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RESEARCH AND POLICY DEVELOPMENT SUBDIVISION

ADAPTABILITY OF FRENCH POTATO VARIETIES IN NAMIBIA

## **FINAL REPORT**





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#### ABSTRACT

In an attempt to facilitate the development of the potato value chain, The Namibian Agronomic Board (NAB) collaborated with farmers in conducting on-farm trials to test new seed potato varieties obtained from the Comptoir Du Plant company in France. The aim was to assess the adaptability of six (6) French potato varieties to the Namibian soil and climatic conditions, that can be used to close the gap in access to quality and affordable seed potato varieties that are adaptable to Namibia's soil and climatic conditions. Hence, on-farm trials were conducted on the six French potato varieties (Barcelona, Montreal, Nicola, Rainbow, Satis, and Spunta) with three local varieties (Allison, Mondial, and Panamera), at four different trial sites (Hochfeld, Doringboom, Guinas and Oshikoto farm). From the population of 240 plants per trial site (30 plants per variety), 20 plants per variety were sampled for the evaluation of dates of emergence, dates of reaching full canopy cover after emergence, pests and diseases, yield, tuber size, tuber shape, skin texture, skin colour, French fries' colour, and tubers' dry matter content. Results show that on average Allison and Mondial emerged first, whilst, Nicola and Rainbow reached full canopy cover first after emergence. Early blight disease, potato tuber moth, and American leaf miner were observed in all tubers, with insignificant differences in the attack on both check varieties and French varieties.

Regarding average yield, Mondial (check variety) scored the highest (73 tons/ha), followed by Spunta (66 tons/ha), Rainbow and Allison (both 62 tons/ha), and the least Panamera (38 tons/ha). Spunta and Montreal recorded the highest number of large/medium and large potato size groups with greater than 50mm size whilst Panamera (check variety) recorded too many tubers that are smaller than 50mm. There were no significant differences found between French varieties and check varieties in terms of the colour of tubers, flesh colour inside of the tubers, and the shapes of tubers. All French varieties had yellow skin tubers, with the exception of Montreal with whitish-yellow tubers. Allison, Mondial, and Panamera (check varieties) had whitish-yellow flesh colour inside tubers, which looked the same as Rainbow. Barcelona, Satis, and Spunta had yellow flesh inside tubers, whilst, Montreal and Nicola had white flesh inside tubers. Irrespective of varieties, the majority of the potatoes were long-oval, oval, and/ or short-oval, except Barcelona which was rather round. However, all these shapes are acceptable in the Namibian market. All harvested varieties scored within the standard average dry matter content level (15% - 25%). Allison (check variety) scored the highest (19%), followed by Rainbow and Satis (both 18%).

On sensory evaluation, Spunta and Rainbow scored the highest, with no significant difference with check varieties in tuber colours (exterior and interior) and tuber shapes. 'Strongly like' dominated the scores of all varieties tested in terms of aroma and texture. Out of the total number of chip strips assessed for French fries, all of them had a colour of either Light, Slightly Light, and Neither Light nor Dark. Lastly, there were no significant differences between the flesh colour of fresh and boiled potatoes across varieties. Based on these results, the trial study recommends further trials on the French potato varieties to obtain longitudinal evidence for adoption so as to complement the local varieties that are normally imported from South Africa. Potato growers are, however, advised to select the varieties that performed as per the target market preferences.

*Keywords:* French varieties, standard/check varieties, yield, skin colour, skin texture, dry matter content, French fries, sensory evaluation, pests, and diseases.



## 1. INTRODUCTION AND BACKGROUND

Potato (*Solanum Tuberosum*) is the most consumed horticultural produce in Namibia, with more than 33 000 tons traded by the formal market during 2018/19, of which more than 23 000 tons were imported from South Africa. Research has indicated inconsistent access to good quality seed potatoes by farmers to be the major attributor of low domestic potato production in Namibia. Therefore, The Namibian Agronomic Board (NAB) in collaboration with Comptoir du Plant company in France, and The Embassy of Namibia in France, embarked upon a project to test the adaptability of the French potato varieties to the Namibian soil and climatic conditions.

About 30 kg of seed potatoes that comprised of six (6) French potato varieties were sent by Comptoir du Plant and arrived in Namibia in early December 2020, for trial purposes. These potato trials were voluntarily planted at four (4) different sites (farms) in Central and Karst production zones. These four (4) volunteer farmers sacrificed their production inputs, labour, and time to manage the trials; whereas, NAB catered for transport, technical guidance on the establishment of the trials, and data collection. All four volunteer farmers managed to plant the six (6) French potato varieties, which are; Barcelona, Montreal, Nicola, Satis, Spunta, and Rainbow, accompanied by three (3) South African varieties – Allison, Mondial and Panamera that were used as standard or check varieties.

Despite some rampant climatic challenges experienced such as prolonged dry periods and sporadic heavy rainfalls, the potato trials were successfully planted, with three trials successfully harvested. Though with some variabilities among the potato varieties planted, they indicated positive responses as evidenced by good germination, good canopy cover, and successful tuber initiation. Three of the potato trials were successfully harvested, whereby the NAB witnessed commendable yields across varieties, both in terms of quantities and quality, though at variable intensities. There were no momentous differences between French potato varieties and standard varieties that are traditionally planted in Namibia, ranging from skin colour, flesh colour, and tuber shape.

