

Impact of tropical forage seed development in villages in Thailand and Laos: research to village farmer production to seed export

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Abstract. Seed of six forage species, Mulato II hybrid brachiaria, Cayman hybrid brachiaria, Mombasa guinea, Tanzania guinea, Ubon stylo and Ubon paspalum, are currently being produced by over 1000 smallholder farmers in villages in northeast Thailand and northern Laos, under contract to Ubon Forage Seeds, Faculty of Agriculture, Ubon Ratchathani University, Thailand. The seed is mainly exported overseas (95%) and the remainder is sold within Thailand. Tropical Seeds LLC, a subsidiary of a Mexican seed company Grupo Papalotla, employs the seed producing and seed research group, Ubon Forage Seeds, to manage seed production, seed sales and export, and to conduct research on new forage species. This paper discusses in detail how the development in villages of a smallholder-farmer seed production program has had positive social and economic outcomes for the village seed growers and enabled farmers in other countries to receive high quality forage seeds. The strong emphasis on seed quality, high purity, high vigour and high germination, has had a large impact on tropical pastures in more than twenty tropical countries in Asia, Africa, the Pacific and Central and South America.

Keywords: Gross margin analysis, hand-seed harvesting.

Introduction

Seed of six forage species, Mulato II hybrid brachiaria (*Bracharia ruziziensis* x *B. decumbens* x *B. brizantha*), Cayman hybrid brachiaria (*B. ruziziensis* x *B. decumbens* x *B. brizantha*), Mombasa guinea (*Panicum maximum*), Tanzania guinea (*P. maximum*), Ubon stylo (*Stylosanthes guianensis* var. *vulgaris* x var. *pauciflora*) and Ubon paspalum (*Paspalum atratum*), are currently being produced by over 1000 smallholder farmers in villages in northeast Thailand and northern Laos. The seed, 150 t in 2013, is mainly exported overseas (95%) and the remainder is sold within Thailand.

Tropical Seeds LLC, a subsidiary of a Mexican seed company, Grupo Papalotla, employs a seed producing and seed research group, Ubon Forage Seeds in the Faculty of Agriculture, Ubon Ratchathani University, to manage seed production, seed sales and export, and to conduct research on existing and new forage species. The decision to produce seed in Thailand was because of forage seed quality, smallholder experience and professionalism (Hare 1993) and Ubon Ratchathani University's involvement in forage seed production (Hare and Horne 2004; Hare 2007).

This paper discusses in detail the seed production of the six forage species and how the development in villages of a smallholder-farmer seed production program has had positive social and economic outcomes for the village seed growers and enabled many smallholder

farmers in other countries to receive high quality forage seeds.

Mulato II and Cayman hybrid brachiaria

Seed Research

Producing good seed yields of Mulato II and Cayman has been very difficult to achieve. Both produce sufficient inflorescences, racemes and spikelets to indicate a potential for useful seed yields. However, by seed harvest, there is usually a massive failure of seed set, caryopsis maturation or both, with the cleaned seed containing less than 9% of the spikelets formed by the crops. The subsequent failure of seed-set is probably due to pollen sterility (Risso-Pascotto *et al.* 2005) and that this sterility was genetic.

A series of field trials have been conducted to try and increase seed yields through agronomic management. The trials have been mainly with Mulato II but the results can be applied to Cayman (Pizarro *et al.* 2013). Field trials have been on time of planting (Hare *et al.* 2007a), closing date (Hare *et al.* 2007b) and methods of seed harvesting (Hare *et al.* 2007c). Through this research, seed yields have increased from 250 kg/ha to over 600 kg/ha.

Farmer Seed Production

Mulato II and Cayman seed production in Thailand is managed by Ubon Forage Seeds and in Laos by Happy Farmers Co. Ltd. Thailand seed is produced in Nong Saeng

village, Roi-et province (130 m.a.s.l 16°N) and in Laos in several villages in Nga district, Oudomxay province (500 m.a.s.l, 23°N). In Thailand, the seed is swept from the ground but in Laos the seeds are knocked from seedheads tied together. Farmers in Thailand treat Mulato II as an annual crop, replanting each year. This is because Mulato II seed crops grown on the very poor soils in Thailand, produce uneconomic seed yields in the second and subsequent years, even with fertiliser. In Laos, on richer soils without fertiliser, many farmers have been producing consistently good yields (300 kg/ha) for over 5 years.

At Ubon Ratchathani University all the Mulato II and Cayman seed is treated in sulphuric acid to remove the lemma and palea husks to improve seed germination, and is washed, dried and recleaned before packaging for sale and export. After acid scarification, Mulato II and Cayman seeds average 88-91% viability (TZ test), 70-90% germination and over 99.5% purity. Without acid scarification, the seed never exceeds 30% germination. Even long-term storage will not increase germination, due to the physical dormancy imposed by the tightly bound lemma and palea husks (Hare *et al.* 2008).

