of market, and market demand. Select healthy seeds that can produce a high yield. Cultivars grown in Namibia are imported from South Africa, namely, Mondial, Allison, Sifra, Panamera, Tyson, Valor, and Fandango, with Sifra and Mondial being the most commonly grown varieties. The Namibian Agronomic Board (NAB) conducted trials from 2020 to 2022 on some French potato varieties and recommended Barcelona, Rainbow, Montreal, and Spunta varieties for production in Namibia.
Crop rotation	Potatoes should return to the same field after 4 or better 5 years. Avoid rotation with other nightshade family plants such as pepper, tobacco, and eggplant. The best previous crop is wheat, soybeans, corn, and other cereals. Alfalfa and pastures are not good prior crops.
Cultivation	<p>Primary tillage: Potatoes require deep primary tillage. Mouldboard ploughs and disk rippers are commonly used for this task. Secondary tillage: Harrow disks, rototill, and tine harrows some days before the planting.</p> <p>Ridge width of 45cm and the height of 35cm.</p>
Planting time	<p>Area with no frost, no extreme cold winter and extreme hot summer: Plant potatoes from February to April in order to harvest from June to September, and again, plant potatoes from August to September in order to harvest in December/ January.</p> <p>Area with frost, extreme cold winter and cooler summer: Plant potatoes from August to February, in order to harvest from December to May/June.</p>
Spacing between rows, on-row spacing, and depth	From 75 to 90 centimetres between rows spacing. In-row spacing from 20 to 30 centimetres, at a depth of about 10 to 20 centimeters
Quantity of seeds	From 2,000kg (80 bags of 25kg) to 3,500kg (140 bags of 25kg) per hectare, depending on seed size. Target between 50,000 and 70,000 plants per





PRODUCTION PRACTICES - SUMMARY (continued)

	hectare.
Soil insecticide	Before planting or at planting
Fertilizing (Guidelines, to be corrected on soil analysis basis)	<p>Soil analysis: It is recommended to have your soil analysed by a reputable laboratory</p> <p>Fertilizer recommendations can then be based on the yield you would like to achieve, the fertility of the soil, and recommendations based on the soil analysis results. General fertiliser recommendations:</p> <p>Basal dressing: Apply 400 – 500 kg/ha of Superphosphate 10.5% and NPK 3:1:5 (38). If rotten manure/ compost is available, apply 20 – 40 tons/ha.</p> <p>Top dressing: Apply 100 to 150kg/ha of the following as per the fertilisation schedule under table 4: LAN 28%, Calcium Nitrate, NPK 3:1:5 38%, Potassium Nitrate (KNO₃)</p> <p>Caution must be taken to avoid burning the crop</p>
Irrigation	Use drip sprinkler irrigation system
Earthing up / Hilling	From 1 to 3 times during the cropping season to avoid greening of tubers
Weed control	Manual, mechanical, and chemical weeding methods can be used. Chemical weeding involving the use of pre-emergence spraying is common, and post-emergence after hilling (ridging). Only chemicals registered in Namibia must be used.
Pest and disease control	Spray the potatoes against diseases and pests during the whole growth season using different chemicals registered in Namibia
Harvesting	Days to maturity range from 80 to 140 days. Harvest when the potato plant dies, and in some cases, the plant can be killed using chemicals. Potatoes must be left in the ground for 1 week after the plant has been killed. Potatoes can be harvested manually using a digging fork and mechanically using a potato harvester.
Sorting and grading	<p>The requirements for the sorting and grading of potatoes for quality are contained in the Namibian Standard (NAMS 009:2021 – Marketing and commercial quality control of potatoes), including the food safety requirements to be met.</p> <p>During sorting and grading, remove and discard any rotten or infected tubers before storing them.</p> <p>Packaging and marking requirements are contained in the said standard, and products may be packaged in different containers (3kg pre-pack, 7kg, and 10kg pockets).</p>
Marketing	High-quality and clean potatoes can be marketed to local buyers or exported to other countries according to the needs of the market.
Production cost and Net Profit	Potato production costs per hectare in Namibia currently stand at N\$221,574.72/ha. An income of about N\$337,500.00 and a net profit of approximately N\$57 500.25 (taxable) can be realised per hectare.





1. INTRODUCTION

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Potatoes (*Solanum tuberosum*) are increasingly becoming an important food crop in Namibia for farmers as more consumers diversify their diets. They are produced almost in every country and the potato is the third most consumed crop in the world after wheat and rice (International Potato Centre, 2017). The potato possesses many desirable characteristics. It stores well, is nutritious, high-yielding, quick growing, and very versatile.



Source: NAB (2021)

According to FAO, the value per hectare of potatoes exceeds that of most food crops. Farmers can earn on average between US\$0.67 and US\$0.80 per kg for their potatoes. Potatoes are harvested for their underground edible portions called tubers which are either round, long/oval, or fingerlings, found in different colours such as white, yellow, purple, or red. People are also eating potatoes more especially in urban areas where they are becoming a staple food for their many uses. Potatoes can be boiled, baked, mashed, fried, and dried.

However, potato farming is not without its challenges. The cost to produce potatoes in Namibia is extremely high, especially compared to other countries. Potatoes can cost approximately between N\$200 000 and N\$221 000/ha to produce in Namibia. These costs include equipment costs, seeds, fertiliser, chemicals, irrigation, and labour. The high production cost of growing potatoes in Namibia has largely limited potato production to large-scale commercial farms.



Source: Hoss University (2021)

The reason is that high yields are necessary for profitability at current production costs. Smallholder farmers with limited resources, experience and knowledge have found it difficult to break into the potato farming world.

Despite the shortcomings, our view is that smallholder farmers can also grow potatoes commercially. There are good examples of countries like South Africa, Kenya, and Malawi where potatoes are grown commercially on a small scale. This guide does not guarantee you a bumper harvest but if you give your potatoes the right conditions and care and you are equipped with the right knowledge, then your success rate will skyrocket.

This guide covers basic information regarding potato production in Namibia, based on primary data collected from Namibian farmers, as well as from other secondary sources. This booklet contains information related to the botanical description, growth stages, climatic and soil requirements, land selection, soil requirements, seed and variety selection, cultivation practice, planting, fertilizer application, irrigation, ridging, pests and diseases, harvesting, sorting and grading, and marketing.





2. THE POTATO PLANT

Commercial potatoes are propagated by planting whole or cut pieces of a tuber, called seed potatoes or seed pieces respectively. New growth develops from the eyes (axial buds) of these 'seeds'. The result is a crop that is slow to emerge but then advances quickly as it accesses its large carbohydrate reserves.

