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A comparison of cassava (*Manihot esculenta* Crantz) varieties Perintis and MM 92 in relation to cropping duration and soil type

[Perbandingan antara varieti ubi kayu (*Manihot esculenta* Crantz) Perintis dan MM 92 berkaitan dengan tempoh penanaman dan jenis tanah]

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Key words: cassava, cropping duration, marketable roots, soil type, starch content, variety, yield

Abstrak

Hasil ubi kayu varieti Perintis dan MM 92 bagi dua tempoh penanaman (6 dan 12 bulan) telah dibandingkan di empat kawasan. MM 92 ialah varieti yang lebih sesuai untuk hasil selepas 6 bulan serta peratusan ubi yang dapat dipasarkan lebih tinggi. Pada amnya, dua giliran tanaman MM 92 tempoh 6 bulan didapati bersamaan atau lebih baik daripada satu tanaman Perintis tempoh 12 bulan, kecuali di kawasan tanah mineral yang mengalami musim kemarau selama 1–2 bulan. Dalam keadaan ini, hasil ubi kayu harus dikutip selepas 12 bulan. Kawasan penanaman di tanah gambut yang bersaliran sempurna dan bermusim kemarau selama 1–2 bulan didapati lebih produktif dalam penghasilan ubi.

Abstract

The yield performance of two cassava varieties, Perintis and MM 92, was compared over two cropping durations (6 and 12 months) and over four sites. MM 92 was a better variety to grow for 6-month yield and for a high percentage of marketable roots. Generally, two 6-month crops of MM 92 were equivalent or better than a single 12-month crop of Perintis, except where the site is on mineral soil and experiences a distinct dry period of 1–2 months. Under such circumstances, the cassava crop should be harvested after 12 months. The site on drained peat having a distinct dry period of 1–2 months was most productive in root yield.

Introduction

Cassava (*Manihot esculenta* Crantz) variety Perintis was released by MARDI in 1988 for being high-yielding and widely adaptable (Anon. 1988). Fresh root yields of 50–60 t/ha compare favourably with the 30–40 t/ha yields of commercial variety Black Twig. MM 92, released in 1992, is an early variety producing fresh root yields of 35–40 t/ha after 6 months (Anon. 1992).

Subsequent testing of Perintis by various parties have shown its high yield potential, sometimes in the region of 100 t/ha (Yong, L. M., Sabah Department of Agriculture, Tenom, pers. comm. 1990; Normah, M., Commodity Production Centre, Titi Gantong, pers. comm. 1992; Chan and Tan 1994). This raises the question of whether it would be more profitable to plant a single crop of Perintis over a 12-month

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period or to plant two crops of MM 92 over the same period.

Materials and methods

A series of trials was designed to test the performance of the two cassava varieties, Perintis and MM 92, over two cropping durations, viz. 6 and 12 months, and over four sites. The latter are characterized by differences in soil type as well as agro-ecological zone *(Table 1)*.

Pontian, Serdang and Jalan Kebun are MARDI research stations, while Lekir is a station of the Department of Agriculture. In Malaysia, there are only very small areas of peat falling within AEZ 2 (e.g. in Kelantan, Kedah and Perak); thus, there was no attempt to locate one of the peat sites in such a zone.

At each site, the trial adopted a randomized complete block design (RCBD) replicated six times. A standard plot size of 7 m x 7 m, with a plant spacing at 1 m x 1 m, was used throughout. The number of sample plants per plot was 25, harvested from the central area. The treatments were

1. Single 12-month crop of Perintis,
2. Two 6-month crops of Perintis,
3. Single 12-month crop of MM 92, and
4. Two 6-month crops of MM 92.

The usual agronomic practices for growing cassava on mineral soils (Chan et al. 1983) and on drained peat (Tan and Chan 1992) were applied accordingly.

After the first 6-month harvests in Treatment 2 and Treatment 4, the second crop was immediately replanted in the vacated area (after clearing the border rows) without further tillage.

