

Research Paper

Herbage yield and quality of *Megathyrsus* cultivars in Northeast Thailand

Rendimiento y calidad de forraje de cultivares de Megathyrsus en el noreste de Tailandia

MICHAEL D. HARE

Ubon Forage Seeds Co. Ltd, Jaeramair, Muang, Ubon Ratchathani, Thailand. ubonforageseeds.com

Abstract

A field trial in Northeast Thailand during 2015–2018 evaluated the forage accumulation and nutritive value of 5 *Megathyrsus* cultivars, Mombasa, Tanzania, Massai, Zuri and Mun River. Mombasa and Tanzania are commonly grown in Thailand, but Massai, Zuri and Mun River had not been evaluated in Thailand before. Overall accumulated DM yields for the various cultivars over the 3 years were 24,550 kg/ha for Tanzania, 30,900 kg/ha for Massai, 32,700 kg/ha for Mombasa, 35,600 kg/ha for Mun River and 35,700 kg/ha for Zuri. Over 3 wet seasons, Mun River and Zuri accumulated 49% more total DM and Mombasa 35% more total DM than Tanzania. Massai accumulated lower total DM yields than Zuri and Mun River in the second and third wet seasons, similar yields to Mombasa, and higher yields than Tanzania in those 2 seasons. Crude protein concentrations in forage were higher in the dry season than in the wet season and in leaves than in stems. There were no consistent differences in CP% of the various cultivars in wet or dry seasons. ADF and NDF concentrations in the dry season were lower than those in the wet season and leaf ADF and NDF concentrations were lower than concentrations in stems. There were no consistent differences of ADF and NDF concentrations between cultivars throughout the study. This trial showed that both Zuri and Mun River would be ideal replacements for Mombasa and Tanzania in Northeast Thailand, as they would appeal to smallholder farmers for cut-and-carry forage with their upright, broad leaves, and at least similar DM production to Mombasa and superior DM production to Tanzania.

Keywords: Crude protein, dry matter yields, Massai, Mombasa, Mun River, Tanzania, Zuri.

Resumen

Entre 2015 y 2018 en un experimento de campo en el noreste de Tailandia se evaluaron la acumulación de forraje y el valor nutritivo de 5 cultivares de *Megathyrsus*: Mombasa, Tanzania, Massai, Zuri y Mun River. Mombasa y Tanzania son cultivares de uso común en Tailandia, mientras que Massai, Zuri y Mun River no habían sido evaluados en el país antes. Los rendimientos totales de materia seca (MS) acumulados durante los 3 años fueron de 24,550 kg/ha para Tanzania, 30,900 kg/ha para Massai, 32,700 kg/ha para Mombasa, 35,600 kg/ha para Mun River y 35,700 kg/ha para Zuri. Durante las épocas lluviosas, Mun River y Zuri acumularon 49% más de MS total y Mombasa 35% más de MS total que Tanzania. En la segunda y tercera época lluviosa, Massai acumuló rendimientos totales de MS más bajos que Zuri y Mun River; los rendimientos fueron similares a los de Mombasa y más altos que los de Tanzania en ambas épocas. Las concentraciones de proteína cruda (PC) en el forraje fueron mayores en época seca que en época lluviosa y mayores en hojas que en tallos. No se presentaron diferencias consistentes en la concentración de PC entre los cultivares en épocas lluviosas o secas. Las concentraciones de FDA y FDN en época seca fueron más bajas que las en época lluviosa y más bajas en hojas que en tallos. No se presentaron diferencias consistentes en las concentraciones de FDA y FDN entre los cultivares a lo largo del estudio. Este experimento mostró que en el noreste de Tailandia tanto Zuri como Mun River aparecen como reemplazos posibles para Mombasa y Tanzania, ya que por sus hojas erectas y anchas y una producción

Correspondence: Michael D. Hare, Ubon Forage Seeds Co. Ltd, Muu 1 602 Tha Bor Road, Jaeramair, Muang, Ubon Ratchathani 34000, Thailand. Email: michaelhareubon@gmail.com

de MS al menos similar a la de Mombasa y superior a la de Tanzania, son atractivos para los sistemas de corte y acarreo de forraje en explotaciones de los pequeños agricultores de la región.