Figure 1 shows the anatomy of a potato plant growing from a seed potato and the important structures of the plant.

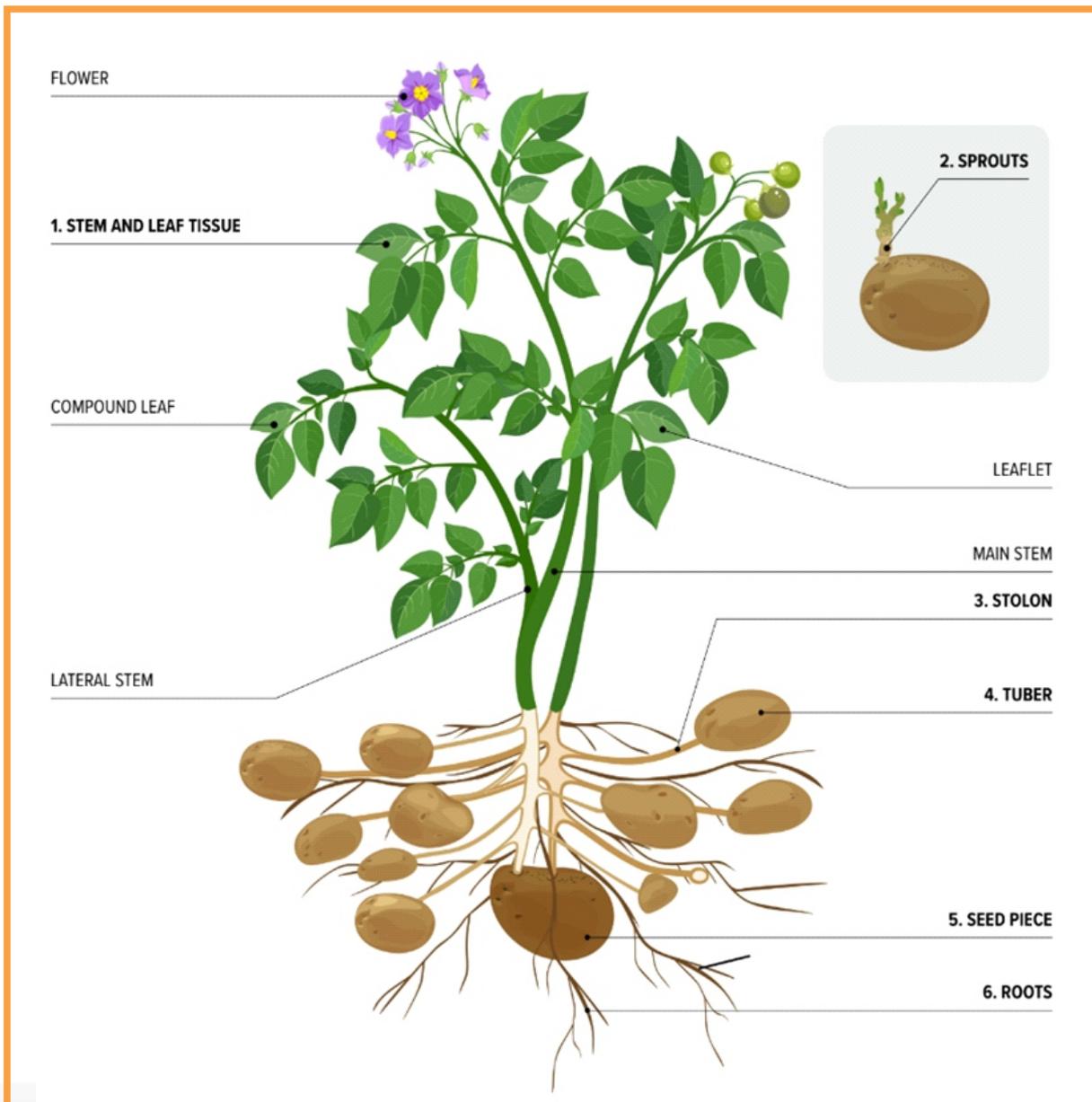


Figure 1: A potato plant propagated vegetatively from a cut seed piece; important below-ground and ground structures are highlighted. (Adapted from Thornton, 2020)





3. POTATO PLANT GROWTH STAGES

There are five potato growth stages: sprout development, vegetative growth, tuber growth, tuber bulking, and maturation.

The potato plant has five distinct growth stages

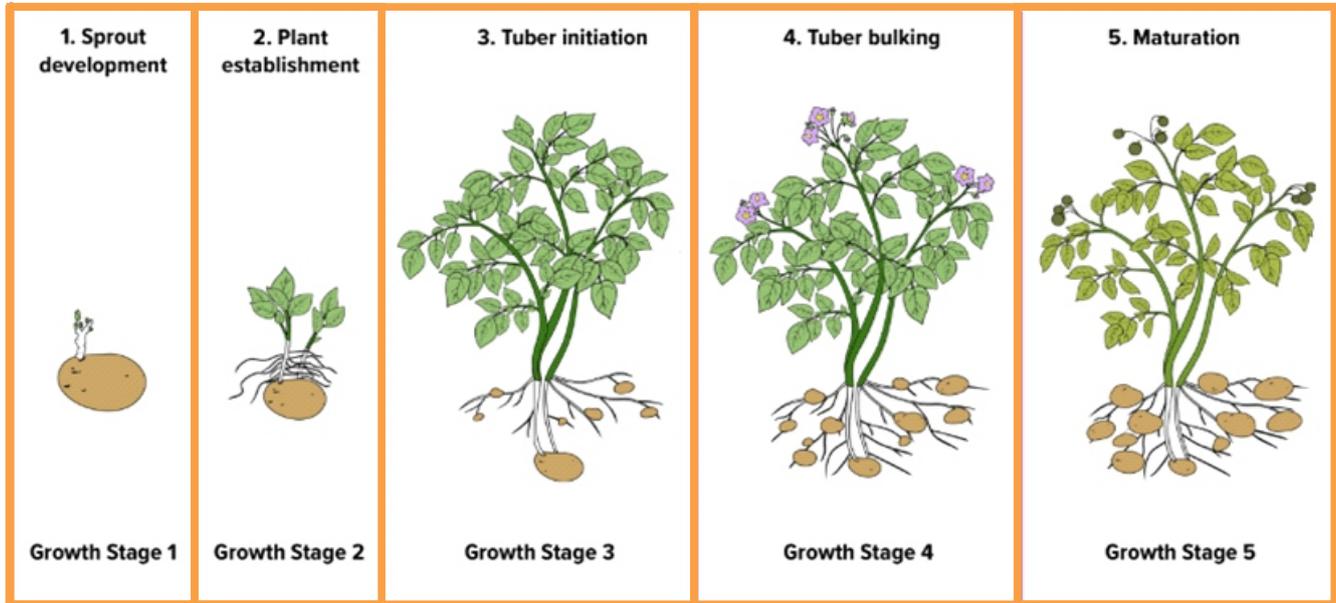


Figure 2: Growth stages of the potato plant (Thornton, 2020)

Stage 1: Sprout Development: The eyes of the potato develop sprouts. The sprouts grow and emerge from the soil. Sprouts and stems rise from the ground two to six weeks after planting depending on the climatic conditions.