The potatoes harvested from trials underwent the dry matter content analysis process, which has also shown positive results. Furthermore, these potatoes underwent the sensory evaluation exercise, which was carried out at the International University of Management (IUM) in Windhoek. Though at diverse magnitudes, those who participated in the sensory evaluation generally attested to the presence of good aroma, texture, and colour of French fries from all varieties under trials.

It was therefore, recommended for Namibian potato growers to further embrace sourcing seed potato from France, should the purchase price and transportation costs be in a feasible region. Further trials on the seed potato varieties are recommended. Various markets prefer different tuber shapes and tuber sizes, thus making it difficult to generalise the best variety among others.



# 2. PROBLEM STATEMENT

Despite being the most consumed horticultural crop in Namibia, constituting about 39% of domestic demand for horticultural products, potato farming remains a challenge especially in terms of access to seed potatoes and value addition. Availability and access to good quality seed potatoes remain the biggest challenges to Namibian potato producers as they have to order seed potatoes in bulk and at least three months in advance, which has negatively affected local potato production.

Potato breeding in Namibia is non-existent as seed potatoes are sourced from South Africa, which is a costly exercise. Namibian potato growers have especially expressed concern of limited supplies of seed potatoes from South Africa during the period of February to May each year, due to South African seed producing companies prioritising their local farmers.

Therefore, these potato trials sought to address the challenge of limited access to quality and affordable seed potatoes in Namibia, through the identification of more potato varieties that are suitable to Namibia's climatic and soil conditions. This would create an opportunity for producers to have access to a wide range of seed potato varieties that are suitable to their soil types and climatic conditions, with high yields and also less susceptible to pests and diseases. The potato trials may also open opportunities for seed potatoes production and multiplication. This development will not only improve local potato production but will also create job opportunities for the locals, thus contributing to the local economy.

#### 3. OBJECTIVES

The main objective of the trials was to assess the adaptability of six (6) French potato varieties to the Namibian soil and climatic conditions.

### The specific objectives were:

- To assess the performance of the French potatoes versus local potato varieties on specific potato growing parameters: days to emergence, canopy cover, yield per unit area, and tuber sizes and shapes;
- To assess the internal and external qualities of the French potatoes versus local potato varieties in terms of colour, texture, and dry matter content; and
- To give recommendations to producers on best performing varieties based on the above parameters.

#### 4. SIGNIFICANCE OF THE STUDY

This potato trial results can enable access by Namibian farmers to high-quality seed potato varieties of which suitability for the Namibian soils and climatic conditions were tested. This, in turn, can increase potato production in the country. The potato trials will also avail relevant information that can trigger domestic and foreign investment into the potato value chain. Recommendations from this study can also aid policy interventions that may facilitate the increment of local potato production.



## 5. RESEARCH METHODOLOGY

The study is primarily experimental, where six (6) French potato varieties were tested for adaptability to the Namibian soil and climatic conditions against the local/standard varieties (imported from South Africa). A trial design of 30 plants per variety was therefore planted at four sites (farms) in the central and Karst production zones, for capturing data such as emergency date, days from emergence to reaching full canopy cover, and pests and diseases. During the harvest of the potato trials at each trial site, data such as *yield, tuber size, tuber shape, skin texture, and skin colour* were captured. The harvested potatoes were further subjected to experimentations on dry matter content analysis, frying (French fries), and cooking (boiling). Moreover, an evaluative research approach was also applied to determine the acceptability (sensory evaluation - colour, shape, aroma, and texture) of the harvested French potatoes to the Namibian market.

#### 5.1 Trial Design

The seed potatoes were planted under the design submitted by the Comptoir du Plant.



- The 5 plants before and after could be harvested during the season to evaluate the growth
- The 20 plants should be harvested at the end to realize the real behaviour of the variety
- Plants should be planted 3 cm below the soil
  Each row should be separated by 75 cm
- Each row should be separated if
   The density is 40 000 plants/ha
- Between each plants on the same row leave 33 cm

#### Figure 1: Trial design (Comptoir Du Plant, France)

Figure 1 above presents the specific trial design used at all four trial sites. The design comprised of 8 varieties – six (6) French varieties and two (2) local varieties. The blue lines at both margins represent the border rows that were not to be sampled. Red lines represent 20 plants that were sampled for representative evaluation per variety, whilst leaving five (5) being planted at each end row that is in green colour.

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### 5.2 Population and Sampling Strategy

The trial population was 240 plants from six French potato varieties (Rainbow, Barcelona, Montreal, Satis, Nicola, and Spunta). Additionally, 90 plants from three local (South African) varieties were also planted as standard varieties for benchmarking purposes only. Due to the scarcity of local seed potatoes in Namibia, this study could not use similar standard varieties at all four sites. Therefore, Panamera was used as a standard variety at three sites, whilst Allisson and Mondial varieties were used at one site. Thirty (30) plants of standard varieties were hence planted at trial marginal rows (end rows). The study initially established four trial sites, but only three sites succeeded to harvest. A representative sampling method was applied to select the plants that were harvested during and post-harvesting data collection. Twenty (20) plants were thus harvested from each variety including standard varieties, leaving out 5 plants at both two ends of the rows for each variety.