Data were collected on fresh root yield, number of marketable roots and starch content of the roots, estimated from specific gravity measurements on root samples (Noor Auni and Tan 1980). Starch yield was computed from the product of fresh root yield and starch content.

Analyses of variance were performed in several forms:

(i) On only the data of the 6-month crops (Treatment 2 and Treatment 4):
   a. By site, as a split-plot design with variety as the main plot and harvest (first and second) the sub-plot;
   b. Combined over the four sites, as a split-split-plot design with site as the main plot, variety the sub-plot and harvest the sub-sub-plot;

(ii) On only the data of the 12-month crops (Treatment 1 and Treatment 3): combined over the four sites, as a split-plot design with site as the main plot and variety as the sub-plot;

(iii) On the data of cumulative root and starch yields, and cumulative marketable root number over 12 months (Treatment 1 to Treatment 4):
   a. By site, as an RCBD;
   b. Combined over sites, as a split-plot design with site as the main plot, and variety and cropping duration (6-month x 2 and 12-month) as the sub-plots.

Monthly rainfall data were compiled over the cropping period from meteorological records of the corresponding station, or, in the case of Lekir, from the nearest meteorological station which is Sitiawan. Correlations were run, overall and

Table 1. Soil type and agro-ecological zone of the four trial sites

Site	Soil type	Agro-ecological zone (AEZ)*
Pontian	Drained peat	AEZ 3 : no distinct dry period
Lekir	Sandy clay loam	AEZ 2 : 1–2 months' dry period
Serdang	Clayey	AEZ 3 : no distinct dry period
Jalan Kebun	Drained peat	AEZ 3 : no distinct dry period

*as defined by Nieuwolt et al. (n.d.)

by variety, between rainfall data for each 6-month period at each site and corresponding fresh root yield, marketable root number and starch content. The same was done between annual rainfall vs. the same characters measured on 12-month crops.

Results and discussion

Fresh root yield

6-month crops Statistical analyses by site showed MM 92 to be higher yielding than Perintis at every site *(Table 2)* as expected, except at Pontian where the difference was not significant. There was a significant decrease in 6-month yields of both varieties from the first to the second harvest (ranging from 10.7% to 62.2%), although the decline was less marked at Jalan Kebun. Jalan Kebun recorded the highest and Lekir the lowest yields of all the sites.

12-month crops No significant yield differences were detected between MM 92 and Perintis when single 12-month crops were grown. Highest yields after 12 months were at Lekir *(Table 2)*.

Cumulative 12-month yields Again, with the exception of Pontian (where varietal yields were not significantly different), MM 92 produced higher cumulative root yields over 12 months than Perintis at all sites

Table 2. Fresh root yields by treatment and site from harvests at 6 and 12 months

Site	Treatment no.	Variety	Yield (t/ha), 6-month harvests			Yield (t/ha), 12-month harvest
			1st	2nd	Mean	
Pontian	1	Perintis	–	–	–	55.3
	2	Perintis	27.2	19.9	23.6a	–
	3	MM 92	–	–	–	48.6
	4	MM 92	31.3	19.7	25.5a	–
		Mean	29.3a	19.8b	24.6x	52.0r
Lekir	1	Perintis	–	–	–	63.6
	2	Perintis	17.7	8.7	13.2b	–
	3	MM 92	–	–	–	70.9
	4	MM 92	33.3	12.6	23.0a	–
		Mean	25.5a	10.7b	18.1z	67.3p
Serdang	1	Perintis	–	–	–	55.5
	2	Perintis	22.4	15.0	18.7b	–
	3	MM 92	–	–	–	55.0
	4	MM 92	30.6	20.6	25.6a	–
		Mean	26.5a	17.8b	22.2y	55.3qr
Jalan Kebun	1	Perintis	–	–	–	61.4
	2	Perintis	29.9	26.7	28.3b	–
	3	MM 92	–	–	–	58.3
	4	MM 92	39.6	33.0	36.3a	–
		Mean	34.8a	29.9b	32.3w	59.9q
		Overall	29.0a	19.5b		
	Variety mean	Perintis			21.0	59.0
		MM 92			27.6	58.2
		$LSD_{0.05}$			1.7	3.6

