



**AGRONOMY AND HORTICULTURE MARKET DEVELOPMENT DIVISION
RESEARCH AND POLICY DEVELOPMENT SUBDIVISION**

NAB - UNAM SEED RESEARCH PROJECT

**FINAL REPORT: WHITE MAIZE AND PEARL MILLET SEED VARIETY
TRIALS – 2020/2021**



20 September 2021

Windhoek, Namibia

1. INTRODUCTION

The Namibian Agronomic Board (NAB) is mandated to promote the agronomic industry and facilitate the production, processing, storage, and marketing of controlled crops. NAB's Strategic plan for 2019-2024, emphasises that seed research and production is one of the key priority areas. White maize and pearl millet are the top most important cereal crops cultivated in Namibia, whose yields are partially hampered by the limited availability of high-yielding adapted varieties. The certified seed sector in Namibia is underdeveloped, thus resulting in dependence on seed and food imports.

Therefore, to widen the range of and access to seed of locally adapted high yielding crop varieties, the NAB and the University of Namibia (UNAM) jointly undertook a Crop Improvement Programme for White Maize and Pearl Millet, through a Memorandum of Understanding (MOU). Field trials of early and intermediate maturing varieties of white maize and pearl millet varieties took place in the 2020/2021 farming season.

2. OBJECTIVES OF THE PROJECT

- a. Evaluate new white maize and pearl millet for high yields and adaptation in four agro-ecological zones in Namibia, and select best performers under Namibia conditions (Current activity).
- b. Multiply and certify seeds of high-yielding and adapted varieties of white maize and pearl millet (A future activity).

3. DESCRIPTION OF MAIZE HYBRIDS

The trial consisted of 30 early maturing elite, pre-release and commercial hybrids, including 12 new hybrids from the International Maize and Wheat Improvement Center (CIMMYT), 7 from NARS (National Agricultural Research) and seed company partners (SEEDCO, DR & SS, ZAMSEED, and EGT inputs), as well as 4 widely grown early and extra-early maturing commercial baseline checks from SEEDCO. The trial also consisted of CORTEVA and ZAMSEED, 3 internal genetic checks, 2 rolling checks, 2 widely grown local checks, one open-pollinated variety promoted by the Ministry of Agriculture Water and Land Reform (MAWLR), Republic of Namibia, and one early maturing variety distributed by Agra within Namibian stores.

The intermediate maturing maize consisted of 30 intermediate maturing elite, pre-release, and commercial white maize hybrids including 13 new hybrids from CIMMYT, 5 from NARS and seed company partners (SEEDCO, DR & SS, ZAMSEED, and EGT inputs), 4 widely grown medium maturing commercial baseline checks from SEEDCO, CORTEVA and ZAMSEED, 4 internal genetic checks, 2 rolling checks and 2 widely grown checks. For mahangu, 24 varieties were acquired from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and there were some local checks (Kangara, Kantana, and Okashana 2).

UNAM/NAB is one of the collaborative testing networks for CIMMYT and ICRISAT, and upon confirmation of highly performing hybrids in Namibia, the institutions will apply for Intellectual Property Rights (IPR) on CIMMYT germplasm for commercialisation.

4. METHODOLOGY

Field trials for white maize and pear millet varieties were conducted at 4 sites in Namibia: (1) Ogongo Campus, the University of Namibia in Omusati Region, (2) Mashare Irrigation PTY (Kavango East Region), (3) Zambezi Vocational Training Center farm, Wenela Road, Katima Mulilo (Zambezi Region), (4) Dorringtonboom farm, University of Namibia, Otjiwarongo (Otjozondjupa Region).

A total of 24 elite pearl millet seed varieties were received from ICRISAT, Eastern and Southern African Regional Office, Nairobi, Kenya, and 3 local checks (27 varieties).

A total of 28 early and 28 intermediate maturing white maize hybrid seed varieties were received from CIMMYT, and early maturing: 1 local and 1 local commercial check, plus 2 intermediate maturing varieties (60 varieties, 30 varieties each).

Land: One hectare of land per site was allocated for the field trials. **Planting** of both white maize and pearl millet took place from **December 2020 to January 2021**.

Field layout info: White maize and pearl millet varieties were evaluated for yield and adaptation-related parameters under partial irrigation and rainfed in the case of the Zambezi site. The 60 varieties of **early and intermediate maturing white maize** were planted in 60 plots, with 3 replications at each of the 4 sites. Seed of each early maturing white maize variety was sown at a spacing of 90 cm by 25 cm between plants in a 1.8 m x 3.25m plot, which is 5.85m² for each plot.

Pearl millet: Each variety in the experiment was replicated 2 times in 4 sites. Seeds of each pearl millet variety were sown at a spacing of 75 x 10 cm using the drill in 3 m x 4m plots, which is 12m² for each plot.

Crop management and care: All varieties were provided with optimum conditions for growth such as fertilizer, water, and pesticides to enable the crop to express its genetic yield potential. However, due to limitations in water availability, the management was not uniform across sites and it varied as stated below:

- ✓ Mashare Irrigation PTY - Mechanised, irrigated, and fertigated, and agronomic conditions were applied optimally. Ogongo Campus – Irrigated but not optimally, fertilizer application was manual.
- ✓ Dorringtonboom farm – Not irrigated until 10 days at maturity. The Zambezi – Under rainfed production.

Data collection: Data collected included Planting date, Plant height, Ear height, Pest and disease occurrence, Open ear tips (Husk cover), Number of productive ears per plant, and Total grain weight.