#### 5.3 Data collection

The process of data collection commenced from the sowing stage throughout to germination and harvesting (tubers counting, weighing, colour, and shape evaluation). Furthermore, a few selected tubers were subjected to dry matter (moisture content) analysis and sensory evaluation, as shown in the figure below (Figure 2).



Figure 2: Potato Trials Data Collection and Analysis Process

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# 5.3.1 Planting, Emergence, and Full Canopy Development

Depending on soil temperature, potatoes takes 14 to 28 days (2 to 4 weeks) from planting to emergence (Cornell University, 2006). The potato plant with a good canopy cover would produce many marketable potatoes, hence more income for the farmer. Potato plants that reach full canopy as soon as possible after emergence are preferred so that they can translocate food produced in the leaves through photosynthesis to the tubers. Good canopy cover, therefore, influences the number of marketable tubers, which consequently affects profitability to the potato grower. Under general circumstances, the potato plant takes approximately 4 weeks (28 days) to reach full canopy cover after emergence. Based on this, the planting date, as well as the number of days the potatoes took from planting to emergence, were recorded. Furthermore, the number of days from germination to full canopy cover was also recorded.

### 5.3.2 Pests and Diseases

The common pests attacking potatoes in Namibia are nematodes, potato tuber moth, aphids, and American leaf miner among others. Diseases that are generally complained about by Namibian potato growers include early blight, late blight, and common scabs. Hence, proper monitoring and observation were employed and pests and diseases observed on the trials were recorded.

#### 5.3.3 Harvesting Stage - Yield of Potato Varieties Harvested

Data in terms of the total number of tubers and their weight from each trial was recorded and analysed. The harvested tubers were split into two groups to record the number and weight of tubers that are larger than 50mm as well as those that are smaller than 50mm from each trial site and for each potato variety. Tubers greater than 50mm are regarded as marketable size.

#### 5.3.4 Tuber Characteristics and other Post-harvest data Collected

#### 5.3.4.1 Shape, Colour, and Texture of Tubers

Upon harvesting, the potato tubers were subjected to evaluations, whereby various data such as the tuber skin and flesh colour, tuber skin texture, and shape of tubers were collected. "Potato colours range from purple, red, pink, gold and yellow, in addition to the usual white" (Cornell University, 2006). A round or long oval tuber shape is preferred for mashed and baked potatoes, whilst only long oval tubers are preferred for French fries (fresh chips), whereas round potatoes are good for retail shelves. The identification of colour, texture, and shape was subjective and the tubers were classified as per the table below.



Attribute	Characteristic description	Picture
Skin Texture	Smooth	Carrie a
	Smooth with rough water nodes	
Skin and Flesh Colour	White	
	Whitish-Yellow	
	Yellow	
Tuber Shape	Long-Oval	
	Short-Oval	
	Oval	
	Round	

# Table 1: Attributes used for tuber characteristics identification



## 5.3.4.2 Dry Matter Content

While the dry matter is used to determine the maturity of fruits and vegetables, for potatoes, being a root crop, dry matter estimation is rather vital to ensure quality control in the supply chain and processing for human consumption. "Potatoes have a water content that varies from 75 to 85% and the rest (15 to 25%) is a dry matter that contains the nutrients for which potatoes are grown" (Trimble, 2019). According to Lemanga and Kabira (2003), potatoes with high dry matter content (above 20%) are mostly preferred for making French fries or crisps, while those with low dry matter content are less preferred because the French fries or crisps will be too soft or too wet and it will need more heat to fry them as the has to evaporate. The dry matter content may also influence the colour of chips, which plays a crucial role in customer satisfaction.

To determine the dry matter content of the potatoes harvested for each variety per trial site, a tuber weighing at least 50g per variety was used. Potato tubers are homogenised by cutting the sample into smaller pieces and shortly blending. A fifty (50) gram sample is then weighed into a dish. The weight recorded dish and sample are dried in a 104°C oven for 4 hours. The sample is removed from the oven and allowed to cool in a desiccator. The weight recorded sample is placed back into the oven for 1 hour, cooled, and weighed, and this step is repeated until there is no significant weight change any more.

## 5.3.4.3 Sensory Evaluation (Texture, Aroma and French Fries colour)

Potato texture may explain the crispness, crunchiness, and hardness of the potato food. The aroma, on the other hand, may be explained by sweet, earthy, nutty, baked, pleasant, and the potato-like of the potato food (McKenzie & Corrigan, 2016). The aroma may not only depend on the variety but may also depend on the cooking method, size of chips, storage system, and production practices. French fries were presented to the sensory evaluators who scored the texture and aroma as strongly dislike; dislike moderately; neither dislike nor like; like moderately and strongly like.

French fries' colours may be light-golden, golden-yellow, and golden-brown, with light-golden being the best colour of French fries, according to the European Potato Processors' Association. For this study, the French fries were prepared as follows:

- 20 tubers were selected from each variety
- Each of the 20 tubers per variety was peeled, and one strip (one French fry) was made in the middle of each potato to have the same diameter
- A French fryer equipment was used to fry the French fries
- Before frying, the strips were put in hot water at 40 °C to remove the starch
- The strips were drained/dried before putting them in the frying equipment at 175 180 °C for 3 minutes
- Using the guide of pictures, the French fries were assessed as to how many tubers look like each of the four scores
   Four rating scores (Light = 0, Slightly Light = 1, Neither Light nor Dark = 2, Slightly Dark = 3 and Dark = 4) were used to assess the colour of French fries made from all the varieties (see Figure 3).