Stage 2: Plant Establishment: Photosynthesis begins in the leaves and stems above ground. Stolons (underground stems) develop underground. The plant prepares to store nutrients in tubers.

Stage 3: Tuber Initiation: Tubers begin forming on the end of stolons; the stolon tips swell and tubers begin to form. Above ground, shoots develop ahead of flowers. Stolons usually swell before the plant flowers (Because the “root” of the potato plant is a stem, not really a root, thus potatoes are considered tubers). Tuber development begins 5 to 6 weeks after sprouts emerge from the soil.

Stage 4: Tuber Bulking: Tubers enlarge. Sugars and starches accumulate in the newly formed tubers. Optimal soil moisture and temperature as well as the availability of soil nutrients are very important for a good yield.

Stage 5: Maturation: The tubers reach full size. The leaves and stems above ground begin to dry out and die. Tuber skins harden. When the top of the plant dries out and dies, tubers are ready for harvesting. The harvest of mature tubers can begin 10 to 26 or more weeks after planting (70 to 120 days) depending on the variety. However, potato tubers can be harvested at any size they are edible.





4. CLIMATIC REQUIREMENTS

The potato has long been classified as a short-day, cool-season crop, but it does very well at high temperatures when water is supplied in uniform quantities that are sufficient to meet evapotranspiration demands. The highest yields are currently being produced in areas where the daytime temperature is often over 38°C during the hottest part of the growing season and nights are cool at 18°C.

A cool average soil temperature between 7°C to 20°C is optimal for potato growth (Naidoo, van Rij & Arathoon, 2010). Areas with a high number of frost days as shown in the diagram below should not be planted potatoes towards and during winter as frost may kill the potato plants, resulting in loss of yield.

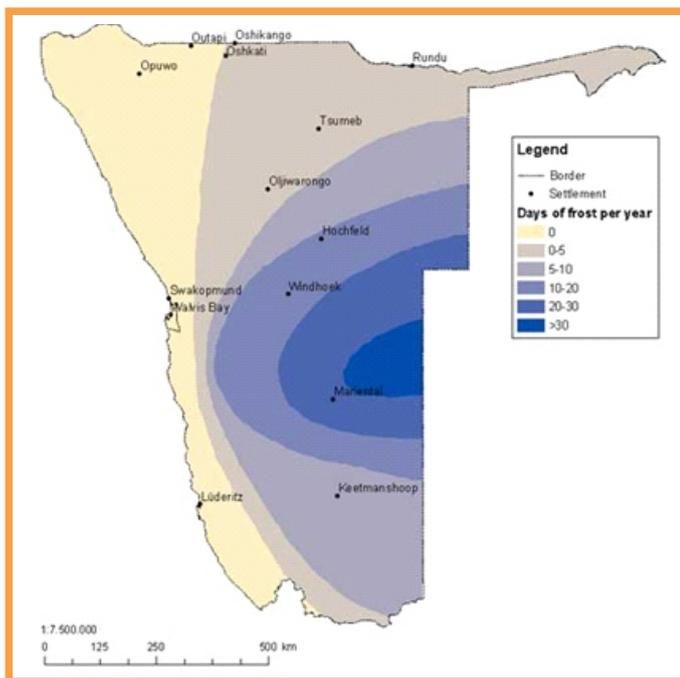


Figure 3: Days of frost per year

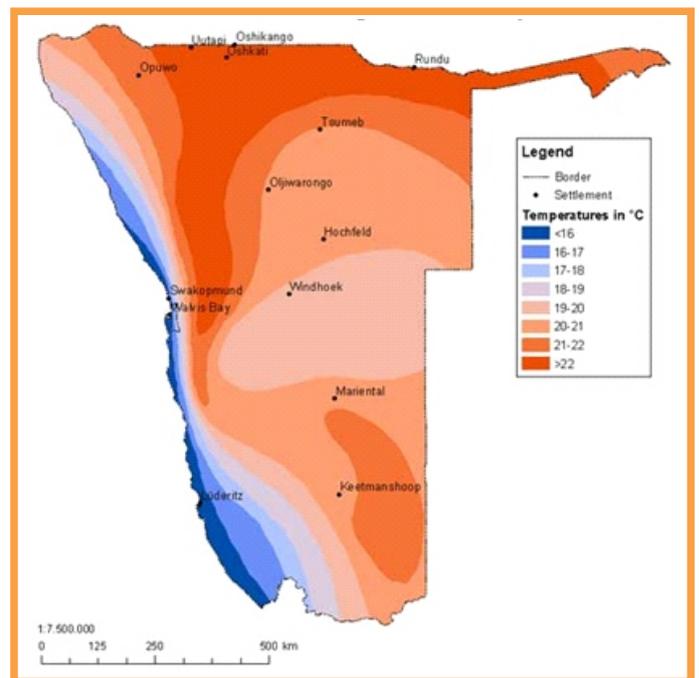


Figure 4: Average annual temperature

Source: http://209.88.21.36/Atlas/Atlas_web.htm





5. SOIL REQUIREMENTS

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5.1 Site and soil

Potatoes grow well on a wide variety of soils. In some areas where potatoes are commercially grown, the soils are acidic, whereas in others they are alkaline. The ideal soil for potato growing is deep, well-drained, and friable (Department of Agriculture, Forestry and Fisheries, 2013).

Potatoes can be grown in a wide range of soil types but well-drained loamy to sandy loam soil is the most recommended. Potatoes also grow well with adequate fertilisation even in sandy soils. Black soils that have undesirable physical and chemical qualities should be avoided. The pH should range between 5.0 and 7.0 but the ideal pH should be 5.5.

The soil should be deep, light, loose, and well-drained but able to retain moisture. It should also be free from pests and diseases such as bacterial wilt, nematodes, and blight. Blight requires a living host to survive between seasons.