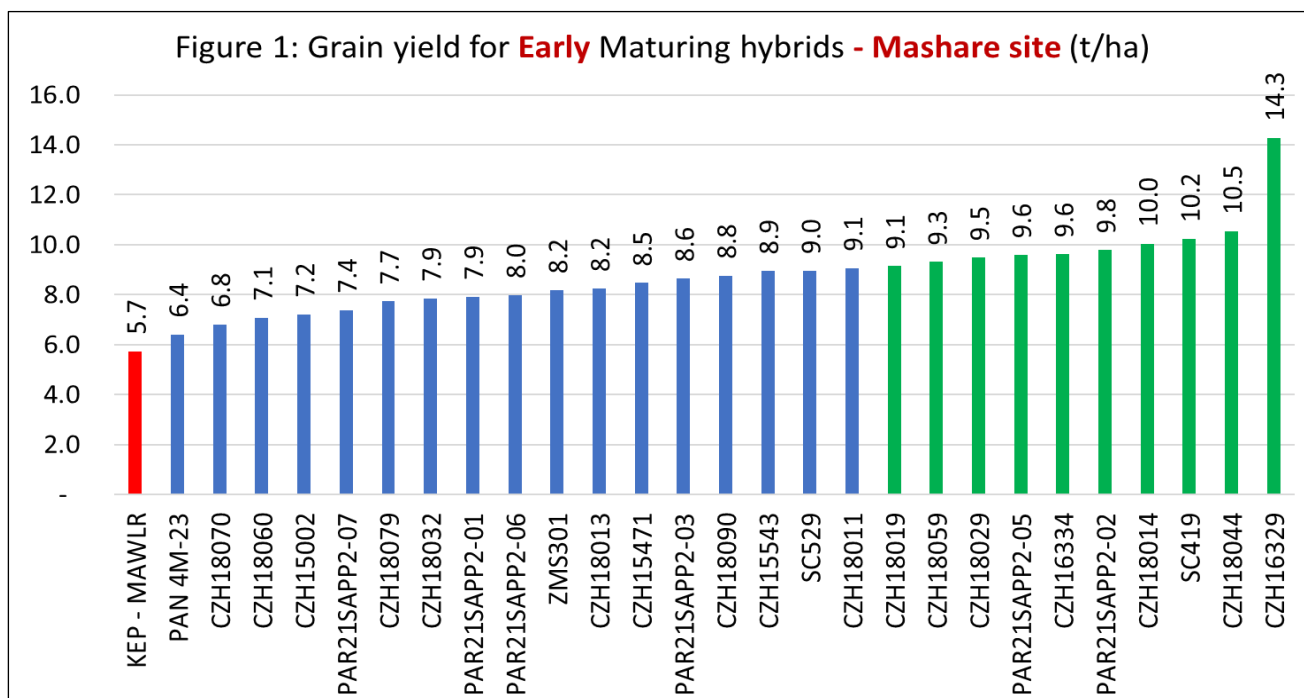
Data analysis: Agronomic scoring methods, and graphical and tabulation analysis.

Harvesting and final screening: Commenced from **mid-May to June 2021**. These multiple evaluations will lead to the selection of promising varieties/hybrids. The selected lines will be taken through Season 2 for further field evaluation.

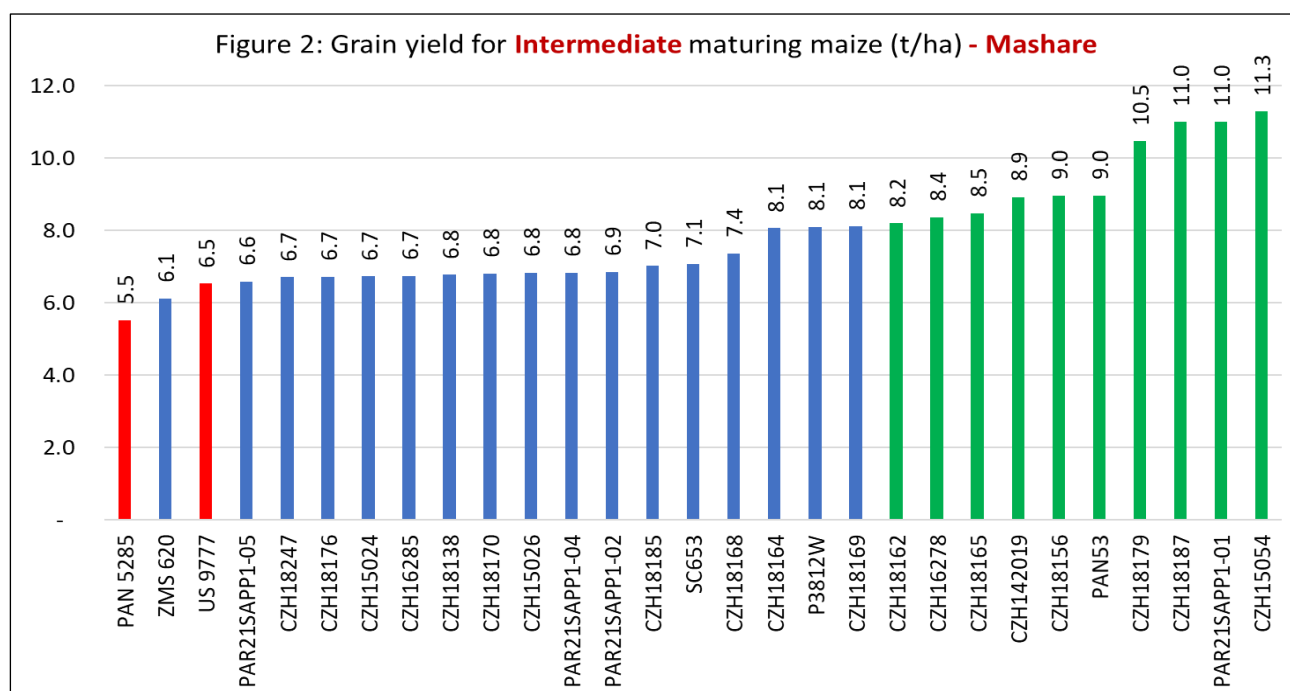
5. WHITE MAIZE FIELD TRIAL RESULTS

SITE 1: MASHARE IRRIGATION PTY

EARLY MATURING WHITE MAIZE: At Mashare Irrigation PTY, the average grain yield of maize hybrids/varieties was 8.7 t/ha. Different varieties showed significant yield differences, with CZH16329 (CIMMYT line) giving the best yield of 14.3 t/ha. This was followed by another CIMMYT line, CZH18044 (10.5 t/ha), SC419 (SEEDCO) (10.2 t/ha), CZH18014 (10.0 t/ha), and another CIMMYT line, PAR21SAPP2-02 (9.8 t/ha). The local variety, Kalahari (KEP – MAWLR), performed poorest at 5.7 t/ha. Figure 1 also shows that 10 CIMMYT hybrids produced over 9 t/ha, with only one commercial variety coming at position 3 (SC419 – 10.2t/ha).



INTERMEDIATE MATURING WHITE MAIZE: In terms of figure 2, Mashare Irrigation PTY produced the highest intermediate maize yield of 7.8 t/ha. All three (3) CIMMYT pre-release varieties gave the highest grain yield: CZH15054 (11.3 t/ha), CZH18187 (11.0 t/ha) and PAR21SAPP1-01 (11.0 t/ha). Other varieties within the top-five performers were CZH18179 (10.5 t/ha) and PAN53 (9 t/ha). Overall, eleven CIMMYT varieties obtained an average grain yield of 8 t/ha and above, a level where only two commercial varieties (P3812 – 8.1t/ha and PAN53 – 9t/ha) were able to attain. The local line acquired from Aqualand Namibia, US9777 obtained the least average grain yield (5.5 to/ha).