Figure 3: A colour guide for the evaluation of French fries (Comptoir du Plant, France)

Figure3 presents the colours of French fries in different categories: Light = 0, Slightly Light = 1, Neither Light nor Dark = 2, Slightly Dark = 3 and Dark = 4. The colour of the French fries is important but it may not only depend on the variety but mainly by the way it is fried, such as equipment used, temperature, time of frying, sugar removal before frying, type of oil, the thickness of the strips, etc.

#### 5.4 Data Analysis

# 5.4.1 Descriptive Statistics

Descriptive statistics were used to analyse and present the results in tables and graphs. All the data collected as per the above section (Data Collection) were analysed using descriptive statistics in the Microsoft Excel Software. Various tables and graphs are listed throughout the report as well as their interpretation.



#### 6. PRESENTATION OF RESULTS AND DISCUSSIONS

This section presents and discusses the parameters of the data collected to assess the performance of the potato varieties in the trials. The parameters are: days from planting to emergence, days from emergence to reaching full canopy cover, yield, shapes, and colour of tubers, dry matter content, and sensory evaluation (aroma, texture, and colour of French fries), as well as pests and diseases.

6.1 Date of Emergency after Planting and Reaching Canopy Cover after Emergence

Days from Planting to Emergence and From Emergence to Reaching Full Canopy Cover at all Trial Sites														
Detete Mariata		Days f	rom Planting	to Emergence	Days from Emergence to Reaching Full Canopy									
Polato variety	Guinas	Hochfeld	Oshikoto	Doringboom	Average	Guinas	Hochfeld	Oshikoto	Doringboom	Average				
Panamera (Standard)	-	10	8	25	14	-	41	-	-	41				
Mondial (Standard)	11	-	-	-	11	30	-	-	-	30				
Allison (Standard)	11	-	8	-	10	30	-	-	-	30				
Rainbow	18	19	8	19	16	23	41	-	24	29				
Satis	15	15	8	15	13	26	41	-	25	31				
Nicola	15	15	8	28	17	26	41	-	17	28				
Montreal	15	15	8	19	14	26	41	-	28	32				
Spunta	14	15	8	17	14	27	41	-	25	31				
Barcelona	16	15	8	-	13	25	41	-	25	30				

## Table 2: Days from Planting to Emergence and days from Emergence to Reaching Full Canopy Cover

Table 1 indicates the number of days it took for each potato variety in the trial to emerge after it was planted, as well as the days each of the potato varieties took to reach full canopy after emergence at each of the four (4) trial sites – Doringboom, Guinas, Hochfeld, and Oshikoto. At Guinas, Mondial and Allison emerged earliest (11<sup>th</sup> day), followed by Spunta (14<sup>th</sup> day) and the last Barcelona (16<sup>th</sup> day). At Hochfeld, Panamera emerged earliest (10<sup>th</sup> day), all the rest emerged on the 15<sup>th</sup> day except Rainbow (19<sup>th</sup> day, the last). At Oshikoto, all varieties emerged on the 8<sup>th</sup> day and this is the earliest emergence compared to all other sites. Lastly, at Doringboom, Satis emerged earliest (15<sup>th</sup> day), followed by Spunta (17<sup>th</sup> day) and the last was Panamera (25<sup>th</sup> day – the latest to emerge off all varieties at all the sites). On average, Allison and Mondial (standard varieties) emerged first on the 10<sup>th</sup> and 11<sup>th</sup> day, the longest being Rainbow and Nicola on the 16<sup>th</sup> and 17<sup>th</sup> day respectively.

For full canopy cover: At Guinas, Rainbow reached the canopy earliest (23<sup>rd</sup> day), followed by Barcelona (25<sup>th</sup> day) and last Mondial and Allison (each 30<sup>th</sup> day). At Hochfeld, all varieties reached full canopy on the 41<sup>st</sup> day – the longest to reach full canopy at all the sites. There was nothing at Oshikoto. Lastly, at Doringboom, Nicola reached the canopy earliest (17<sup>th</sup> day), followed by Rainbow (24<sup>th</sup> day) and the last being Montreal (28<sup>th</sup> day). On average, Nicola and Rainbow (French varieties) reached full canopy cover first on the 28<sup>th</sup> and 29<sup>th</sup> day and the longest was Panamera on the 41<sup>st</sup> day after emergence.

### 6.2. Pests and Diseases

American leaf miner and potato tuber moth were the pests which were identified on potatoes within the trials, with no observed selectivity among the varieties. Early blight disease affected all the varieties at Guinas and Hochfeld trial sites, with no observable selectivity among varieties, but this was kept under control. Some brown spots and marks were observed inside few tubers of Rainbow and Barcelona which were harvested from Hochfeld, which is probably due to a deficiency of some micro-nutrients. The following figures (4,5 and 6) presents some of the pests and diseases as observed from the trials.