Partially decomposed tubers, which give rise to plants known as 'volunteers', infected with late blight, are a major source of blight infestation in subsequent potato crops. Poultry can be used to remove the partially decomposed tubers from the field after the crop has been harvested.

6. POTATO CULTIVARS SELECTION

There are several varieties of cultivars with differences in shape, colour, texture, skin texture, size, yield, and days to maturity. Potatoes are grouped into 3 types: early, medium, and late maturing, and they are used for baking, chipping, and other multi-uses. The factors that affect the choice of cultivars include seed availability, yield, maturity, disease resistance, and market preferences.



Potato types, Source: Natasha Foote (2023)





POTATO CULTIVARS SELECTION (Continued)

The most common cultivars grown in Namibia are imported from South Africa, namely, Mondial, Allison, Sifra, Panamera, Tyson, Valor, and Fandango, with Sifra and Mondial being the most commonly grown varieties. The Namibian Agronomic Board (NAB) conducted research trials from 2020 to 2022 on some French potato varieties and recommended Barcelona, Rainbow, Montreal, and Spunta varieties for production in Namibia.

Table 1: Common potato varieties that are grown in Namibia

Variety	Picture	Average yield	Maturity Days	Skin Colour	Flesh Colour	Tuber Shape	Dry Matter Content
Mondial		Very High	Medium late (95 -115 days)	Cream	Cream	Long oval	19%
Sifra		Very High	Medium late (95 -115 days)	White	Cream (after cooking)	Round	18.90%
Allison		High	Medium late (95 -115 days)	Cream/ Yellowish	White	Long-oval, Oval	20.10%
Panamera		Very High	Medium late (95 -115 days)	Yellow	Light yellow (after cooking)	Oval	17%
Tyson		High	Medium late (95 -115 days)	Cream	Cream	Round oval	20.90%
Valor		High	Late (120+ dats)	White	Light cream	Short oval	–
Fandango		Very High	Medium late (95 -115 days)	Cream	Cream	Short-round Oval	19.50%
Barcelona		Very High	Late (120+ dats)	Yellow/ Cream	Whitish-yellow	Long oval	18.5%
Montreal		Very High	Early (80 -90 days)	Yellow/ Cream	Whitish-yellow	Short oval	20.50%
Rainbow		Very High	Medium late (+- 110 days)	Yellow/cream	Yellow/cream	Short oval	18.50%
Spunta		High	Medium late(+/- 110 days)	Yellow/cream	Yellow/cream	Long-oval	19.50%
Nicola		Moderate	Late (120+ dats)	Yellow/cream	Whitsh-yellow	Long-oval	17%
Satis		Moderate	Late (120+ dats)	Yellow/cream	Whitsh-yellow	Long-oval	18%

Average yield Levels: Low = Below 30 Tons/ha, Moderate = 30 to 40 ton/ha, High 40 to 50 tons/ha, Very high = above 50 tons/ha

Sources: Wesgro (2022), Marks (2010) & NAB (2021)





7. SELECTING HEALTHY SEED POTATO

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The most important element of successful potato farming is using good quality seed. Buy and use only uncut, certified, disease and pest-free "seed potatoes" (tubers), and in doing so you prevent a lot of problems later by starting with good quality seed. Tubers vary in size, colour, and texture. Seed tubers are usually about 25-55mm. Seed potato is the most expensive input for potato production, and makes up about 40% of input costs, and they are sold in 25kg pockets.

Sprouting the seed before planting allows the seed tuber to commence growth in the store before planting in the field, thereby resulting in a consequent reduction in the time from planting until emergence.

Sprout the seed potatoes by placing the seeds in trays out of direct sunlight at 18 degrees Celsius, then move them to a cooler place when they start to sprout. When shoots are 2.5 cm long, which takes about 6 weeks, they are ready to plant. Avoid excessive sprouting, as the sprouts can break during planting.

It is strongly advised to plant certified seed potatoes at all times as uncertified seed potatoes may bring diseases and pests to your field or may affect your yield. Where own tubers are used to replant, it should not be replanted more than once after its original certified version as seeds may lose original quality. Certified seeds are produced under virus and disease-free conditions. Additionally, tubers from retail shops are risky to plant as these tubers, especially the imported ones, may have been treated to prevent sprouting.



Sources: Wesgro (2022), Marks (2010) & NAB (2021)



Certified Seed potato, Source: NAB (2021)





7. SELECTING HEALTHY SEED POTATO (continued)

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Planting from true seeds may also not be ideal because the plants grow from a slender taproot with lateral branches, and only a few tubers are obtained in the end. Potato plants grown from true seeds develop one main stem vs many stems/stolons that develop from tubers and chances of roots developing from the stolon are occasional.



Matured potato plant, Source: NAB (2021)





8. SOIL PREPARATION

Soil preparation to grow potatoes is typically done using machinery to speed up the process. Plough the soil using a chisel/disc/mouldboard plough to a depth of about 20-25cm, to a fine tilth. You can also use a hand-held digger or a rotary tiller for working your soil before planting. It may take a little more time and energy but can be better for your soil structure. Do not till the soil when it is wet.

Follow through with a disc harrow to disc dead weeds. It takes many passes to get your soil to the ideal state for planting and good tuber development. Look into renting farm equipment and factor equipment rental and fuel costs into your overall costs. The next step is to make straight ridges using a potato ridger to set up ridges. Ridges should be between 75-90cm apart, with a 45cm ridge width.

<p>Disc Plough</p> 	<p>Chisel Plough</p> 	
<p>Mould Board Plough</p> 	<p>Rotary tiller</p> 	
<p>Disc Harrow</p> 		
<p>Ridger</p>		
<p>Manual Tools (<i>hoes, digging forks, measuring tape, builder's line</i>)</p>		

Source: Farm Cultivator Suppliers of Agricultural Implements (2023)





9. PLANTING POTATOES

In Namibia, potatoes are planted from December to April and then July to August, depending on local weather conditions. Sow sprouted tubers (seed potatoes) into the ridges at a planting depth of 10-20cm right way up with eyes (or chits) facing upward. Seed potatoes are planted by hand or machine planter. The ideal spacing for potato seed is 20 to 30cm apart within rows (intra-row) and the inter-row distance is 75 to 90cm and at least 1 tuber per stand. Seed size and soil fertility affect row spacing.