Values within a column or within a row with the same letter are not significantly different from one another according to the LSD test at $p \leq 0.05$

(Table 3). Generally, a single 12-month crop produced higher yields than two consecutive 6-month crops, although at Pontian this difference was not significant. By contrast, Jalan Kebun, as with the 6-month crops, recorded significantly higher cumulative 12-month yields than the other sites.

Figure 1 gives an idea of the productivity of the four sites. As may be seen, the highest yields came from Jalan Kebun, with a margin of more than 10 t/ha over the other sites. Comparing the relative productivity of the two varieties and the cropping duration practised over the four sites, it is obvious that Perintis is not an early variety and is not amenable to 6-month cropping. It would appear that there is no advantage in growing two crops of MM 92 in a year since the cumulative yield obtained is no better than from a single crop of either Perintis or MM 92 left to grow till 12 months. This is especially apparent at Lekir *(Table 3)*. Nevertheless, as may be seen from the same table, under certain circumstances (such as in Jalan Kebun), planting two crops of MM 92 is superior to harvesting a single crop of either of the two varieties after 12 months.

Marketable roots

If the roots are destined for the fresh food market, then the number of marketable roots

Table 3. Cumulative fresh root yields over a 12-month period by treatment and site

Site	Treatment no.	Variety	Cumulative yield (t/ha) over 12 months		
			6-month x 2	12-month	Mean
Pontian	1	Perintis		55.3	
	2	Perintis	47.1		51.2a
	3	MM 92		48.6	
	4	MM 92	51.0		49.8a
		Mean	49.1a	52.0a	50.5z
Lekir	1	Perintis		63.6	
	2	Perintis	26.4		45.0b
	3	MM 92		70.9	
	4	MM 92	45.9		58.4a
		Mean	36.2b	67.3a	51.7z
Serdang	1	Perintis		55.5	
	2	Perintis	37.4		46.4b
	3	MM 92		55.0	
	4	MM 92	51.2		53.1a
		Mean	44.3b	55.2a	49.8z
Jalan Kebun	1	Perintis		61.4	
	2	Perintis	56.6		59.0b
	3	MM 92		58.3	
	4	MM 92	72.6		65.5a
		Mean	64.6a	59.9a	62.3y
		Overall	48.5z	58.6y	
	Variety mean	Perintis			50.4
		MM 92			56.7
		$LSD_{0.05}$			2.5

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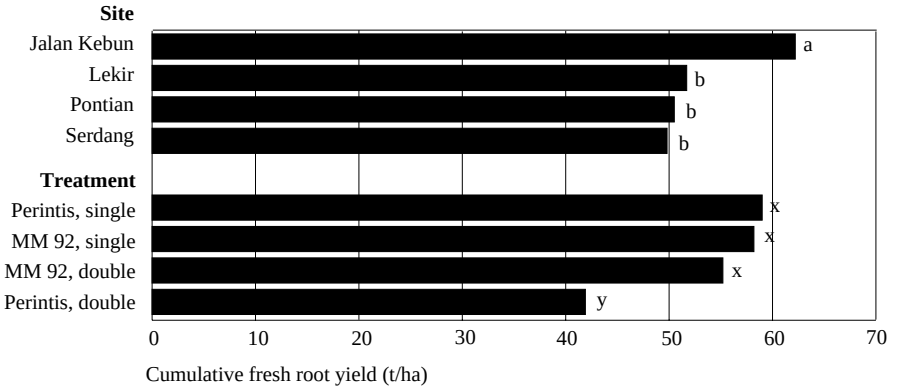

Figure 1. Cumulative fresh root yields at the four trial sites averaged over treatments, and of the four treatments averaged over sites

is more relevant than fresh root yield. Marketable roots are those which are at least 15 cm in length.