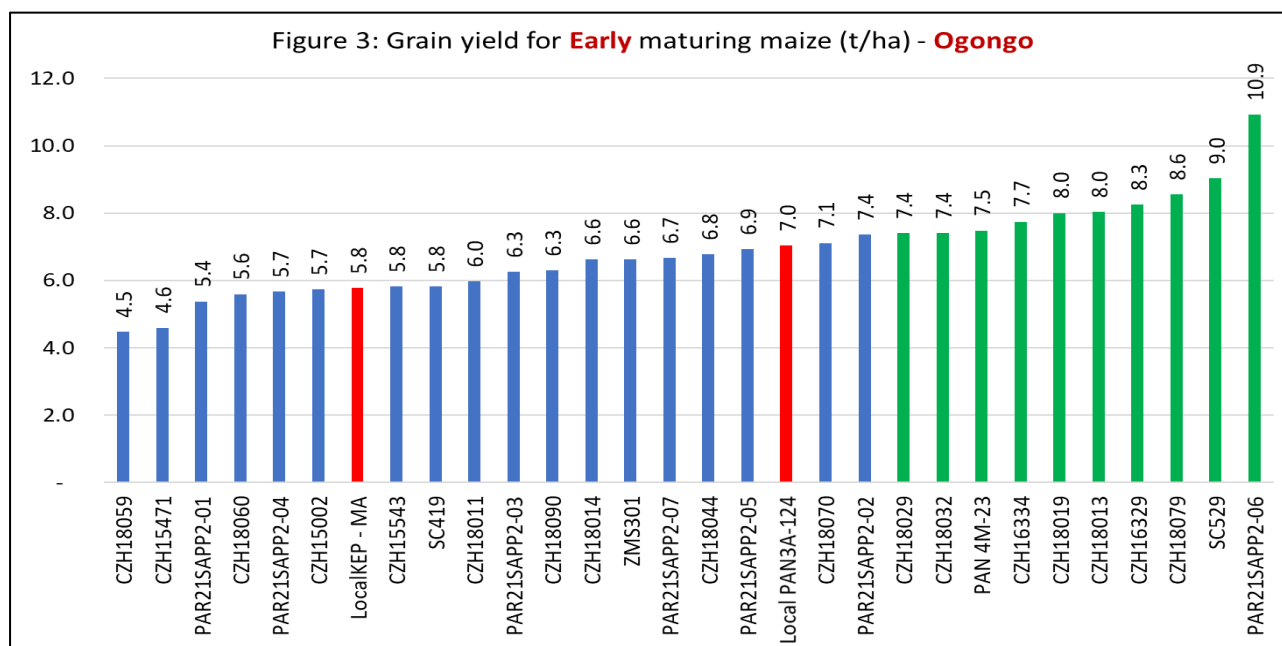


SITE 2: OGONGO UNAM CAMPUS

EARLY MATURING WHITE MAIZE: The average yield of early maturing white maize at Ogongo campus was 6.8 t/ha and the varieties tested did not show statistically significant differences in yield. The best variety was PAR21SAPP2-06 (10.9t/ha), a CIMMYT pre-release hybrid, followed by SC529, a SEEDCO hybrid (9.0 t/ha). Under Ogongo conditions, the CIMMYT line CZH16329, which topped at Mashare emerged among the top 5 performers (8.2 t/ha).

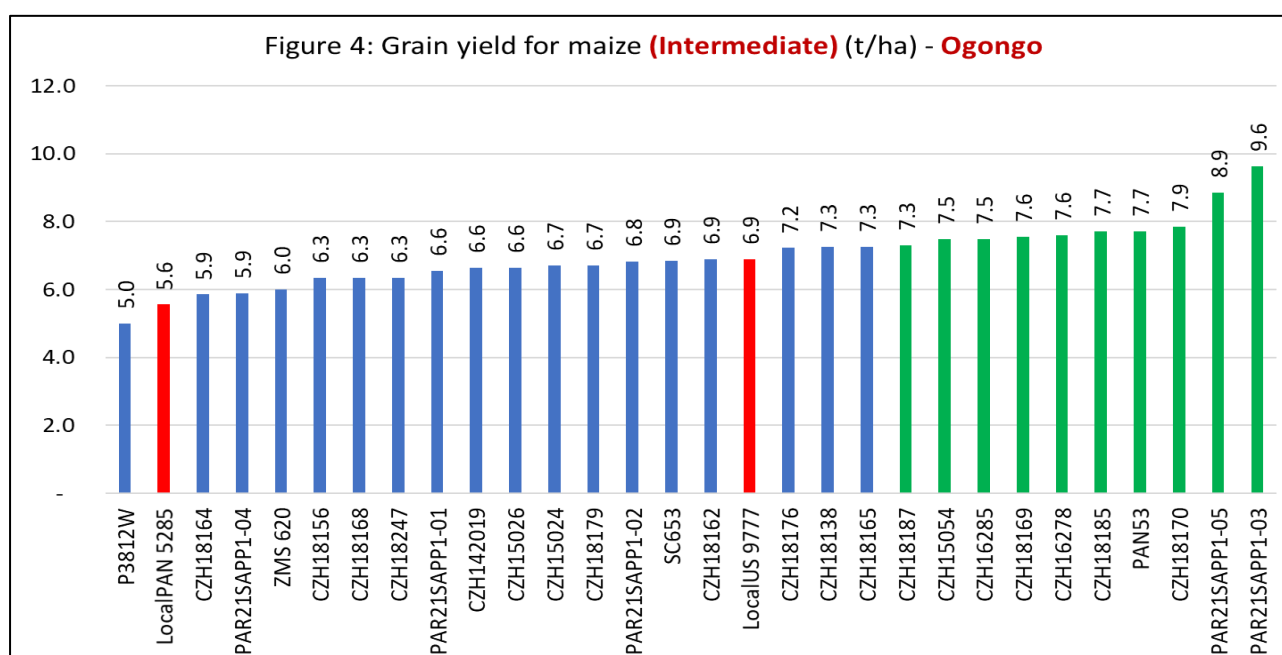
The least performing variety, CZH18059, gave 4.5 t/ha under Ogongo conditions. The local varieties, PAN 3A-124 (7 t/ha) and KEP – MAWLR (5.8 t/ha) obtained from within Namibia were found to be

average and below average respectively (Fig 2, Table 2). This study concludes that the local KEP - MAWLR be selected for the hot and low rainfall conditions of Namibia.