Palabras clave: Massai, Mombasa, Mun River, producción de materia seca, proteína cruda, Tanzania, Zuri.

Introduction

Tanzania guinea grass [*Megathyrsus maximus* –formerly *Panicum maximum*– cv. Tanzania (cv. Si Muang in Thailand)] and Mombasa guinea grass (*M. maximus* –formerly *Panicum maximum*– cv. Mombasa) are the 2 most popular grasses in Thailand for cut-and-carry for dairy and beef cattle (Nakamane et al. 2008) and goats (Hare 2017) and for fresh grass sales (Hare 2018). Tanzania has been grown in Thailand for over 30 years (Phaikaew et al. 2007) and Mombasa for 10 years (Hare et al. 2013). In a series of trials in Northeast Thailand on cutting intervals (Hare et al. 2013), sowing rates (Hare et al. 2014) and nitrogen fertilizer levels (Hare et al. 2015), Mombasa on average produced 17–23% more dry matter (DM) than Tanzania and was larger and taller than Tanzania (Hare et al. 2014). In terms of crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF) concentrations, Tanzania was generally superior to Mombasa in these trials.

Currently, Mombasa has become more popular than Tanzania with farmers in Thailand, because of its greater DM production, long leaves and high acceptability by livestock. Seeds of both cultivars are produced in Northeast Thailand, but it is mainly Mombasa seed that is exported to other countries in Asia, the Middle East and the South Pacific. In 2015, we decided to study other *Megathyrsus* cultivars that may produce DM yields similar to or greater than Mombasa, but with the superior quality levels of Tanzania.

Zuri guinea grass (*M. maximus* –formerly *Panicum maximum*– cv. BRS Zuri) was released in Brazil in 2014 (Jank et al. 2016) and has been found to be more productive than Mombasa, Tanzania and Massai (*M. maximus* × *M. infestus* –formerly *Panicum maximum* × *P. infestum*–cv. Massai) (Oliveira et al. 2019). Zuri is also resistant to a leaf spot disease caused by *Bipolaris maydis*, which has substantially lowered production of Tanzania in Brazil (Jank et al. 2016) and now is becoming a problem with Tanzania in Thailand (Hare personal observation). We imported seed of Zuri from Brazil for our trials. In Southern Vietnam, an accession of *M. maximus* × *M. infestus* (K280) is very popular for cut-and-carry forage for dairy cows (Cook et al. 2020). There was no seed available of accession K280, so we imported Massai seed from Brazil. In some dry tropical environments, Massai

has produced greater DM yields of higher quality than other guinea grasses (Cook et al. 2020).

We were also given a small quantity of seed of an unknown guinea grass from Costa Rica, which from observations in small plots was producing superior DM yields to Mombasa (E. Stern pers. comm.). We named this grass Mun River guinea grass.

The objective of the research in this paper was to examine the production and quality in a field trial of 3 *Megathyrsus* grasses new to Thailand, i.e. Zuri, Massai and Mun River, in comparison with Mombasa and Tanzania.