As in fresh root yields, the number of marketable roots of MM 92 tended to be larger at 6 months than Perintis, and there were less marketable roots from the second harvest than from the first *(Table 4)*. As before, the production of marketable roots was significantly higher at Jalan Kebun.

It would appear that planting two 6-month crops of cassava at any site produced more marketable roots within a year than from a single 12-month crop, especially if the variety is MM 92 *(Table 4)*.

Starch content of roots

Starch content is important when cassava roots are to be marketed for starch production. There was no significant difference between the starch contents of Perintis and MM 92 at 6 months, and starch content appeared to drop in the second harvest compared with the first *(Table 5)*. As a site, Lekir was unfavourable for producing 6-month crops because starch content at this stage was significantly lower than at the others.

Perintis harvested at 12 months recorded a significantly higher starch content than MM 92. This difference is especially large at Lekir and Serdang, the mineral soil sites, compared with the peat sites of Pontian and Jalan Kebun. Jalan Kebun appeared to be unfavourable for producing 12-month crops for starch because the content at this stage was significantly lower than at the other sites.

Starch yield

As starch yield is a product of fresh root yield and starch content, it is not surprising that the trends are similar to those of fresh root yields. Thus, for the 6-month crops, MM 92 generally produced higher starch yields than Perintis at all the sites *(Table 6)*, while the first harvest yielded higher starch yields than the second. Jalan Kebun outperformed the other three sites for this trait. Lekir, on the other hand, was the worst site for 6-month starch yield.

For 12-month starch yields, it made no difference which of the two varieties were planted, but the best site was Lekir.

Examining the cumulative starch yields at the end of 12 months, the best yields may be expected from growing single 12-month crops of cassava at mineral soil sites *(Table 7)*. For Jalan Kebun on peat, it seems better to plant two 6-month crops, especially of MM 92. Overall, this site also produced the highest starch yields. For Pontian, the other peat site, it made no difference which variety was grown and for how long a cropping duration.

Table 4. Number of marketable roots (per 25-plant plot) over a 12-month period by treatment and site

Site	Treatment no.	Variety	No. roots, 6-month harvests			Cumulative no. roots over 12 months		
			1st	2nd	Mean	6-month	12-month	Mean
Pontian	1	Perintis	–	–		–	125	
	2	Perintis	79	63	71a	142		134a
	3	MM 92	–	–	–		118	
	4	MM 92	110	84	97a	194		156a
		Mean	95a	74a	84z	168a	122b	145z
Lekir	1	Perintis	–	–	–		140	
	2	Perintis	92	54	74b	146		144b
	3	MM 92	–	–	–		197	
	4	MM 92	180	67	123a	247		222a
		Mean	136a	61b	99z	197a	169a	183y
Serdang	1	Perintis	–	–	–		132	
	2	Perintis	112	59	85a	171		151b
	3	MM 92	–	–	–		177	
	4	MM 92	139	79	108a	218		197a
		Mean	126a	68b	97z	195a	155b	174y
Jalan Kebun	1	Perintis	–	–	–		184	
	2	Perintis	144	110	127b	254		219b
	3	MM 92	–	–	–		205	
	4	MM 92	182	132	157a	314		260a
		Mean	163a	121b	142y	284a	195b	240x
		Overall	130a	81b		211y	160z	
	Variety mean	Perintis			89			162
		MM 92			122			209
		$LSD_{0.05}$			15			13

Values within a column or within a row with the same letter are not significantly different from one another according to the LSD test at $p \leq 0.05$