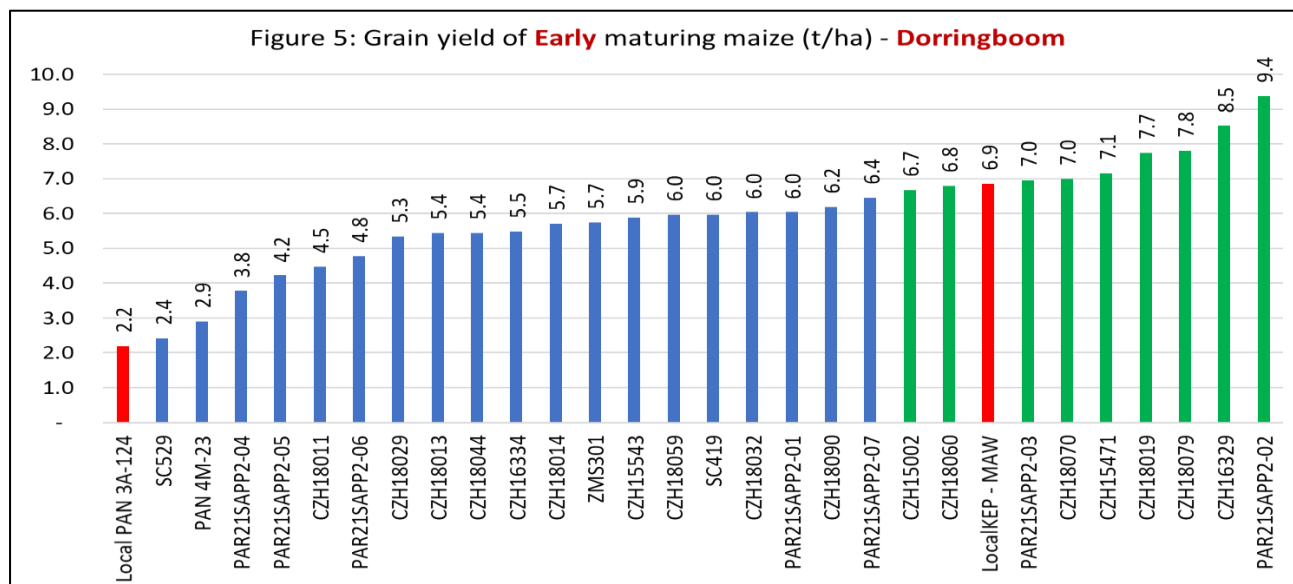
INTERMEDIATE MATURING WHITE MAIZE: According to figure 4, the grain yield of intermediate maturing white maize at Ogongo was on average 7.0 t/ha ranging from 5.0 t/ha to 9.6 t/ha). CIMMYT pre-release varieties, PAR21SAPP1-03 (9.6 t/ha) and PAR21SAPP1-05 (8.9 t/ha), were among the highest grain yielders. Others making up the list of the top-five varieties in terms of grain yield were CZH18170 (7.9 t/ha), PAN53 (7.7 t/ha), and CZH18185 (7.7 t/ha).

The least grain yielders were P3812W (5 t/ha) and the local PAN 5285 (5.6 t/ha). Overall, twelve CIMMYT varieties obtained an average grain yield of 7 t/ha and above, a level where only one commercial variety (PAN53 – 7.7t/ha) was able to attain.

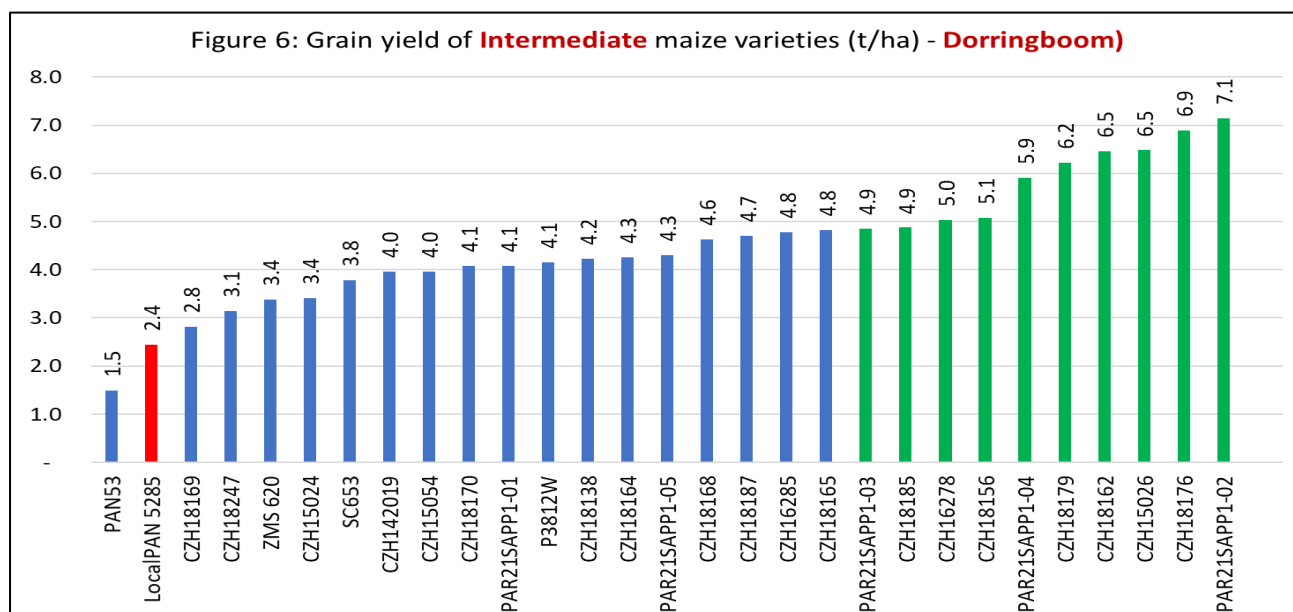


Site 3: DORRINGBOOM UNAM FARM

EARLY MATURING WHITE MAIZE: The mean grain yield for early maturing maize at Dorringtonboom farm was 5.8 t/ha, with PAR21SAPP2-02 topping at 9.4 t/ha followed by CZH16329 (8.5 t/ha) (Figure 5). The variety CZH16329 (8.5 t/ha) topped as number 1 in grain yield at Mashare and gave the 4th best yield at the Ogongo site. The local variety, PAN 3A-12, yielded the lowest grain yield of 2.2 t/ha at Dorringtonboom. This local variety had the lowest biomass yield at Ogongo. Seven CIMMYT hybrids had a grain yield of 7t/ha and above.