Materials and Methods

A field experiment was conducted at Ubon Ratchathani University, Thailand, (15° N, 104° E; 130 masl) from 2015 to 2018. The site was on an upland sandy low humic gley (Paleaquult) soil (Roi-et series) (Mitsuchi et al. 1986). Soil samples, taken at seed sowing in July 2015, showed that the soil was acidic (pH 4.4; water method) and low in organic matter (0.7%), N (0.03%), P (8.9 ppm; Bray II extraction method) and K (7.1 ppm). Prior to planting the experiment, the site had grown a series of *Brachiaria* grass trials for many years. Five guinea grass cultivars (Mombasa, Tanzania, Massai, Zuri and Mun River) were sown in a randomized complete block design with 4 replications; details of field crop management are presented in Table 1. Seed germinations tested prior to sowing were: Mombasa 70%, Tanzania 60%, Massai 20%, Zuri 40% and Mun River 50%, and sowing rates were adjusted to sow at 8 kg pure-live-seed/ha. At each sampling cut, when the grasses were at about a 50–70 cm height above ground level, the forage in six 0.25 m² quadrats per plot was cut 5 cm from ground level and weighed fresh. A 300 g subsample was sorted into leaves and stems and dried separately at 70 °C for 48 h to determine dry weight. The dried subsamples were analyzed for total N using the Kjeldahl method (Kjeldahl 1883) in order to calculate crude protein (CP, %N × 6.25), acid detergent fiber (ADF, Van Soest method, Van Soest 1963) and neutral detergent fiber (NDF, Van Soest method, Van Soest 1963) concentrations. At each sampling cut, observations were recorded for emergence of inflorescences. After each sampling cut, the remaining herbage in the plots was cut to 5 cm from ground level and removed.

Table 1. Field crop management and sampling harvests during the evaluation of *Megathyrus* cultivars at Ubon Ratchathani, Thailand.

Management, harvest	Date, activity
Crop management	
Spraying	Jun 2015: glyphosate at 3 L/ha
Field cultivation	July 2015: plowing × 2, disking × 1, harrowing × 1
Plot size	3 × 5 m with 1 m walkway around plots and 1 m between replications
Sowing date	10 Jul 2015
Sowing rate adjusted for germination	8 kg pure-live-seed/ha hand-broadcast and raked into soil along with lime and fertilizer
Fertilizer	1,000 kg lime/ha and 200 kg NPK/ha (15:15:15) at sowing; 200 kg NPK/ha (15:15:15) after each sampling harvest
Sampling harvests	
First wet season	2015: 21 Sep & 5 Nov (2 cuts as seeds were sown in mid-wet season)
First dry season	2016: 27 Apr
Second wet season	2016: 10 Jun, 26 Jul, 7 Sep & 26 Oct
Second dry season	2017: 18 Jan & 26 Apr (2 cuts due to good growth in Nov & Dec)
Third wet season	2017: 7 Jun, 20 Jul, 5 Sep & 17 Oct
Third dry season	2018: 30 Apr

Data from the experiments were subjected to analysis of variance, using the IRRISTAT program from the International Rice Research Institute (IRRI). Entry means were compared by Fisher's protected LSD ($P \leq 0.05$).

Results

Rainfall

Rainfall in the wet season (May–Oct) in 2016 and 2017 was 18 and 10%, respectively, above the 20-yr mean (Figure 1). In the dry season (Nov–Apr) rainfall was close to average in the 2015/2016 season, 13% below average in the 2016/2017 season and 26% above average in the 2017/2018 season.

Forage accumulation

For all cultivars, DM production during the wet seasons far exceeded that in the dry seasons. Over 3 wet seasons, Zuri and Mun River accumulated 49% more total DM and Mombasa 35% more total DM than Tanzania (Table 2). In the establishment year, Mombasa and Massai out-yielded Tanzania during the wet season ($P < 0.05$; Table 2) but did not differ from other cultivars ($P > 0.05$). No significant differences between cultivars occurred in the