Performance in relation to rainfall

Rainfall (Anon. 1994) in relation to monthly crop growth stage at each site is shown in *Figure 2*. The site Jalan Kebun was classified by Nieuwolt et al. (n.d.) as belonging to AEZ 3, i.e. having no distinct dry period. Nevertheless, the year of study may be considered atypical for Jalan Kebun as there were in fact 2 months (corresponding to the ninth and 10th month from planting) during which rainfall was less than 40–60 mm. Nieuwolt (1981) had defined a dry period as agricultural drought occurring when rainfall is less than 40–60 mm. In other words, for that particular year, Jalan Kebun had the characteristics of AEZ 2, similar to Lekir. Although the sites Pontian and Serdang also showed a drier month (corresponding to the 11th and ninth month), these months were only marginally dry, having rainfall amounting to 53 mm and 44 mm respectively. Thus, Pontian and Serdang can still be considered typical of AEZ 3.

Data on total rainfall after the first and second 6-month cropping periods and over the 12 months are given in *Figure 3*. Although rainfall was not associated with root yield *(Table 8)*, it may be seen that at all sites the second 6-month period received

Table 5. Starch content of roots by treatment and site from harvests at 6 and 12 months

Site	Treatment no.	Variety	Starch content (%), 6-month harvests			Starch content (%), 12-month harvest
			1st	2nd	Mean	
Pontian	1	Perintis	–	–	–	19.5
	2	Perintis	21.3	18.8	20.0a	
	3	MM 92	–	–	–	19.3
	4	MM 92	21.6	19.1	20.3a	
		Mean	21.5a	19.0b	20.2y	19.4q
Lekir	1	Perintis	–	–	–	20.7
	2	Perintis	19.1	17.8	18.4a	
	3	MM 92	–	–	–	19.0
	4	MM 92	19.3	17.1	18.2a	
		Mean	19.2a	17.5b	18.3z	19.9q
Serdang	1	Perintis		–	–	21.9
	2	Perintis	19.9	19.6	19.7a	
	3	MM 92	–	–	–	20.0
	4	MM 92	20.6	20.3	20.4a	
		Mean	20.3a	20.0a	20.1y	21.0p
Jalan Kebun	1	Perintis	–	–	–	17.8
	2	Perintis	20.7	18.8	19.8a	
	3	MM 92	–	–	–	17.3
	4	MM 92	21.3	18.9	20.1a	
		Mean	21.0a	18.9b	20.0y	17.6r
		Overall	20.5a	18.8b		
	Variety mean	Perintis			19.5	20.0
		MM 92			19.8	18.9
		$LSD_{0.05}$			0.4	0.6

Values within a column or within a particular site with the same letter are not significantly different from one another according to the LSD test at $p \leq 0.05$

less rainfall than the first, and this might explain the generally lower second crop fresh root yields. Both Lekir and Jalan Kebun, as mentioned above, may be considered to be from AEZ 2, and the amounts of total rainfall in their second 6-month periods are practically the same. However, the second crop root yields at Lekir were very much lower than at Jalan Kebun *(Table 2)*. The difference in soil type may be the main reason. Thus, although Jalan Kebun faced an agricultural drought, peat generally retains more moisture under such conditions. Moreover, in the 2 months before the dry period at Jalan Kebun, rainfall was more than in the corresponding 2 months before the dry period at Lekir, implying that there was probably more retained soil moisture at the former site. This amount seems to suffice for Jalan Kebun to be the best site for second crop root yield.

Positive and significant correlations were detected only between rainfall and starch content in both the varieties *(Table 8)*. This explains the lower starch contents at Lekir (both harvests) and in the second harvest at Jalan Kebun *(Table 5)*.