A hectare may need about 2,000kg (80 bags of 25kg) to 3,500kg (140 bags of 25kg) of seed potatoes, depending on seed size. The plant population should be at least 50,000 to 70,000 plants per hectare or more. Spacing plants far enough apart in the rows will give them enough room to thrive. Crowding them can cause reduced fruit yield, size, and quality. Cover over the tubers with at least 2.5 cm of soil. It takes about 10-15 days for plants to germinate. Days to maturity range from 80 to 140 days.

As the shoots emerge and reach about 4cm-6 cm tall, ridge the soil to cover most of the leaves. This is a process known as hilling. Hilling up (or ridging) soil around young potato plants increases yield, loosens the soil,

and prevents weeds. It also prevents tubers from greening and getting a bitter taste. Three weeks later, ridge (hill) again and top dress with fertiliser.



Mechanical planting, Source: Farm Cultivator Suppliers of Agricultural Implements (2023)



Sprouted potato planting, Source: Farm Cultivator Suppliers of Agricultural Implements (2023)



Potato manual planting, Source: NAB (2020)





10.1 Fertilization

A soil test is effective for a good fertilisation strategy. Apply fertiliser requirements based on your soil analysis results. Potatoes respond well to organic matter so provide them with well-rotted compost or manure to amend your soil.

Mix in 30t/ha of well-rotted manure evenly over the ridge/ seedbed. If farm yard manure is to be applied, it must be well rotten or applied 6 months before planting as it may attract nematodes. Using compost and soil amendments can help you reduce your fertiliser costs.



Fertiliser application, Source: AGRA (2019)

Potatoes need plenty of nitrogen, and both manure and compost are also good sources of nitrogen. Nitrogen is important for the overall development of plant stems and leaves. Signs of nitrogen deficiency are slow growth, stunting, and smaller than normal potato leaves.

However, the application of the different types of fertilisers will depend on the soil analysis results, soil type, and climate conditions. Do not overuse nitrogen, though, stick with the recommended quantities. Plants with too much nitrogen are far too lush and green and have little or no fruit. Do not put fertilizer on plants as it can scorch foliage. Instead, put it around plants. No fertilizer must be allowed to stay on the foliage (canopy), to avoid scorching foliage.





10. PLANT MANAGEMENT (continued)

Table 2: Nutritional elements required for potato growth

ELEMENT	FUNCTION	FERTILIZERS WITH THESE ELEMENTS IN LOCAL SUPPLY (IN NAMIBIA)
Nitrogen (N)	Protein synthesis (growth and production)	NPK, Urea, Ammonium Nitrate, Ammonium Sulphate, LAN, Calcium Nitrate, Potassium Nitrate
Phosphorus (P)	Cell division and energy formation	Superphosphate & MAP
Potassium (K)	Sugar transport and stomata control Potassium improves the tuber quality (size, starch content, and storability).	Potassium Nitrate, Potassium Sulphate & Potassium Chloride
Calcium (Ca)	Improve tuber resistance to disease infection	Calcium Nitrate, Calmag & Lime
Sulphur (S)	Special amino acids synthesis	Ammonium Sulphate, Potassium sulphate
Magnesium (Mg)	The core of the chlorophyll molecule	CalMag, Magnesium Sulphate & Magnesium Nitrate
Iron (Fe)	Chlorophyll formation	Nitrifed, Multifed, etc.
Manganese (Mn)	Essential for photosynthesis	Nutrifed, Multifed, etc.
Boron (B)	Cell wall division	Solubor, Nitribor & Borox
Zinc (Zn)	Plant hormone synthesis	Zinc & Zinc Sulphate
Copper (Cu)	Metabolism of nitrogen and carbohydrates	Nitrifed, Multifed, etc.
Molybdenum	Parts of nitrate reductase and azotase	Nitrifed, Multifed etc.





Table 3: General potato fertilizer programme for Namibia

Week No.	Fertilizer	Area (Hectare)	Kg per hectare	Number of Bags
Before Planting	Superphosphate 10.5%	1	400	8
At planting	NPK 3:1:5 (38)	1	500	10
Weeks after emergence:				
1	LAN 28%	1	150	3
2	Calcium Nitrate	1	100	4
3	NPK 3:1:5 38%	1	150	3
4	Calcium Nitrate	1	100	4
5	NPK 3:1:5 38%	1	150	3
6	Calcium Nitrate	1	100	4
7	Potassium Nitrate (KNO ₃)	1	100	4
8	Potassium Nitrate (KNO ₃)	1	100	4
9	Potassium Nitrate (KNO ₃)	1	100	4
10	Potassium Nitrate (KNO ₃)	1	100	4
11				
12				
13				
14				
15	<i>Kill the plant canopy (if not dry) with Paraquat chemical</i>			
16				
17	<i>Harvest</i>			

Source: Maraise (2022)

Agricultural Gypsum (calcium supplement) may be broadcasted pre-planting or at planting in furrows. It is important to ask the supplier if certain fertilizers can be mixed in the same tank or not, e.g. calcium, sulphate, and phosphate cannot be mixed in the same fertigation tank. Saline soils (high content of sodium or chloride) should be avoided as potato plants may die after a month.

10.2 Irrigation (Watering Potatoes)

Water is important for potato farming, so plan to set up irrigation early. Potatoes are shallow-rooted and need ample amounts of water during tuber setting and full growth. Keep the soil moist but not wet, using furrow, drip, or sprinkler irrigation. Drip irrigation is the best because it saves time, water usage, and effort. Provide extra water for early potatoes during dry conditions. However, centre pivot and sprinkler irrigation can be used to irrigate potatoes on a commercial scale, and under small-scale production, potatoes can be irrigated manually with a bucket or a horse pipe.

Potatoes are sensitive to drought. Water deficit during critical periods such as tuber development causes low yields and small tubers. If the soil dries after tuber development, the second growth will result in knobby potatoes. Dry conditions can cause hollow heart in potatoes.





Good watering tips:

- Water in the early morning or in the evening.
- Do not water during the hot period of the day, it leads to evaporation.
- Use soil moisture sensors and rain gauge to monitor water.
- End irrigation about 10 days before harvesting.
- Don't overwater



Centre pivot irrigation, Source: AGRA (2019)



Drip irrigation, Source: AGRA (2019)



Watering can, Source: Morning Chores (2009)



Sprinkler irrigation, Source: Grekkon Limited

Irrigation should begin before sowing (5 to 10 days before sowing). Tubers may decay if planted in cold wet soil and cool dry soil may delay sprouting and emergence. Consistent moisture is required, whereas water requirements may depend on variety, relative humidity, solar radiation, day length, season length, etc. Potatoes require not less than 460 mm over the growing season, however, 760 mm to 910 mm may be required sometimes depending on the soil type, weather, and cultivar.