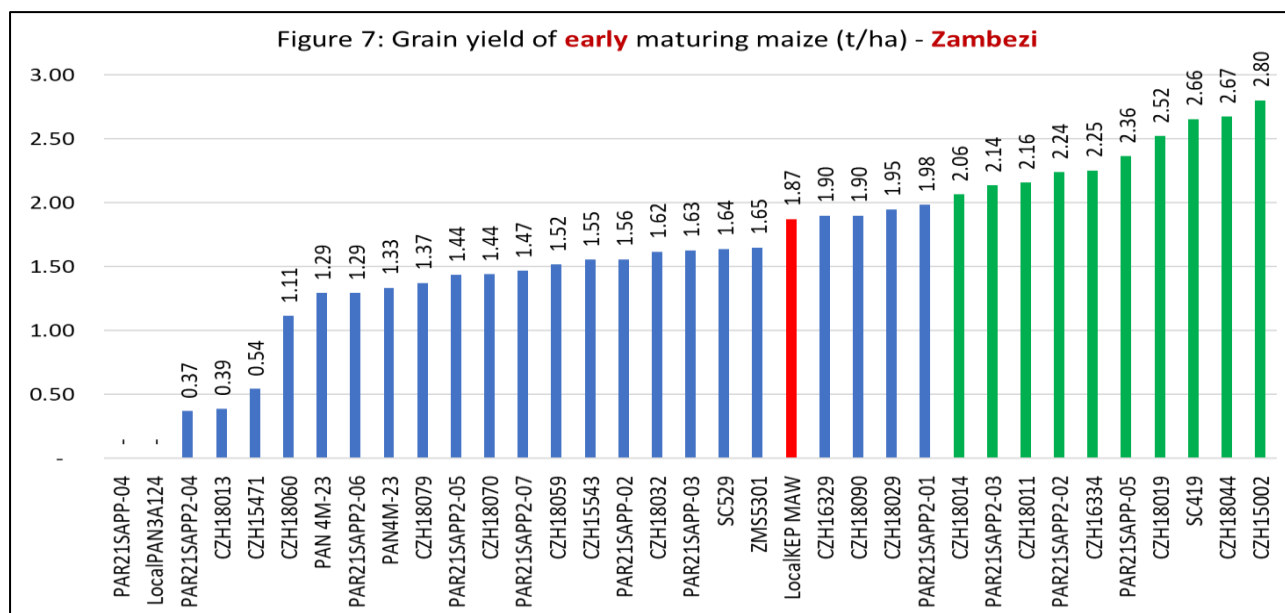


INTERMEDIATE MATURING WHITE MAIZE: Grain yield for intermediate white maize varieties at Dorringtonboom was on average 4.5 t/ha, ranging from 1.5 t/ha to 7.1t/ha (Figure 5). There were no significant varietal differences between the maize lines in terms of grain yield. The varieties which gave the highest yield above 6 t/ha in descending order were PAR21SAPP1-02 (7.1 t/ha), CZH18176 (6.9 t/ha), CZH15026 (6.5 t/ha), CZH18162 (6.5 t/ha), and CZH18179 (6.2 t/ha), all being CIMMYT lines. Contrarily, the local PAN 5285, commonly planted by Green Schemes in Namibia, gave some of the lowest grain yields.

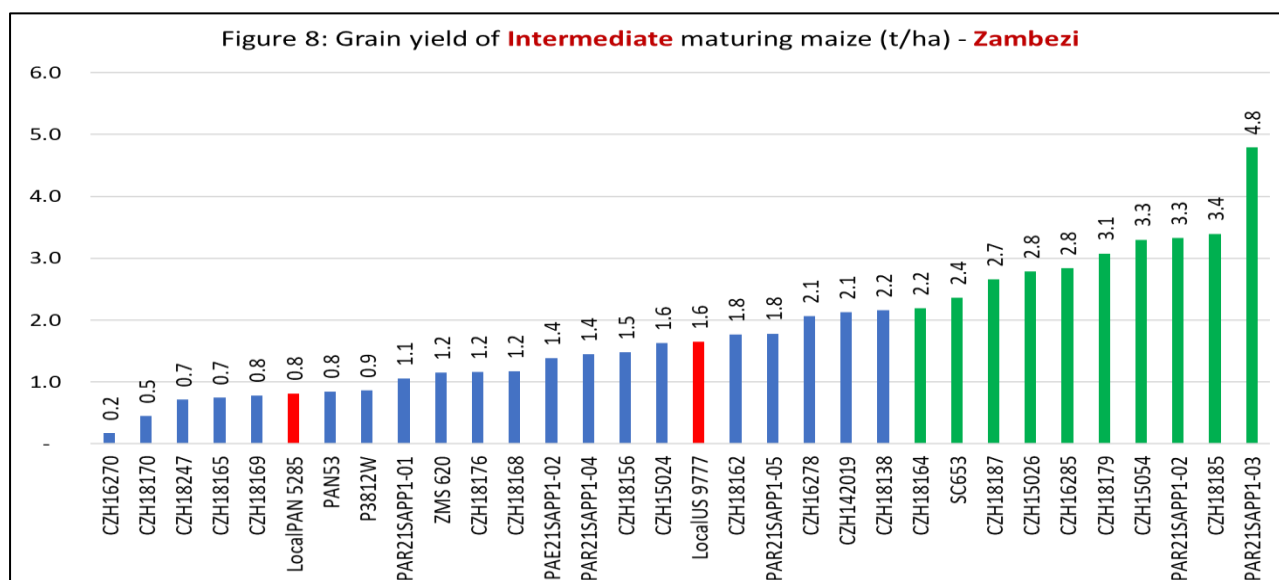


Site 4: ZAMBEZI VTC

EARLY MATURING WHITE MAIZE: The Zambezi site gave an average yield of 1.6 t/ha, the lowest of all 4 sites. This was due to severe water stress at the critical stages of plant growth. The maize varieties differed significantly in grain yield ($P < 0.05$). PAR21SAPP-04 and local PAN 3A-124 gave zero tons per hectare (0t/ha) in terms of grain yields, while CZH15002 (2.8 t/ha), CZH18044 (2.7 t/ha) and SC419 (2.7 t/ha) gave the highest yield under the Zambezi conditions (Fig. 7).



INTERMEDIATE MATURING WHITE MAIZE: Figure 8 shows that the average yield of intermediate maturing white maize at Zambezi VTC was 1.8 t/ha. This low yield was occasioned by water stress at a critical time of crop development. Though the yields at the Zambezi site were the lowest, they exhibited consistency with the results of other sites. The CIMMYT pre-release variety PAR21SAPP1-03 was the best yielder at the Zambezi site with 4.8 t/ha; a position it maintained at the Ogongo site. This was followed by CZH18185 (3.4 t/ha, which was one of the best at Ogongo), PAR21SAPP1-02 (3.3 t/ha, which was leading at Dorringtonboom), and CZH15054 (3.3 t/ha, which was leading at Mashare).



WHITE MAIZE TOP 10 GRAIN YIELD PERFORMERS PER SITE

According to table 1, the best performing varieties in all 4 sites were early maturing varieties from CIMMYT at Mashare Irrigation (CZH16329, 14.3 t/ha). In terms of intermediate varieties, the best performing variety was again at Mashare Irrigation (CZH15054, 11.3t/ha). On the other hand, the poorest performing early and intermediate maturing varieties were recorded at the Zambezi site with grain yields of 2.8t/ha and 4.8t/ha respectively.

Early maturing varieties performed best at all for the 4 sites because December/January is the best time for planting such varieties since they do not require a longer growing cycle to reach maturity before temperatures start dropping below the optimum level for growth. Intermediate varieties require a longer growing cycle and hence early planting is recommended.