Examining the annual rainfall at each site in relation to 12-month fresh root yield, there appears to be a negative correlation between rainfall and fresh root yield *(Table*

Table 6. Starch yields by treatment and site from harvests at 6 and 12 months

Site	Treatment no.	Variety	Starch yield (t/ha), 6-month harvests			Starch yield (t/ha), 12-month harvest
			1st	2nd	Mean	
Pontian	1	Perintis	–	–	–	10.8
	2	Perintis	5.8	3.8	4.8a	–
	3	MM 92	–	–	–	9.5
	4	MM 92	6.8	3.8	5.3a	–
		Mean	6.3a	3.8b	5.1x	10.2r
Lekir	1	Perintis	–	–	–	13.2
	2	Perintis	3.4	1.6	2.5b	–
	3	MM 92	–	–	–	13.5
	4	MM 92	6.4	2.2	4.3a	–
		Mean	4.9a	1.9b	3.4z	13.4p
Serdang	1	Perintis	–	–	–	12.2
	2	Perintis	4.5	2.9	3.7b	–
	3	MM 92	–	–	–	11.0
	4	MM 92	6.3	4.2	5.2a	–
		Mean	5.4a	3.6b	4.5y	11.6q
Jalan Kebun	1	Perintis	–	–	–	10.9
	2	Perintis	6.2	5.0	5.6b	–
	3	MM 92	–	–	–	10.1
	4	MM 92	8.4	6.3	7.3a	–
		Mean	7.3a	5.7b	6.5w	10.5qr
		Overall	6.0a	3.7b		
	Variety mean	Perintis			4.2	11.7
		MM 92			5.5	11.0
		$LSD_{0.05}$			0.4	0.9

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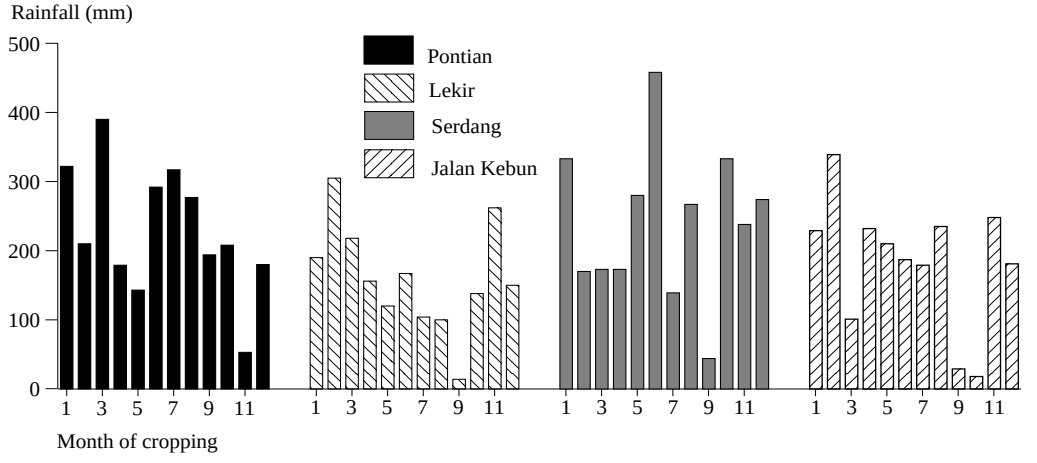

Figure 2. Monthly rainfall in relation to crop growth stage at each site

Table 7. Cumulative starch yields over a 12-month period by treatment and site

Site	Treatment no.	Variety	Cumulative starch yield (t/ha) over 12 months		
			6-month x 2	12-month	Mean
Pontian	1	Perintis		10.8	
	2	Perintis	9.5		10.2a
	3	MM 92		9.5	
	4	MM 92	10.5		10.0a
		Mean	10.0a	10.1a	10.1z
Lekir	1	Perintis		13.2	
	2	Perintis	5.0		9.1b
	3	MM 92		13.5	
	4	MM 92	8.6		11.1a
		Mean	6.8b	13.3a	10.1z
Serdang	1	Perintis		12.2	
	2	Perintis	7.4		9.8a
	3	MM 92		11.0	
	4	MM 92	10.5		10.7a
		Mean	9.0b	11.6a	10.3z
Jalan Kebun	1	Perintis		10.9	
	2	Perintis	11.2		11.1b
	3	MM 92		10.1	
	4	MM 92	14.7		12.4a
		Mean	13.0a	10.5b	11.7y
		Overall	9.7z	11.4y	
	Variety mean	Perintis			10.0
		MM 92			11.0
		$LSD_{0.05}$			0.6