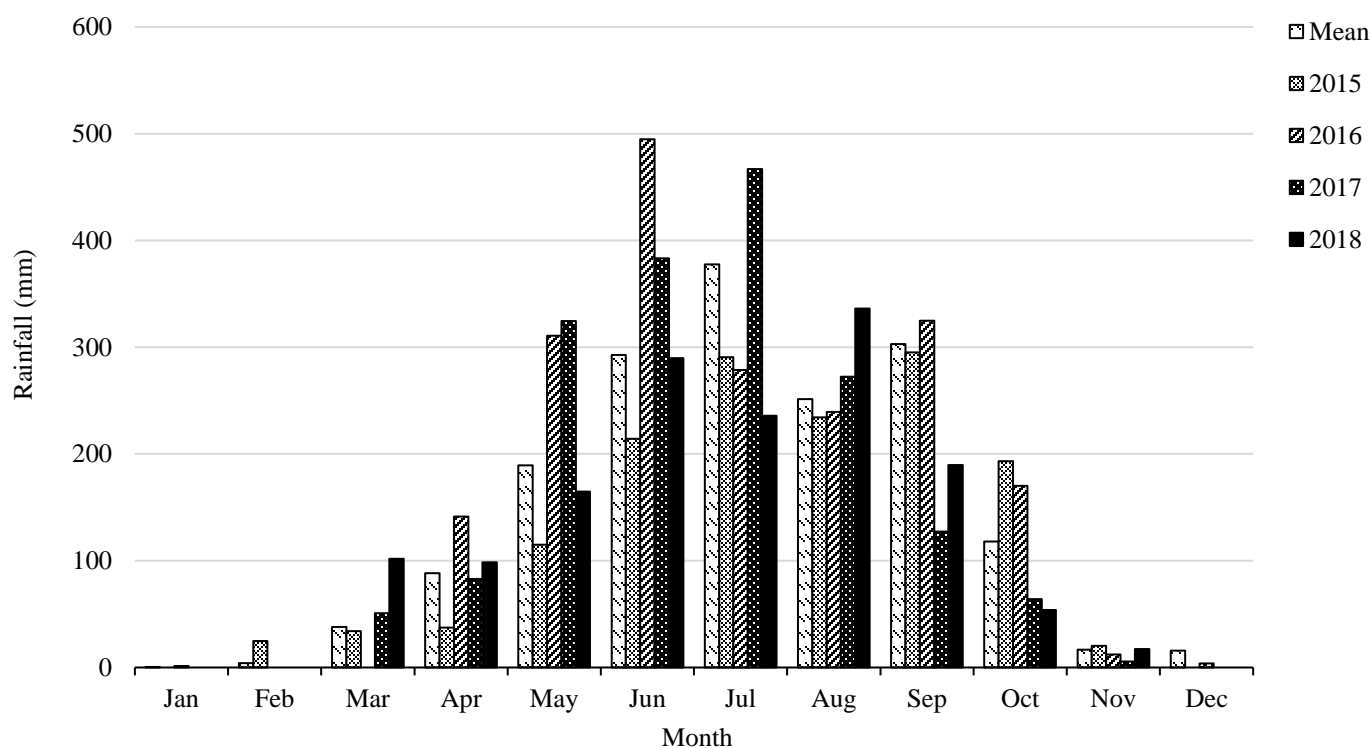


Figure 1. Rainfall at the Ubon Ratchathani University meteorological station, 200 m from the research site, during the experiment and the 20-yr mean (1998–2018).

Table 2. Total dry matter accumulation (kg/ha) of 5 *Megathyrsus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016		Second year 2016/2017		Third year 2017/2018		Accumulated total yield	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Mombasa	5,056a ¹	520	12,642cd	1,267ab	11,589ab	1,629a	29,287a	3,416ab
Tanzania	2,473b	406	10,398d	1,285ab	8,724c	1,265b	21,595b	2,956ab
Massai	4,873a	652	12,935bc	905b	10,427bc	1,225b	28,235ab	2,755b
BRS Zuri	3,652ab	457	16,115a	1,631a	12,200ab	1,648a	31,967a	3,736a
Mun River	3,887ab	438	15,206ab	1,451a	13,220a	1,426ab	32,313a	3,315ab
LSD (P<0.05)	2,324	NS	2,468	400	2,671	320	7,463	883

¹Means within columns followed by the same letter are not significantly different (P>0.05).

first dry season (P>0.05). Yields increased dramatically in the second wet season (mean yield 3,988 kg DM/ha in 2015/2016 vs. 13,459 kg DM/ha in 2016/2017) and Zuri out-yielded Tanzania, Mombasa and Massai (P<0.05), while Mun River out-yielded Mombasa and Tanzania (P<0.05). Growth differences between cultivars occurred in the second dry season with Zuri and Mun River out-yielding Massai (P<0.05). High DM yields persisted in the third wet season (mean 11,232 kg DM/ha), with Mun River, Zuri and Mombasa out-yielding Tanzania, while Mun River also out-yielded Massai. During the third dry season, DM yields for Zuri and Mombasa exceeded those for Massai and Tanzania (P<0.05). Overall DM yields for the various cultivars over the 3 years ranged from 24,550 kg/ha for Tanzania to 35,650 kg/ha for Zuri and Mun River. Accumulated wet season DM yields for Tanzania were significantly lower than those for Zuri, Mun River and Mombasa (Table 2).