Figure 4: A sign of American leaf miner attack on the potato leaf



Figure 5: Brown spots / marks inside a few tubers of Rainbow (Hochfeld only)



Figure 6: Dark-brown hollows inside a few tubers of Barcelona (Hochfeld only)

## 6.2 Yield of Potato Varieties Harvested from Guinas, Hochfeld, and Doringboom

Table 3: Yield of Potato Trials from Guinas, Hochfeld, and Doringboom.

	Yields Data Recorded During the Harvesting of Potatoes from Trial Sites											
Parameter	Trial Site	Panamera	Mondial	Allison	Rainbow	Satis	Nicola	Montreal	Spunta	Barcelona		
No. of Turbons Cusatan	Guinas	0	191	231	75	141	138	105	130	130		
No of Tubers Greater	Hochfeld	175	0	0	127	163	186	103	117	199		
than somm	Doringboom	0	0	0	260	114	168	108	172	110		
No of Tuboro Looo	Guinas	0	37	47	23	16	54	38	31	17		
than 50mm	Hochfeld	130			45	73	119	75	48	115		
	Doringboom	0	0	0	90	76	344	328	135	83		
Total Number of	Guinas	0	228	278	98	157	192	143	161	147		
Tubers Harvested	Hochfeld	305	0	0	172	236	305	178	165	314		
from 20 Plants	Doringboom	0	0	0	350	190	512	436	307	193		
Kar of Turkows Oreston	Guinas	0	34.78	29.08	11.1	23.8	15.9	18.1	22.5	18.0		
than 50mm	Hochfeld	15.7	0	0	14.1	15.9	11.3	11.2	14.8	22.5		
	Doringboom	0	0	0	63.3	24.4	27.8	22.1	51.0	28.2		
Ka of Tuboro Loop	Guinas	0	1.18	1.5	0.6	0.5	1.6	1.1	0.9	0.3		
than 50mm	Hochfeld	3.1	0	0	0.9	1.6	2.3	1.9	1.1	2.6		
	Doringboom	0	0	0	1.9	4.2	12.7	12.6	7.4	4.1		
Total Karfaam 20	Guinas	0	36.0	30.6	11.7	24.3	17.5	19.3	23.4	18.3		
I otal Kg from 20	Hochfeld	18.8	0	0	15	17.5	13.6	13.1	15.9	25.1		
Fidins	Doringboom	0	0	0	65.3	28.6	40.5	34.7	58.4	32.3		
Cotimeted Total Visial	Guinas	0	73	62	24	49	35	39	47	37		
Tons) Per Ho	Hochfeld	38	0	0	30	35	27	26	32	51		
	Doringboom	0	0	0	132	58	82	70	118	65		
Estimated Average Yie	eld (Tons) Per Ha	38	73	62	62	47	48	45	66	51		

Table 3 indicates the yield obtained from each trial site – Doringboom, Guinas, and Hochfeld. The yields are expressed in terms of the number of tubers greater than 50mm (the marketable size), the number of tubers less than 50mm (non-marketable size or baby potatoes), the total number of tubers harvested from 20 plants, weight (kg) of tubers greater than 50mm, weight (kg) of tubers less than 50mm, and total weight (kg) of tubers harvested from 20 plants of each variety. Ultimately, the average yields in tons are presented per variety for each of the three trial sites as well as the average estimated yield in tons per hectare for each variety.

At the Guinas trial site, Mondial (standard variety) had the highest yield (73 tons/ha), followed by Allison which is a standard variety as well (66 tons/ha). French varieties yielded as follows: Satis (49 tons/ha), Spunta (47 tons/ha), Montreal (39 tons/ha), Barcelona (37 tons/ha), Nicola (35 tons/ha) and lastly, Rainbow (24 tons/ha). At the Hochfeld trial site, Barcelona (French variety) had the highest yield (51 tons/ha), followed by Panamera (standard variety) with 37 tons/ha, and then Satis (35 tons/ha), Spunta (32 tons/ha), Rainbow (30 tons/ha), Nicola (27 tons/ha) and lastly, Montreal (26 tons/ha). At the



Doringboom trial site, on the other hand, standard varieties were not successful as the seed was planted late. French varieties yield s at Doringboom were follows: Rainbow was highest with 132 tons/ha, followed by Spunta with 118 tons/ha, and thereafter, Nicola (82 tons/ha), Montreal (70 tons/ha), Barcelona (65 tons/ha) and lastly, Satis (58 tons/ha).

On average, Mondial (standard variety) yielded the highest (73 tons/ha), followed by Spunta (66 tons/ha) and then Rainbow and Allison (62 tons/ha each). Except for Panamera (38 tons/ha), all other varieties attained yields above 40 tons per hectare, which is the average potato yield per hectare in Namibia.