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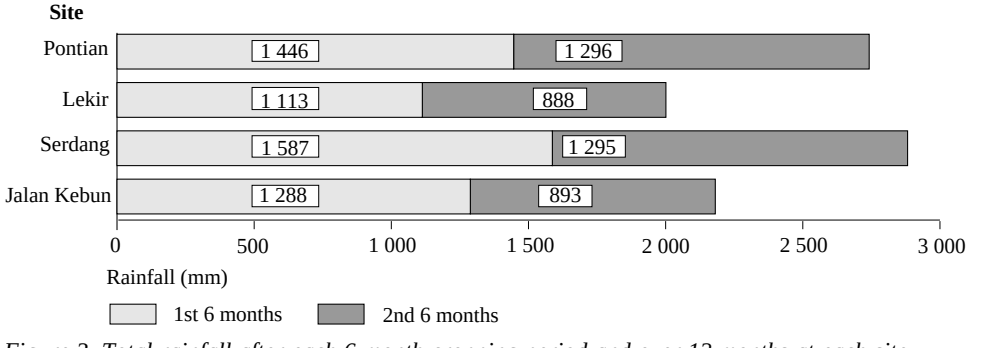

Figure 3. Total rainfall after each 6-month cropping period and over 12 months at each site

Table 8. Correlation between rainfall with fresh root yield, marketable root number and starch content

	Root yield	Marketable root no.	Starch content
6-month data (n=8)			
All data	0.32 (0.43)*	0.16 (0.71)	0.74 (0.001)
Perintis	0.37 (0.36)	0.19 (0.66)	0.73 (0.04)
MM 92	0.27 (0.52)	0.13 (0.75)	0.79 (0.02)
12-month data (n=4)			
All data	-0.90 (0.06)	-0.70 (0.26)	0.55 (0.42)
Perintis	-0.99 (0.003)	-0.58 (0.39)	0.42 (0.55)
MM 92	-0.83 (0.13)	-0.67 (0.29)	0.67 (0.30)

*Figures in brackets refer to probability level

8), especially when Perintis was grown (r = -0.99). This supports the data that cassava grown in areas in AEZ 2 with annual rainfall around 2 000–2 200 mm (such as recorded at Jalan Kebun and Lekir) are the most productive for 12-month cassava crops. Areas in AEZ 3 with higher annual rainfall, exceeding 2 700 mm (such as Pontian and Serdang), appear to be less conducive to high cassava yields.

Conclusions

1. Areas with rainfall characteristics of AEZ 2, especially on drained peat (where soil moisture is higher during the dry period), are better for high cassava yields than those classified as belonging to AEZ 3. This is probably because too much rain is not necessarily conducive to yield.
2. When planning for 6-month yields, MM 92 is a better choice than Perintis since it is more productive in this short crop duration.
3. While two 6-month crops of MM 92 were generally equivalent to or better than a single 12-month crop of Perintis in terms of root yield, in non-peat areas with a distinct dry period, it might be more sensible to plant cassava for 12-month yields. MM 92 provides the flexibility in such practice.
4. When cassava is to be sold in the fresh root market for table consumption, the optimum practice would be to grow two 6-month crops of MM 92 for a higher percentage of marketable roots.
5. For 6-month crops, optimum starch content may be expected in either variety in areas with higher rainfall during that period of cropping.
6. For 12-month crops (especially of Perintis), areas with annual rainfall of about 2 000–2 200 mm are more favourable for high fresh root yield than areas with higher rainfall.

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