Table 1: Top 10 high yielding white maize varieties (ranked in descending order) in all the 4 sites

Mashare			
Early	T/ha	Intermediate	T/ha
CZH16329	14.3	CZH15054	11.3
CZH18044	10.5	PAR21SAPP1-01	11
SC419	10.2	CZH18187	11
CZH18014	10	CZH18179	10.5
PAR21SAPP2-02	9.8	PAN53	9
CZH16334	9.6	CZH18156	9
PAR21SAPP2-05	9.6	CZH142019	8.9
CZH18029	9.5	CZH18165	8.5
CZH18059	9.3	CZH16278	8.4
CZH18019	9.1	CZH18162	8.2

Ogongo			
Early	T/ha	Intermediate	T/ha
PAR21SAPP2-06	10.9	PAR21SAPP1-03	9.6
SC529	9	PAR21SAPP1-05	8.9
CZH18079	8.6	CZH18170	7.9
CZH16329	8.3	PAN53	7.7
CZH18013	8	CZH18185	7.7
CZH18019	8	CZH16278	7.6
CZH16334	7.7	CZH18169	7.6
PAN 4M-23	7.5	CZH16285	7.5
CZH18032	7.4	CZH15054	7.5
CZH18029	7.4	CZH18187	7.3

Dorringboom

Zambezi

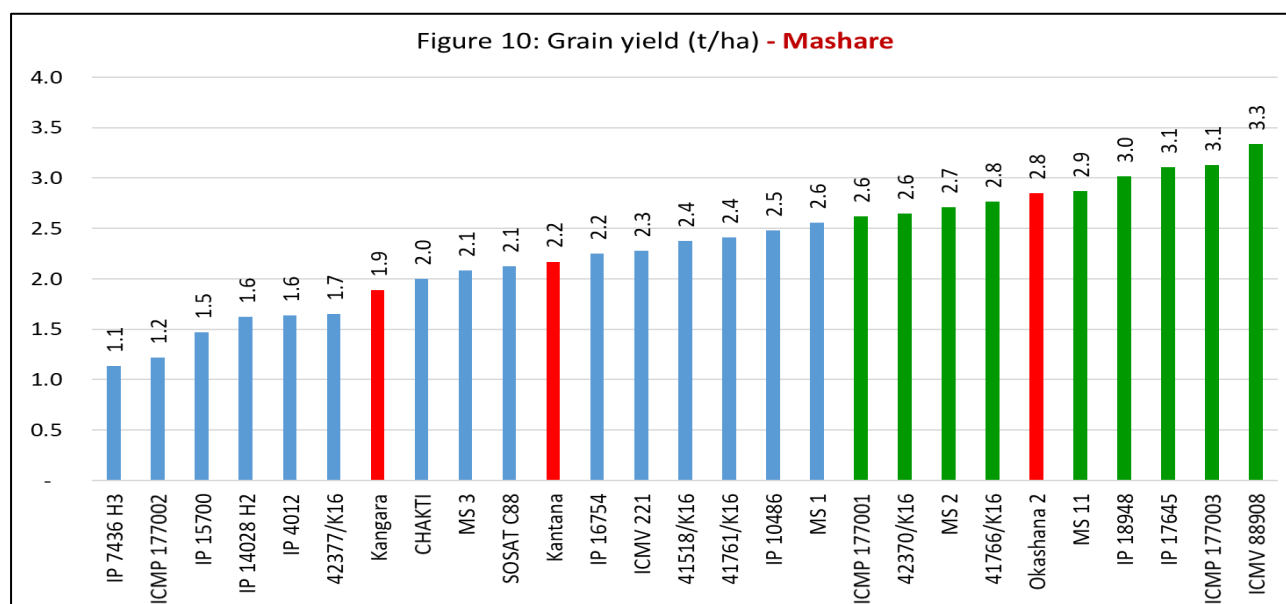
Early	T/ha	Intermediate	T/ha
PAR21SAPP2-02	9.4	PAR21SAPP1-02	7.1
CZH16329	8.5	CZH18176	6.9
CZH18079	7.8	CZH15026	6.5
CZH18019	7.7	CZH18162	6.5
CZH15471	7.1	CZH18179	6.2
CZH18070	7	PAR21SAPP1-04	5.9
PAR21SAPP2-03	7	PAR21SAPP1-03	5.1
LocalKEP - MAW	6.9	CZH18156	5
CZH18060	6.8	CZH16278	4.9
CZH15002	6.7	CZH18185	4.9

Early	T/ha	Intermediate	T/ha
CZH15002	2.80	PAR21SAPP1-03	4.8
CZH18044	2.67	CZH18185	3.4
SC419	2.66	PAR21SAPP1-02	3.3
CZH18019	2.52	CZH15054	3.3
PAR21SAPP-05	2.36	CZH18179	3.1
CZH16334	2.25	CZH16285	2.8
PAR21SAPP2-02	2.24	CZH15026	2.8
CZH18011	2.16	CZH18187	2.7
PAR21SAPP2-03	2.14	SC653	2.4
CZH18014	2.06	CZH18164	2.2