In the first wet season Mombasa produced more leaf DM than Tanzania (Table 3; P<0.05) but in the second wet season both Zuri and Mun River accumulated more leaf DM than Mombasa, Massai and Tanzania (P<0.05). In the third wet season, Zuri, Mun River and Mombasa produced more leaf DM than Tanzania (P<0.05). Differences between cultivars in leaf production during the dry seasons tended to be relatively small with Zuri

consistently highest. Massai accumulated significantly lower stem DM yields than the other 4 cultivars in the dry season and Tanzania accumulated significantly lower stem DM yields than the other 4 cultivars in the third wet season (Table 4).

Massai produced a lower proportion of leaves than some cultivars in some wet seasons, but a significantly (P<0.05) higher leaf proportion than the other 4 species in the dry season (Table 5). Leaf proportions of other cultivars varied little in different seasons. Massai produced a dense population of inflorescences in September–October of each year, but inflorescence emergence of the other species was either negligible or very sparse.

Forage quality

Crude protein concentrations in forage were higher in the dry season than in the wet season and in leaves than in stems (Table 6). There were no consistent differences in CP% between the various cultivars in wet or dry seasons.

ADF and NDF concentrations varied between cultivars, seasons and plant parts (Tables 7 and 8). Dry season concentrations were lower than those in the wet season and leaf concentrations were lower than concentrations in stems. There were no consistent differences between cultivars throughout the study.

Table 3. Total leaf dry matter accumulation (kg/ha) of 5 *Megathyrsus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016		Second year 2016/2017		Third year 2017/2018	
	Wet	Dry ¹	Wet	Dry	Wet	Dry
Mombasa	3,842a ²	-	9,228b	1,064ab	8,924ab	1,352abc
Tanzania	1,904b	-	7,798b	1,079ab	6,805c	1,050d
Massai	3,411ab	-	9,183b	878b	7,612bc	1,103bcd
BRS Zuri	2,812ab	-	11,442a	1,337a	9,028ab	1,384a
Mun River	3,109ab	-	11,404a	1,190ab	9,783a	1,212abcd
LSD (P<0.05)	1,766	-	1,639	344	2,056	272

¹Not measured.

²Means within columns followed by the same letter are not significantly different (P>0.05).

Table 4. Total stem dry matter accumulation (kg/ha) of 5 *Megathyrus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016		Second year 2016/2017		Third year 2017/2018	
	Wet	Dry ¹	Wet	Dry	Wet	Dry
Mombasa	1,214ab ²	-	3,414	203b	2,665d	277a
Tanzania	569c	-	2,600	206b	1,919e	215b
Massai	1,462a	-	3,752	27c	2,815c	122c
BRS Zuri	840bc	-	4,673	294a	3,172b	264ab
Mun River	778c	-	3,802	261ab	3,437a	214b
LSD (P<0.05)	425	-	NS	65	62	53

¹Not measured.²Means within columns followed by the same letter are not significantly different (P>0.05).**Table 5.** Leaf proportion (%) of 5 *Megathyrus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016		Second year 2016/2017		Third year 2017/2018	
	Wet	Dry ¹	Wet	Dry	Wet	Dry
Mombasa	76a ²	-	73ab	84b	77ab	83b
Tanzania	77a	-	75a	84b	78a	83b
Massai	70b	-	71b	97a	73b	90a
BRS Zuri	77a	-	71b	82b	74b	84b
Mun River	80a	-	75a	82b	74b	85b
LSD (P<0.05)	5.0	-	3.0	2.2	3.9	4.2