Table 4: Frequency of irrigation required for potato growth in different soil types

SOIL TYPE	HOT MONTHS	COLD MONTHS	IRRIGATION REQUIRED
Light soils	3 to 4 days interval	5 to 7 days interval	25 to 30 mm
Heavy soils	4 to 5 days interval	8 to 9 days interval	30 to 35 mm





10.3 Weeding

Keep the soil free of weeds to ensure high yields. Weeding is easier with potatoes because of hilling. Potatoes have shallow roots, so be careful not to damage them with a hoe when you are hand weeding. Remove weeds early and often before they flower and set seed. Young weeds are also the easiest to remove. Tips for controlling weeds: Manually weed using a hand fork or hoe or mechanically using a cultivator. Then leave weeds in the sun to dry before discarding them.



Source: AGRA (2019)

Mulch with straw or compost to help suppress and control weeds. Solarize the soil before planting, and this should be done by trapping the heat of the sun using plastic and raising soil temperature to several degrees, thereby killing weed seeds, roots, and bulbs. Use pre- and post-emergence herbicides (such as Topogard, and Senco) if weeds are excessive.



Manual weeding tools, Source AGRA (2019)

10.4 Ridging/earthing up

A potato plant is a shallow root crop, therefore, excessive cultivation should be avoided when plants are growing. Earthing up by ridging is necessary to prevent tubers from greening and to prevent the tuber-moth from burrowing through soil cracks, as well as late blight disease. Potatoes need to be earthed again as they expand, at 25cm high, to avoid tuber exposure to the sun, and too steep ridges should be avoided as they may lead to erosion and fast drying up of the soil.

Earthing up a potato field using a tractor



Mechanical earthing up, Source: Marks 2010

Potatoes growing on ridges



Manual earthing up, Source: NAB (2021)





10.5 Crop Rotation

Potatoes are one of the best crops for opening up new land. Following potatoes, maize yields have proven phenomenal as this crop tends to utilize all the residual fertilizer in the soil after harvesting the potatoes. Only plant potatoes in the same field every four (4) to five (5) years.

11. PESTS AND DISEASE MANAGEMENT

The potato is often the victim of several pests and diseases which can cause crop losses if not properly managed. Minimize the chances of disease by planting disease-resistant seed potato varieties and rotating crops to a new field each year. Potatoes are susceptible to several common pests including aphids, nematodes, potato tuber moth, beetle, leaf miner etc.

11.1 Common Pests

Pest and disease control tips:

- Add organic matter (well-rotted compost/manure) to the soil
- Keep weeds under control
- Plant disease-free tubers
- Choose disease resistant varieties
- Rotate your crops
- Use mulch
- Irrigate well
- Remove and destroy infected plants
- Use pre-and-post emergence herbicides and fungicides
- Hand-pick large pests
- Sanitize tools
- Solarize soil using clear plastic to destroy harmful agents
- Use sticky traps for early pest detection and monitoring
- Use beneficial insect predators to attack pests
- Remove plants from fields at the end of the season and keep the field clean
- Use agricultural fleece





Potato leaf infested by aphids

Source: <https://www.agric.wa.gov.au/>

Nematodes: They are whitish, translucent worms, and they are barely visible. They live in the soil and attack plant roots. Signs of nematodes are stunted plants with yellow leaves. Control: Choose resistant varieties, rotate fields with grasses, use compost, and use sticky traps to detect and solarize the soil to prevent nematodes. Potato tuber damage by nematodes (nematodes are not visible to the naked eye).

Aphids: If the foliage on your plant curls, puckers, or turns yellow, it is a sign of aphids. Aphids are tiny green, brown, or pinkish insects that appear on the undersides of leaves. These are a serious threat to young plants

Control: You can attract beneficial bugs such as ladybugs and wasps to eat aphids. Other solutions are blasting with a hose, pyrethrin, and neem. Chemical control: Thionex, Azodrin



Potato tuber damaged by nematodes,
Source: Holmes (1999)



Potato Tuber Moth

Source: Insect Science (2023)

Potato Tuber Moth: Larvae that make tunnels in the plant, and the plants will wilt and die.

Solution: Ridge plants. Chemical control: Azodrin or Novacron.





Potato leaf hopper,
Source: University of Kentucky

Flea Beetle: If you find several holes or perforations in the leaves of your plants, the plants may have flea beetles. Flea beetles are long, shiny, and black with yellow or white markings.

Control: Rotate your crops, use sulfur and neem. Apply 2 applications of pyrethrum 3 to 4 days apart.

Potato Leafhopper: Leafhoppers pierce leaves, buds, and stems and thus making potato plants to be weak. They put small white specks of freckle leaves and the leaf edges turn brown.

Control: Use pyrethrum, neem, and through weeding, and sanitize implements after harvest



Flea Beetle, Source: Beaulieu (2023)



Potato leaf damaged by maggots of leaf miner, Source: Nduwayezu, Uwumukiza and Ingabire (2023)

Leaf miners: Silvery grey trails loop through the leaves. Headless, legless, whitish maggots inside the leaves. The adult insect is a fly.

Control: Weeding, rotating your crops, using pyrethrin, and neem, and encouraging beneficial insects.





11.2 Common Diseases (viral, fungal and bacterial)

Early Blight: Also known as leaf spot. Signs are circular and irregular dark spots that develop on older leaves. The spots have yellow halos.

Control: Manage water, mulch, and weed. Chemical control: Apply fungicides (Ridomil, Dithane) every 7-10 days according to directions.

Late Blight: Occurs when relative humidity is above 70% and temperature is 22-25 degrees Celsius. Spreads quickly in the wet season. Signs are purple or brown-black areas on the blade of the leaf or leaf stalk. Fruits will have large and greasy brown spots.

Control: Hill the rows to help prevent spores from getting to the tubers. Remove all infected foliage at once and discard it. Don't compost it.

Potato Scab: Areas of the surface become brown and roughened. Caused by soils with a high pH and that are dry. Unightly but still the potato is edible.

Control: Manage water, improve drainage, weed, mulch and don't lime.

Blackleg: A bacterial disease that causes stunting and wilting of plants, and a decrease in yield. It thrives in wet conditions. Signs are blackening and decay of the lower stem.

Fusarium Wilt: Causes yellow foliage, brown discolouration, and wilting of leaves and stems.

Verticillium Wilt: Later in the season leaves infected with verticillium wilt become yellow and die.

Control: Apply a sulphur fungicide every 7 to 10 days once the symptoms have been found.

Remember: Prevention practices are most effective (cost and effort) in the long run.