	Small		Small/Medium		Ме	dium	Large	/Medium	Large	
Variety	Weight (KG)	No of tubers								
Barcelona -Guinas	0.3	17	2.34	31	11.46	62	4.32	13	3.46	7
Montreal -Guinas	1.14	38	3.72	44	4.94	28	6.96	28	2.5	5
Nicola- Guinas	1.64	54	3.22	46	8.88	73	3.78	19	0	0
Rainbow - Guinas	0.64	23	1.26	20	6.76	44	3.06	11	0	0
Satis - Guinas	0.48	16	2.78	40	13.06	74	5.32	20	2.68	7
Spunta - Guinas	0.92	31	3	31	5.46	27	7.24	25	6.76	16
Allison - Guinas	1.5	47	5.56	79	14.36	88	9.16	64	0	0
Mondial - Guinas	5.5	37	8.74	52	9.04	79	8.32	38	4.26	22

# Table 4: Size Groups of Potatoes Harvested from Guinas

Table 4 presents the yield obtained from Guinas only, as it is the only site which had the data. The yields are expressed in kg and the number of tubers obtained per size group (small, small/medium, medium, large/medium, and large) tubers per variety harvested from 22 plants at Guinas. Although Mondial had the highest number of large-sized tubers (22), its weight was outperformed by Spunta with the highest weight of large sized tubers (6.76kg) from 16 tubers. Montreal and Spunta attained weights of large/medium (6.96kg and 7.24 kg), which is closer to the weights of Allison and Mondial (9.16kg and 8.32 kg), despite the fewer numbers of tubers (28 and 25) as compared to Allison and Mondial which had 64 and 38 tubers respectively.

# 6.3 Shape and Colour of Tubers

Table 5: Skin Texture, Skin Colour, Flesh Colour, and Tuber Shape of Potatoes Harvested from Trial Sites.

	Skin Texture and Colour, Flesh Colour and Tuber Shape of Potatoes Harvested from Guinas, Hochfeld and Doringboom Trial Sites											
Parameter	Trial Site	Panamera	Mondial	Allison	Rainbow	Satis	Nicola	Montreal	Spunta	Barcelona		
	Guinas	Not planted	Smooth	Smooth	Smooth with rough water nodes	Smooth	Smooth	Smooth	Smooth	Smooth		
Skin texture	Hochfeld	Smooth	Not planted	Not planted	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth		
	Doringboom	Not planted	Not planted	Failed	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth		
	Guinas	Not planted	Yellow	Whitish-yellow	Yellow	Yellow	Yellow	Whitish-yellow	Yellow	Yellow		
Skin Colour	Hochfeld	Yellow	Not planted	Not planted	Yellow	Yellow	Yellow	Whitish-yellow	Yellow	Yellow		
	Doringboom	Not planted	Not planted	Failed	Yellow	Whitish-yellow	Yellow	Whitish- yellow	Yellow	Yellow		
	Guinas	Not planted	Whitish-yellow	Whitish-yellow	Whitish-yellow	Yellow	White	White	Yellow	Yellow		
Flesh Colour	Hochfeld	Whitish-yellow	Not planted	Not planted	Whitish-yellow	Yellow	White	White	Yellow	Yellow		
	Doringboom	Not planted	Not planted	Failed	Whitish-yellow	Yellow	White	White	Yellow	Yellow		
	Guinas	Not planted	Oval	Long oval	Oval	Long-oval	Long-oval	Short- oval	Long-oval	Round		
Tuber Shape	Hochfeld	Long-oval	Not planted	Not planted	Oval	Oval	Long-oval	Short-oval	Long-oval	Round		
	Doringboom	Not planted	Not planted	Failed	Oval	Short-oval	Long-oval	Short-oval	Long-oval	Round		

Table 5 presents the skin texture, skin colour, flesh colour, and tuber shapes observed on each potato variety harvested from Guinas, Hochfeld and Doringboom. The skin for all varieties was smooth, just as the market prefers, except for a few tubers of Rainbow that had rough water nodes, and these are sometimes caused by over-irrigation (waterlogging). There were no big differences in the skin colour between standard and French potato varieties; they were either whitish-yellow (the traditional colour in the Namibian local market) or a yellow skin colour that is not too far distinguishable from whitish-yellow. Long-oval, oval and short-oval tuber shapes are good for French fries and catering services, a shape that is matched by all

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varieties, including Barcelona which is a large round potato. On the other hand, Barcelona being a round potato, could be good for both the shelf and catering services.



Figure 7: Flesh colours of potato varieties harvested from Guinas

Figure 7 presents the colours of inside tuber flesh of potato varieties harvested from Guinas, as it is the only site with this data. Rainbow (French variety) and two standard varieties are whitish-yellow, whilst French varieties such as Barcelona, Spunta, and Satis appear yellow. Only Montreal and Nicola look white among the French varieties. Worth noting is that all these various colours for each variety at Guinas correspond with their standard colours.