6. PEARL MILLET (MAHANGU) FIELD TRIAL RESULTS

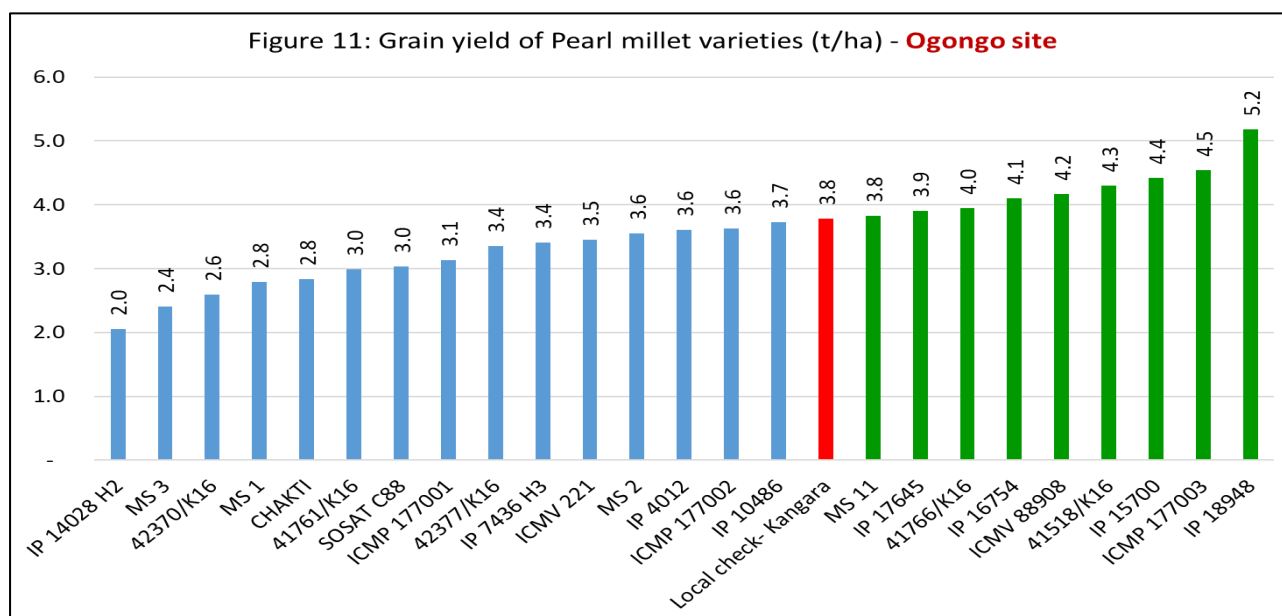
SITE 1: MASHARE IRRIGATION

At Mashare, the grain yield from the best variety was 3.3t/ha (ICMV 88908) and one of the local checks (Okashana 2) was number 6 amongst the best 10 performing varieties. However, the ICRISAT varieties performed better than the local check at this site. At Mashare, there was bird damage, excess water from heavy rains and irrigation as well.



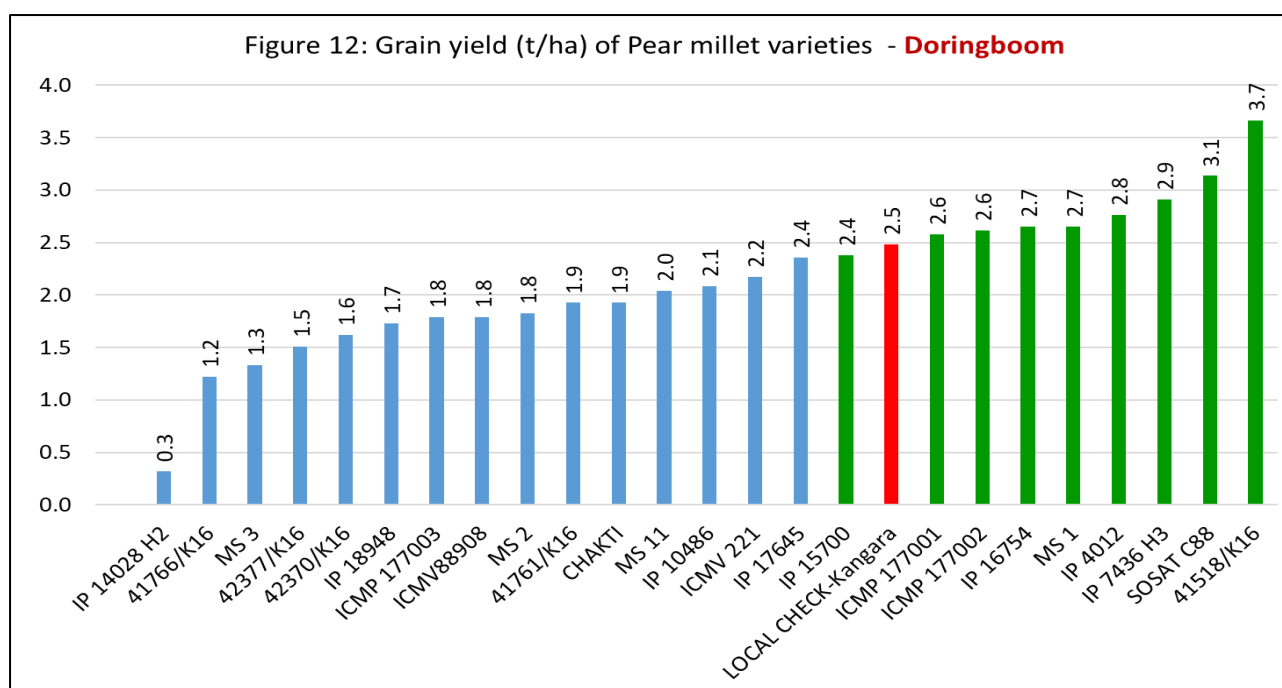
SITE 2: OGONGO UNAM CAMPUS

At the Ogongo site, different varieties exhibited different yield potentials. Grain yield from the best variety was 5.2t/ha. The ICRISAT varieties which attained yields from 4 t/ha upwards are IP 18948 (5.2 t/ha), ICMP 177003 (4.5t/ha), IP 15700 (4.4t/ha), 41518/K16 (4.3t/ha) ICMV 88908 (4.2t/ha), IP 16754 (4.1t/ha), and 41766/K16 (4t/ha). Local check Kangara was amongst the best varieties (3.8t/ha).



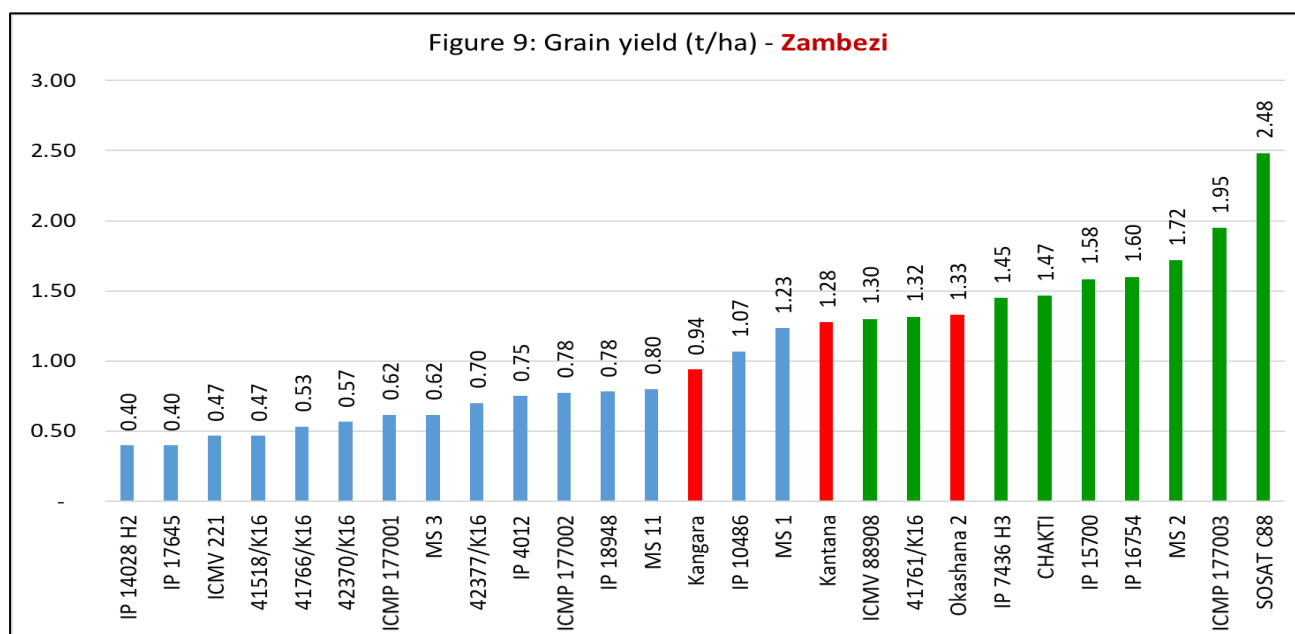
SITE 3: DORRINGBOOM UNAM FARM

Grain yield from the best variety was 3.7t/ha for ICRISAT number 41518/k16. The ICRISAT varieties were the best performers in terms of grain yield, with local check, Kangara, being amongst the top 10 best performing varieties. At Dorringboom, plants in some plots were destroyed by rats.