Using Chemical Control:

If spraying becomes necessary only use a chemical that is specific against the particular pest involved and use it strictly in line with the manufacturer's instructions.

Never spray a chemical without knowing what it's for and properly identifying the pest. Chaos spraying can damage crops.

Choose the weakest chemical if it can do the job. You can buy insecticides, pesticides and herbicides from different agri-input suppliers in Namibia.

Tips for good use of chemicals

- Fully read directions before you spray
- Wear protective clothing
- Mix chemicals in a well-ventilated room
- Choose a cool and dry day to spray
- Wash your hands and face after using chemicals
- Store chemicals out of the reach of children
- Do not overdose, it does not help





12. HARVESTING AND STORING POTATOES

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12.1 Harvesting

In Namibia, potatoes are mainly harvested from May to September and then from December to January, approximately within 80 to 120 days after planting. Correct harvesting and timing are important. Potatoes can be harvested by hand-digging and using garden forks or a mechanical lifter (potato harvester) to unearth the entire plant. Harvest the potatoes once 95% of the foliage begins to die. To facilitate harvesting, remove potato haulms two weeks before harvesting. It can help firm the potato skins for storage. Harvest in the morning during dry periods. Be careful when harvesting to avoid bruising, skinning, or cutting the tubers.



Mechanical harvesting
Source: Farm Cultivator Suppliers of Agricultural Implements (2023)



Manual harvesting, Source: NAB (2020)

Leave the potatoes on the surface of the soil for at least a few hours to dry their skins. In hot conditions put them in a sheltered place to avoid a drop in quality.

The average yield for potatoes in Namibia is 30-35t/ha in summer and 40-45t/ha in winter. According to the International Potato Centre, attainable potato yields can be as high as 60t/ha with good farm management.





12. HARVESTING AND STORING POTATOES

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12.2 Sorting, Grading, and Packaging

The requirements for the sorting and grading of potatoes for quality are contained in the Namibian Standard (NAMS 009:2021 – Marketing and commercial quality control of potatoes), including the food safety requirements to be met.

During sorting and grading, remove and discard any rotten or infected tubers before storing them.

Packaging and marking requirements are contained in the said standard, and products may be packaged in different containers (3kg pre-pack, 7kg, and 10kg pockets).

Copies of this standard can be obtained at a minimal fee from the NSI's Standards Publications, Sales & Information Division (Tel: +264 61386400, email address: sales@nsi.com.na).

Potatoes can be cleaned, sorted, graded and packed by a machine, and manually by hand



Potato cleaning, sorting and packaging machine
Source: First Industry, CO, LTD (2020)



Potato manual cleaning
Source: Getty Images (2023)



Potato grading and packaging machine
Source: First Industry, CO, LTD (2020)



Potato manual sorting and grading
Source: Pepper Equipment (2020)





12. HARVESTING AND STORING POTATOES (cont.) 28

12.3 Storage

Good storage is important for maintaining potato quality before marketing. Store potatoes at ambient temperature in a cool, dark, and well-ventilated building. Good storage prevents dehydration, sprouting, and bruising. It is important that potatoes are protected from light otherwise they will go green and become toxic. Use light only when very necessary.

Store potatoes dirty at between 3 - 5 °C. Potatoes can be stored in pallets for short periods of about 4-5 months. Long-term pallet storage is not recommended due to poor air circulation. Well-stored potatoes can be stored for up to 6 months or more.

13. MARKETING

Farmers must make plans for marketing potatoes before planting, and transport arrangements must be made before harvesting. If as a farmer you can coordinate marketing with other farmers then consider it as it can reduce marketing and transportation costs. Farmers must be careful when transporting their potatoes as they can be damaged during transportation due to mishandling, and hence make sure that you monitor how your potatoes are handled. Package potatoes in the right containers depending on your market. Most potatoes sold on the Namibian fresh market are sold in 7kg and 10kg pockets.

Consumption trends: There is an increasing demand for potatoes in urban areas from the growing number of fast food outlets and restaurants. More consumers are diversifying their eating habits and eating more fresh chips (French fries). Demand for potatoes is affected by price, and if they are too expensive consumers will buy less and substitute them for a cheaper option. The fresh potato demand in Namibia currently stands at about 50 0000 tons (4,166 tons per month) inclusive of both the formal and informal markets, and more than 60% of this is being imported from South Africa.

Selling to the fresh market: Farmers must deliver clean and quality potatoes to the fresh market (formal and informal), and they have to remember that they are competing with imports from South Africa that are of higher quality and are clean, which most customers prefer.

The prices of fresh potatoes in the fresh market are affected by supply and demand, and this fluctuation makes potato prices largely unstable. The NAB provides a weekly update on market prices by always checking for historic prices of potatoes and keeping track of current market prices.

When selling to supermarkets or wholesalers, you need to understand the quantities required, the payment terms, and the quality requirements. Some supermarkets may require you to grade, wash, sort, and package your potatoes before you supply them.

Exporting: There is potential to export potatoes to countries such as Angola, South Africa, and the Democratic Republic of Congo (DRC). Smallholder farmers need to coordinate marketing efforts with other potato farmers to make it possible, while big farmers can export on their own. It is important to know the export regulatory requirements of each country before exporting your potatoes, including the requirements of the buyer.





14. CONCLUSION

This is a full breakdown of what it takes to grow, harvest, and market potatoes in Namibia. Remember that you need to focus on your soil, the quality of tubers, the right planting time, fertilisation, weeding, irrigation, and pest and disease control if you want to have a good potato crop.

ANNEXURE 1: POTATO PRODUCTION ENTERPRISE BUDGET Guide for one (1) hectare (Estimates only)