# 6.4 Dry Matter Content

Table 6: Test Report on the Di	y Matter/ Moisture Contents	of the Potatoes ha	rvested from Trial Sites
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Dry Matter vs Moisture Content of Potato Varieties Harvested from Guinas, Hochfeld, and Doringboom													
		Moisture g/1	00g		Dry Matter g/	100g	Dry Matter %						
Variety	Guinas	Hochfeld	Doringboom	Guinas	Hochfeld	Doringboom	Guinas	Hochfeld	Doringboom	Average Dry Matter %			
Panamera	0	83	0	0	17	0	0	17%	0	17%			
Mondial	83	0	0	17	0	0	17%	0	0	17%			
Allison	81	0	0	19	0	0	19%	0	0	19%			
Rainbow	83	83	80	17	17	20	17%	17%	20%	18%			
Satis	84	84	78	16	16	22	16%	16%	22%	18%			
Nicola	83	84	82	17	16	18	17%	16%	18%	17%			
Montreal	85	84	83	15	16	17	15%	16%	17%	16%			
Spunta	84	84	83	16	16	17	16%	16%	17%	16%			
Barcelona	86	85	81	14	15	19	14%	15%	19%	16%			
Notes: The no	ormal dry ma	atter content fo	or potatoes is betw	veen 15% an	d 25%								

Internationally recommended dry matter content of potatoes for French fries should be above 20%

Table 6 presents the test report of the dry matter content analysis done on the potatoes harvested from Guinas, Hochfeld, and Doringboom trial sites. The average dry matter content for each variety is presented in the last column. Allison (standard variety) scored the highest average dry matter content (19%), followed by Rainbow and Satis (18% each). Note: the dry matter content for all the varieties is within the normal dry matter content for potatoes – 15% to 25%.



# 6.6 Sensory Evaluation

This section presents the sensory evaluation (aroma, texture, and colour) done on the French fries and boiled potatoes made from potatoes harvested at Guinas and Hochfeld.

### 6.6.1 Texture and Aroma Assessment



Figure 8: Aroma of Potato Varieties Harvested from Guinas



# Figure 9: Aroma of Potato Varieties Harvested from Hochfeld

Figures 8 and 9 present the percentage scores on the aroma of different potato varieties harvested from Guinas and Hochfeld respectively. All scores were dominated by either "strongly like" or "like moderately" on the aroma. For potatoes harvested from Guinas, Spunta, Rainbow, Allison, and Mondial varieties scored high in terms of strongly liked the aroma, whilst Montreal, Satis, Nicola ad Barcelona were highest in being moderately liked. For potatoes harvested from Hochfeld, two French varieties and one standard variety scored highest in terms of the strongly liked aroma and these are, Barcelona, Satis, and Panamera respectively; whilst Montreal, Barcelona, and Rainbow were the most in being liked moderately.





Figure 10: Texture of Potato Varieties Harvested from Guinas



Figure 11: Texture of Potato Varieties Harvested from Hochfeld.

Figures 10 and 11 above present the percentage scores on the texture of different potato varieties harvested from Guinas and Hochfeld. All varieties harvested from these two sites were dominated either by "strongly like" or "like moderately" on the texture, except Barcelona that was dominated by the "neither liked nor disliked" texture of the potatoes harvested from Guinas.

Out of all potatoes harvested from Guinas, Spunta, Rainbow, Allison, and Mondial scored the highest percentage in terms of the texture being strongly liked, whilst, Satis, Montreal, and Mondial scored highest in terms of being moderately liked texture. For potatoes harvested from Hochfeld, Satis, Rainbow, Panamera, and Barcelona were the highest in being the strongly liked texture, whilst, Montreal, Spunta, and Nicola are highest in having the moderately liked texture.



# 6.6.2 Sensory Evaluation for French Fries Colour

Colour of French Fries for Potatoes Harvested from Guinas, Hochfeld, and Doringboom										
Parameter	Trial Site	Panamera	Mondial	Allison	Rainbow	Satis	Nicola	Montreal	Spunta	Barcelona
	Guinas	0	2	12	7	5	0	0	0	0
Light = 0	Hochfeld	9	0	0	7	0	0	0	0	0
-	Doringboom									
	Guinas	0	10	8	0	15	0	16	20	0
Slightly Light = 1	Hochfeld	11	0	0	13	19	19	19	20	0
	Doringboom									
Noither Light nor	Guinas	0	8	0	13	0	19	4	0	15
Dark = 2	Hochfeld	0	0	0	0	1	1	1	0	14
Daik - 2	Doringboom									
	Guinas	0	0	0	0	0	1	0	0	5
Slightly Dark = 3	Hochfeld	0	0	0	0	0	0	0	0	6
	Doringboom									
	Guinas	0	0	0	0	0	0	0	0	0
Dark = 4	Hochfeld	0	0	0	0	0	0	0	0	0
	Doringboom									
Total Number of Stri	ps Assessed	20	20	20	40	40	40	40	40	40
No of Strips Scored (Light =0+ Slightly										
Light =1+ Neither Light nor Dark =2)		20	20	20	40	40	39	40	40	29
Percentage (Light Slightly Light+										
Neither Light nor D	ark)/Total No of									
Strips Assessed		100%	100%	100%	100%	100%	98%	100%	100%	73%

### Table 7: French Fries Colour Assessment - Counting of French Fries According to Colour Categories

Table 7 presents the assessment done on the colour of French fries made from potatoes harvested at Guinas, Hochfeld, and Doringboom. Rainbow, Satis, Nicola, and Spunta among French varieties scored 100% as percentage scores of chips or strips that looked: light, slightly lighter, and/or neither light nor dark. The least scoring varieties that were also reasonably high are Nicola (98%) and Barcelona (73%) – (See *Annexure 9.1*).

### 6.6.3 Colour of Boiled Potatoes

Figure 12 shows the colours observed on boiled tubers from different potato varieties harvested from Guinas and Hochfeld trial sites.