¹Not measured.²Means within columns followed by the same letter are not significantly different (P>0.05).**Table 6.** Crude protein concentrations (%) in stems (S) and leaves (L) of 5 *Megathyrus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016				Second year 2016/2017				Third year 2017/2018			
	Wet		Dry ¹		Wet		Dry		Wet		Dry	
	S	L	S	L	S	L	S	L	S	L	S	L
Mombasa	2.8bc ²	7.1	-	-	5.3a	6.1c	7.7b	8.9ab	3.5c	7.6b	8.1c	12.5c
Tanzania	4.2a	7.2	-	-	4.2b	6.9b	6.7c	8.4bc	4.1b	7.8a	8.7bc	10.6d
Massai	3.6ab	7.8	-	-	3.4c	8.8a	8.7a	9.1a	4.8a	7.6b	10.8a	13.4b
BRS Zuri	3.7a	7.1	-	-	3.7bc	5.9c	6.3d	9.3a	4.1b	7.4c	9.4b	13.1bc
Mun River	2.5c	7.0	-	-	3.2c	5.8c	7.0c	8.1c	4.1b	7.1d	9.4b	14.6a
LSD (P<0.05)	0.9	NS	-	-	0.6	0.7	0.4	0.6	0.6	0.2	0.8	0.9

¹Not measured.²Means within columns followed by the same letter are not significantly different (P>0.05).

Table 7. Acid detergent fiber concentrations (%) in stems (S) and leaves (L) of 5 *Megathyrus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016				Second year 2016/2017				Third year 2017/2018			
	Wet		Dry ¹		Wet		Dry		Wet		Dry	
	S	L	S	L	S	L	S	L	S	L	S	L
Mombasa	41.9b ²	36.9b	-	-	47.2ab	42.2c	36.4c	34.8b	46.4d	39.7d	39.9c	35.8c
Tanzania	41.6b	35.7c	-	-	46.3b	41.8c	37.5b	36.6a	46.7cd	41.2c	41.3b	39.5a
Massai	45.1a	38.4a	-	-	49.0a	43.1b	34.2d	35.2b	49.2a	41.2c	39.9c	37.6b
BRS Zuri	41.6b	35.6c	-	-	49.4a	43.8a	38.5a	35.3b	47.4bc	42.1b	42.6a	37.5b
Mun River	42.0b	36.7b	-	-	48.1ab	43.5ab	37.5b	35.5b	48.2b	43.9a	41.6b	37.6b
LSD (P<0.05)	0.4	0.4	-	-	2.4	0.6	0.6	0.8	0.9	0.3	0.8	0.5

¹Not measured.²Means within columns followed by the same letter are not significantly different (P>0.05).**Table 8.** Neutral detergent fiber concentrations (%) in stems (S) and leaves (L) of 5 *Megathyrus* cultivars in wet (May–Oct) and dry (Nov–Apr) seasons during 2015–2018 at Ubon Ratchathani, Thailand.

Cultivar	First year 2015/2016				Second year 2016/2017				Third year 2017/2018			
	Wet		Dry ¹		Wet		Dry		Wet		Dry	
	S	L	S	L	S	L	S	L	S	L	S	L
Mombasa	69.7a ²	64.8	-	-	75.7c	73.6c	70.0c	68.9	75.1c	69.2c	69.5b	64.1c
Tanzania	69.5a	64.4	-	-	75.9c	73.6c	70.3c	70.0	75.9bc	70.5bc	70.6b	69.6b
Massai	65.1b	62.1	-	-	80.2a	76.7a	68.4d	69.9	77.8a	71.9b	72.6a	71.4a
BRS Zuri	69.9a	63.5	-	-	79.0b	75.6b	73.5a	69.6	76.8b	72.7ab	72.2a	69.0b
Mun River	70.3a	63.8	-	-	80.3a	76.7a	71.4b	68.8	75.9bc	73.4a	72.4a	69.7b
LSD (P<0.05)	3.3	NS	-	-	0.8	0.9	0.7	NS	0.9	1.4	1.0	1.1

¹Not measured.²Means within columns followed by the same letter are not significantly different (P>0.05).