SITE 4: ZAMBEZI VTC

Grain yield from the best variety was 2.48 t/ha for ICRISAT's SOSAT C88. The ICRISAT varieties were the best performers and two local checks (Okashana 2 and Kantana). At the Zambezi site, the experiment was affected by initial flooding, which reduced the germination and plant stand and also hit by drought at a critical time, and the heads were damaged by birds.



PEARL MILLET TOP 10 GRAIN YIELD PERFORMERS PER SITE

Ogongo had an average pearl millet yield of 3.55 t/ha (an average of all the varieties). This placed Ogongo as the best site to test the pearl millet varieties in the future. Main factors that contributed to yield performance include: climate, birds control strategy, and some level of irrigation that was provided.

Table 2: Top 10 high yielding pearl millet varieties (ranked in descending order) in all the 4 sites

	Ogongo		Mashare		Zambezi		Dorringboom	
	Pearl millet Variety	Grain yield t/ha	Pearl millet Variety	Grain yield t/ha	Pearl millet Variety	Grain yield t/ha	Pearl millet Variety	Grain yield t/ha
1	IP 18948	5.19	ICMV 88908	3.34	SOSAT C88	2.48	41518/K16	3.67
2	ICMP 177003	4.54	ICMP 177003	3.13	ICMP 177003	1.95	SOSAT C88	3.14
3	IP 15700	4.42	IP 17645	3.10	MS 2	1.72	IP 7436 H3	2.91
4	41518/K16	4.30	IP 18948	3.01	IP 16754	1.60	IP 4012	2.77
5	ICMV 88908	4.17	MS 11	2.87	IP 15700	1.58	MS 1	2.65
6	IP 16754	4.10	Okashana 2	2.85	CHAKTI	1.47	IP 16754	2.65
7	41766/K16	3.95	41766/K16	2.76	IP 7436 H3	1.45	ICMP 177002	2.62
8	IP 17645	3.90	MS 2	2.71	Okashana2	1.33	ICMP 177001	2.58
9	MS 11	3.83	42370/K16	2.65	41761/K16	1.32	Kangara	2.48
10	Kangara	3.78	ICMP 177001	2.62	ICMV 88908	1.30	IP 15700	2.38

Key: Similar coloured cells represent the same variety appearing among the top10 best performers in more than one site. Varieties in the white coloured cells appear only per site.

BEST OF OVERALL GRAIN YIELD AND CRITERIA BASED ON THE FREQUENCY OF APPEARING AMONG THE BEST IN MORE THAN ONE SITE

According to the results (Grain yield of pearl millet (t/ha)) from an average of 4 sites, there are pearl millet varieties which emerged in the top ten among the 25 varieties tested. Furthermore, there are those varieties that did well across 2 of 3 varieties, an indicator that if used in Namibia, they can perform well across a wide range of agroecological zones. These are listed here:

1. ICMP 177003 – 1st overall (2.85t/ha) and 2nd best in 3 sites)
2. IP 15700 – 2nd best overall (2.82t/ha) and top 10 in 3 sites
3. 41518/16 – 3rd best overall (2.70t/ha) and top 4 in 2 sites
4. SOSAT C88 – 4th best overall (2.70t/ha) and top 2 in 2 sites
5. IP 18948 – 5th best overall (2.68/ha) and top 4 in 2 sites
6. IP 16754 – 6th best overall (2.65t/ha) and top 6 in 3 sites
7. ICMV 88908 – 7th best overall (2.65t/ha) and top 10 in 3 sites
8. MS 2 – 8th overall (2.45t/ha) and top 10 in 2 sites
9. IP 17645 – 9th best overall (2.44t/ha) and top 10 in 2 sites
10. MS 11 – 10th best overall (2.39t/ha) top 10 in 2 sites

Only the ICRISAT varieties made it to the top 10 list of best yield performers.

Yield performance of local checks

Okashana 2 (local improved) was the best of the 3 local varieties, followed by Kangara (local improved) and Kantana (local indigenous). None of the local check pearl millet varieties (improved or unimproved) appeared within the top 5 high-yielding varieties. Okashana 2 came position 6 and 8 in Mashare and Dorringtonboom respectively, while Kangara was position 9 and 10 in the Zambezi and Ogongo sites respectively.



7. CONCLUSION

- CIMMYT early variety: CZH16329 gave the best performance of grain yield (14 t/ha), at Mashare, and the least was CZH18014 (2.06 t/h) at the Zambezi site (Top 10 results).
- CIMMYT intermediate variety: CZH15054 gave the best performance of grain yield (11.3 t/ha) at Mashare, and the least was CZH18014 (2.2 t/h) at the Zambezi site (Top 10 results).
- Mashare produced the best grain yield results for both early and intermediate white maize varieties.
- A total of 4 local checks white maize varieties did not perform very well in all the 4 sites, except for KEP-MAWLR which yielded 6.9 tons per ha at Dorringtonboom and it is in the top 10, on position number 8 (Top 10 results).
- The local variety early maturing PAN 3A-124 was the least performer in all sites in terms of grain yield per hectare.
- In the top 10, ICRISAT varieties of pearl millet gave better yields than the local varieties (Okashana 2, Kangara, and Kantana) in all the 4 sites.
- Pearl millet: Okashana 2 and Kangara are part of the top 10 varieties on some sites.
- Ogongo was the best site to test the pearl millet varieties because of better yields, with grain yield of up to 5 t/ha, and the least performer in the top 10 was in Zambezi (1.30t/ha).

- The optimum performance at the Ogongo campus was because the pearl millet heads were not attacked by birds at the Ogongo site.
- The Ogongo site, therefore, gave a true reflection of the yield potential of the varieties. Crops in other sites suffered different incidences that compromised grain yield.

8. RECOMMENDATIONS

- For the second trials, the selection criteria should be based on overall yield, yield stability across sites, maturity time, and other properties like proneness to bird damage.
- All varieties should be tested under managed water stress (rain shelter) to delineate the genetic potential for drought tolerance.
- Material transfer and seed multiplication will only commence after the second trial, as per the second objective of the project.
- The trial site should be used as demo plots, to create awareness about the varieties to the farmers.

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