POTATO CROP BUDGET					1ha	
INCOME						
	Units	Units (kg/ha)	Estimate Price (N\$/kg)	Total Revenue (N\$/ ha)		
Sales	Kg	45,000	7.5	337,500.00		
Variable Costs						
Cost Description	Unit	Quantity	Cost/Unit	Total Cost/ ha	Sub-Total & % share of Total Cost of Production	
PLANT MATERIAL						40,000.00
Seeds	25kg Bag	100	400	40,000.00	18%	
LAND PREPARATION						2250
Discing/ Harrowing	Ha	1	750	750	1%	
Ripping	Ha	1	750	750		
Ridging	Ha	1	750	750		
FERTILIZERS						35,640.00
NPK 3:1:5	50kg Bag	8	1020	8,160.00		
Superphosphate 10.5%	50kg Bag	8	680	5,440.00		
KAN 28%	50kg Bag	3	900	2,700.00		
Calcium Nitrate	25kg Bag	12	680	8,160.00	16%	
Potassium Nitrate	25kg Bag	16	680	10,880.00		
Borox	2kg	1	300	300.00		
AGROCHEMICALS						5,939.61
Progib or Plant Start (Growth hormone)						
Lamda (potato tuber moth)	Litre	1	225	225	3%	
Agrimectin/ Abamectin	Litre	1	195.11	195.11		
Aroxytrobin/ Aroxy (Early & late Bright)	5litre	0.5	2970	1485		
Cyromazine (American Leaf Miner)	10kg(10)	1	1207.5	1207.5		
Oxymil, Platoon, or Oxadate (nematode)	5litre	0.5	1280	640		
Terbifos (Nematodes)	18kg	1	600	600		
Aziphos (Potato tuber moth)	5litre	1	1587	1587		
IRRIGATION						15,000.00
Electricity	kW	4 746.84	3.16	15,000.00	7%	
LABOUR						12,463.20
Planting	Man/day	52	57.7	3,000.40	6%	
Fertilizers Application	Man/day	30	57.7	1,731.00		
Weeding	Man/day	74	57.7	4,269.80		
Irrigation & Spraying	Man/day	30	57.7	1,731.00		





14. CONCLUSION (continued)

Harvesting & Packaging	Man/day	30	57.7	1,731.00	
PACKAGING, TRANSPORT & TELEPHONE					46,205.00
Packaging	Pocket 10 kg	4,500	7	31,500.00	14%
Transport (inputs & Outputs)	Trip	17	800	13,600.00	6%
Telephone	Month	5	221	1,105.00	0.5%
Total Variable Costs (TVC)				157,497.81	
Percentage Share TVC takes from Total Costs				71%	
Gross Profit				180,002.19	
Gross Margin				53%	
FIXED COSTS					
	Unit	Number of units	Cost/Unit	Total Cost/ha	
Salaries	Month	5	3500	17,500.00	8%
Depreciation (Equipment, Machinery & Buildings)	Month	5	5842.11	29,210.55	13%
Land Lease	Month	5	1666.67	8,333.35	4%
Miscellaneous (5% of Cost of Production): <i>Handling, stationery, courier, cleaning, advertisement, repair & maintenance</i>	Times	1	9,033.02	9,033.02	4%
Cost of the standard	Once-off	1	75	75.00	0.03%
Training on the training costs	Once-off	1	3000	3,000.00	1%
Total Fixed Costs N\$/ha (TFC)				67,151.92	
% Share Total Fixed Cost taken from Total Costs				30%	
Total Cost (TC) of Production N\$/ha				224,649.73	
% share Total Cost taken out of Total Revenue				67%	
NAB Levy (1.4% of Total Sales)				4,725.00	
Net Profit Before Interest & Tax N\$/ha				108,125.27	
Less: Opportunity Cost (10.5% pa) @ 5 Months				9,828.43	
Profit After Interest N\$/ha (Before tax)				98,296.84	
Less: Value Added Tax (VAT 15%)				50,625.00	
Net Profit (Taxable Income)				57,500.27	
% share Net Profit taken out of Total Revenue				17%	
Break-Even Analysis					
Break-Even Price (N\$/kg)				4.99	
Break-Even Yield (kg/ha)				29,953	
SENSITIVITY ANALYSIS					
Yield per hectare (kg)	Break-Even Price (N\$/kg)				
70,000	3.21				
55,000	4.08				
45,000	4.99				
<p><i>The sensitivity analysis indicates that the lower the yield, the higher the break-even price. For example, at a yield of 70 000 kg per hectare, the break-even price was N\$ 3.21 per kg, but when the yield decreased to 45 000 per hectare, the break-even price increased to N\$ 4.99 per kg.</i></p>					





15 REFERENCES

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Alliance for a Green Revolution in Africa (AGRA). (2019). A fertiliser mix that works for the soil. <https://agra.org/news/a-fertiliser-mix-that-works-for-the-soil/>.

Department of Agriculture, Forestry and Fisheries. (2013). Potatoes production guideline. SA. https://www.academia.edu/30814223/production_guidelines_Potatoes_Potaotes.

Farm Cultivator Suppliers of Agricultural Implements. (2023). <https://www.indiamart.com/proddetail/suppliers-of-agricultural-implements-26171875797.html>.

Farmbiz Africa. (2023). National-government-to-provide-meru-farmers-with-certified-potato-seeds. Farmbiz Africa.com.

Holmes. G. (1999). [Root-knot nematode \(Genus Meloidogyne\) \(ipmimages.org\)](http://ipmimages.org). [root-knot nematode Meloidogyne spp.](http://ipmimages.org)

International Potato Centre. (2017). https://cipotato.org/press_room/blogs/potato-production-in-africa-can-be-increased-by-140-find-out-why/.

Insect Science (2023). [Tuber moth \(Potato\) - Insect Science](https://www.insectscience.org)

Jianhua. (2019). Potato production technology. Hunan Academy of Agricultural Sciences. China.

Maraise. (2022). Personal conversations and training sessions are offered to potato farmers in Namibia.

Marks, D. (2010). [Independent assessment of the Valor potato variety \(gardenfocused.co.uk\)](http://gardenfocused.co.uk) <https://www.potatopro.com/potato-varieties/valorPro>.

Mendelson. J., Jarvis. A., Roberts. C., & Robertson. T. (2003). Atlas of Namibia: A portrait of the land and its people. [www.researchgate.net/publication/263546846-Atlas of Namibia](http://www.researchgate.net/publication/263546846-Atlas_of_Namibia).

Morning Chores. (2009). [9 Irrigation System Options for Effortless Watering on Your Garden \(morningchores.com\)](http://morningchores.com)

Naidoo, M., van Rij, N., & Arathoon, J. (2010). National Department of Agriculture: Directorate Food Safety and Quality Assurance. Potato production for Kwazulu-Natal. SA https://www.kzndard.gov.za/images/Documents/researchandtechnologydevelopment/publications/Research_and_Technology_Bulletins/Potato-production-for-Kwazulu-natal.pdf.

Namibian Agronomic Board (NAB). (2020–2022). www.nab.com

Namibian Agronomic Board (NAB). (2021). Adaptability of French Potato Varieties In Namibia – 2nd Trials. <https://www.nab.com.na/research-and-development/research-reports/>.

Natasha, F. (2023). 11 of the Best Potato Varieties to Grow at Home. <https://gardenerSPATH.com/plants/vegetables/best-potato-varieties/>.





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