Discussion

This study has shown that 2 *Megathyrus* cultivars, new to Thailand, i.e. Zuri and Mun River, can produce more dry matter in some seasons than the 2 cultivars commonly grown in Thailand, i.e. Mombasa and Tanzania. While they were slower to establish, Zuri and Mun River produced excellent DM yields in the second and third wet seasons after sowing. They produced 24% more DM than Mombasa in the second year and similar yields to Mombasa in the third year. By comparison, DM yields of Zuri and Mun River in the second and third years exceeded those of Tanzania by 50 and 46%, respectively. Zuri and Mun River also performed well in the dry seasons by producing more total DM than Mombasa and Tanzania but differences were generally non-significant.

The performance of Zuri in this trial, while not as spectacular as the findings of Oliveira et al. (2019) in Brazil, where Zuri produced on average 84% more DM than Mombasa and Tanzania, did confirm that Zuri is a very productive *Megathyrus* cultivar. While we did not achieve such large differences in our trial, the mean DM increases of 17 and 48% for Zuri in the second and third wet seasons over Mombasa and Tanzania, respectively, were most impres-

sive. The fact that increased yields were not confined to the wet season, with Zuri producing yields at least as good as those of Mombasa and Tanzania in the dry season once established, was an added benefit of this cultivar. Despite the higher yields in Zuri, no consistent differences in quality parameters, e.g. CP, ADF and NDF concentrations, between cultivars were recorded, which reinforced the conclusion that this cultivar seems to have distinct advantages over Tanzania in this environment.

The performance of Mun River was more variable than that of Zuri. Its DM production in the wet season was similar to that of Zuri and sometimes better than that of Mombasa but it was consistently more productive than Tanzania. Quality parameters were generally at least equal to those of the established cultivars. We have distributed seeds of Mun River to several smallholder goat farmers and they find it softer to cut and more palatable for goats than Mombasa for cut-and-carry forage. The leaf edges of Mombasa are serrated, while those of Mun River are smooth (Cook et al. 2020), which may explain why farmers find it softer to handle. This softer cutting attribute is important for smallholder farmers. However, more field trials and laboratory analyses are needed to confirm this attribute. The

original seeds we received from Costa Rica in 2015 did not have a name. We have since learned that the plants in Costa Rica came from an aberrant type discovered in a field of cv. Mombaça in the State of Mato Grosso, Brazil (Cook et al. 2020). We consider Mun River to be very similar to cv. Miyagi registered in Brazil (Cook et al. 2020). Studies are needed to confirm if Mun River and Miyagi are indeed one and the same cultivar.

Massai also performed quite well in this environment with generally similar DM yields to Mombasa, Zuri and Mun River. Despite its tendency to produce profuse flowering in September-October each year, forage quality was also quite acceptable. In some studies, Massai has produced greater yields of DM of higher quality than other guinea grasses (Cook et al. 2020), but in our trials, while the dry season quality of Massai was high, it had significantly lower DM production than both Zuri and Mun River. For cut-and-carry forage in Thailand, the shorter height and slender leaves of Massai would not appeal to farmers who like the broad-upright leaves of *M. maximum* cultivars.

In previous trials with Mombasa and Tanzania in Thailand (Hare et al. 2013; 2014; 2015), Mombasa always produced significantly higher DM yields than Tanzania, but the quality of Tanzania was always superior. In this trial, Mombasa maintained its higher DM production than Tanzania, but quality of forage from both cultivars was generally similar. Tanzania in this trial was quite severely affected by the leaf spot disease caused by *Bipolaris maydis*, and this would have lowered its DM production and probably lowered its quality. Zuri, Mun River and Mombasa have not been shown to be affected by the leaf spot disease.

This trial has shown that both Zuri and Mun River would be ideal replacements for Mombasa and Tanzania in Northeast Thailand, as they would appeal to smallholder farmers for cut-and-carry forage with their upright, broad leaves and at least similar DM production to Mombasa and superior production to Tanzania.

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(Note of the editors: All hyperlinks were verified 5 August 2020.)

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