### Figure 12: Colours of Boiled Potatoes of Different Varieties

Figure 12 shows different colours of boiled potatoes of the different varieties. There were no significant differences between the flesh colour of fresh and boiled potatoes. Boiled potatoes of Barcelona, Montreal (Guinas), Spunta, Satis, and Nicola look yellow, whereas, Montreal (Hochfeld), Rainbow, Panamera, and Mondial look whitish-yellow, with Allison being the only boiled potato that looks white.

# 7. CONCLUSIONS AND RECOMMENDATIONS

#### 7.1 Conclusions

Despite some rampant climatic challenges experienced such as prolonged dry periods and heavy rainfalls, the potato trials were successfully planted, with three sites being successfully harvested, namely Guinas, Hochfeld, and Doringboom. All the six French varieties (Barcelona, Montreal, Nicola, Rainbow, Satis, and Nicola) can adapt to the Namibian soil and climatic conditions, as primarily evidenced by the emergence and reaching of canopy cover observed, though at different intensities. There were no significant differences in the attack by American leaf miner and potato tuber moth pests and early blight disease among the French and check varieties. However, a dark-brown hollow was detected inside two tubers of Barcelona and brown spots inside three tubers of Rainbow harvested at the Hochfeld trial site only.

Regarding the estimated average per hectare, all the French varieties yielded more than the average Namibian yield of 40 tons/hectare and outperformed all the standard varieties, though there was an exception of Mondial (standard variety) that



yielded 73t/ha. In the aspect of the weight in kgs of large sized tubers obtained from 20 plants, Spunta scored the highest (6.76kg) followed by Mondial (4.26kg - standard variety), Barcelona, Satis, Montreal, and the rest had no large sized tubers. In addition, with regards to the weight in kgs of large/medium size tubers from 20 plants, Allison scored the highest (9.16kg), followed by Mondial (8.32kg- standard variety), Spunta, Montreal, Satis, Nicola, Barcelona, and then Rainbow. Last but not least, with regards to the weight in kgs of medium-sized tubers from 20 plants, Allison again scored the highest (14.36kg), followed by Satis, Barcelona, Nicola, Rainbow, Spunta, and Montreal. Though they gave slightly lower yields than Mondial; Spunta, Rainbow, and Barcelona gave the highest yields among French varieties. Notably, Spunta gave more large size kgs of tubers than Mondial.

The shapes of potato tubers harvested indicate that the long oval potatoes were Spunta, Nicola, Satis, Allison and Panamera; whereas oval potatoes were Mondial and Rainbow, and short-oval potatoes were Montreal, whilst Barcelona was found to be round. Spunta, Nicola, Satis, and Rainbow could be good for chipping into French fries, just like Allison and Mondial; whilst, Montreal being short-oval and Barcelona being round would be good for retail shelves. On dry matter content analysis, Allison (standard variety) scored the highest average dry matter content (19%), followed by Rainbow and Satis (French varieties) both with 18% each. However, all varieties scored within the acceptable normal dry matter content, which is 15% to 25%.

The skin and interior flesh colour of all the harvested potatoes corresponded with their respective standard colours. The sensory evaluation on French fries' texture, aroma, and colour indicate that on average, standard varieties scored higher than the French varieties as all standard varieties scored above 50%, with Allison scoring 80%; while for the French varieties, only Rainbow (70%) scored above 50% on texture. On aroma, all French varieties scored 50% and less, whilst for standard varieties this was 50%-50% (Mondial and Panamera scored above 50%, Montreal and Allison less than 50%). With regards to colour, as in, the best colour for French fries (light, slightly lighter and/or neither light nor dark), both varieties scored 100% with the exception of Nicola and Barcelona that scored 98% and 73% respectively.

#### 7.2 Recommendations

Considering the performance of potato varieties in terms of yields, the interior and exterior traits, and sensory evaluations observed, it is worth recommending that the French potato varieties be considered for adoption by Namibian potato growers after second trials have been done. Access to these French seed potato varieties should be considered as a way to complement the existing local supply chain, that is wholly dependent on South Africa. This is however pending the results of second seed potato trials that are currently being further conducted in Namibia. Furthermore, the adoption of these varieties should be based on the preference of the market that each grower is targeting to supply, to ensure customer satisfaction since different market segments may prefer differentiated internal and external qualities.

Specific potato varieties such as Spunta, Rainbow and Barcelona are highly recommended for adoption in Namibia as they scored high yields and a significant number of uniform tubers larger than 50mm as compared to other French and check varieties. Satis, Nicola and Montreal also yielded higher than the standard varieties with a fairer proportion of large, large/medium, and medium-sized tubers.



Lastly, Section 34 of the Seed and Seed Varieties Act No 23 of 2018 states that the compensation to farmers "where the seed of any kind or a variety of plant is sold to a farmer, the producer must disclose the expected performance of such kind of variety to the farmer under given conditions, and if, such registered seed fails to provide the expected performance under such given conditions, the farmer may claim compensation from the producers as if that seed had a hidden defect and the producer was an expert in the provision of seed". Therefore, second trials on the French varieties are recommended to be conducted to get assurance of the expected performance of each variety.



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# 9. ANNEXURES

Annexure 1: Pictures Presenting the Colours of French Fries Made from Various Potato Varieties from Trials