Seed yields from ground harvested Mulato II seed in Thailand have averaged 400 kg/ha since 2009 and many farmers are now harvesting over 630 kg/ha. Thailand production has increased from just under 10,000 kg in 2009-10, produced by 45 farmers, to 41,000 kg in 2012-13, produced by 107 farmers.

In Laos, seed production has increased from 155 farmers in 9 villages producing 2,205 kg in 2007-8, to 600 farmers in 30 villages producing 28,000 kg in 2012-13.

Mombasa and Tanzania guinea grasses

Farmer seed production

In 2008, Ubon Forage Seeds first started producing Mombasa guinea seed for Tropical Seeds, mainly for export back to Mexico. Because Mombasa is a large, leafy and very productive grass, a strong market has recently developed for Mombasa in Asia. In 2010, Tropical Seeds asked Ubon Forage Seeds to start producing Tanzania guinea seed for export to Central America, because they wanted seed of pure true-to-type Tanzania guinea, without contamination with common varieties.

We have relied on farmer experience in producing Tanzania seed for several years (Phaikaew *et al.* 1995) to use the same methods to produce Mombasa seed.

Strong winds in October can be a major problem, blowing a lot of good seed down to the ground. Guinea grass seed farmers do not sweep fallen seed from the ground. Seed yields of Mombasa guinea have ranged from 318 kg/ha in 2008 to 492 kg/ha in 2012

In the past there has been a problem with too much light and empty seed in the farmer's guinea seed we purchased and it had to be cleaned again at the university, losing over 20% in weight in some instances. To overcome this problem, starting in 2010, small seed cleaners with a strong air blast were manufactured and given free to the seed growers. These cleaners have been very successful, as the farmers are able to clean their seed to over 99.5% purity, with seed of a high thousand seed weight (TSW)

(Mombasa 1.54 g TSW; Tanzania 1.20 g TSW). No further cleaning needs to be done at the university for sale and export.

Ubon stylo

Seed research

Ubon stylo produced 2.6 times the seed yield of Tha Phra stylo (*S. guianensis*) (959 vs 365 kg/ha) in a field trial at Ubon Ratchathani University (Hare *et al.* 2007d). Closing stylo seed crops in September doubled seed yield over closing in October (Hare *et al.* 2007d). Germination tests on 1-year old stored Ubon stylo seed (Hare 2007), showed that hot water and machine scarification significantly increased germination and reduced hard and dead seed. Without scarification, seed germination was less than 10%. These days, we acid scarify the stylo seed because it is relatively easy to do, and very high germinations (99%) can be achieved.

Farmer seed production

All Ubon stylo seed is swept from the ground in January to February. The seed is acid scarified at the university to remove soil and seed coats to improve seed purity and to break hardseededness to maximise seed germination. The farmers yields currently average more than 1000 kg/ha.

Ubon paspalum

Seed research

Field trials have been conducted on method and time of planting (Hare *et al.* 2001a), method of harvesting (Hare *et al.* 1999) and closing date (Hare *et al.* 1999). A growth room study confirmed Ubon paspalum as a long-short day plant exhibiting a quantitative response to long days followed by a qualitative response to short days (Hare *et al.* 2001b).

Farmer seed production

Ubon paspalum seed is currently only produced in one village in Thailand because the market demand for seed is very small. Flowering is well synchronized and it is the first seed crop harvested every year with harvesting taking place in late September-early October.

Profitability of smallholder forage seed production in Thailand and Laos

Forage seed crops are far more profitable than rice in Thailand (Table 1), but forage seed crops can not be planted on the low-lying, waterlogged paddies where only rice can be grown. Mulato II is the most profitable forage seed crop because yields from ground-swept seed are now consistently between 500-650 kg/ha.

Cassava is the main competitor with forage seeds for land in Thailand, particularly seed crops of Mombasa, Tanzania and Mulato II. Cassava is a relatively easy crop to grow and with the tubers in the soil, there is minimal risk of losing seed from climate variations as with grass seed crops. If cassava prices increase to more than US\$0.10/kg, many farmers would prefer to grow cassava. But if the cassava price drops to US\$0.08/kg, then farmers will plant more forage seed crops.

Table 1. Estimated costs and gross and net income (US\$/ha) from rice, cassava and forage seeds in northeast Thailand.

	Rice	Cassava	Ubon paspalum	Mulato II	Ubon stylo	Mombasa
Direct Costs						
Cultivation	125	125	125	125	125	125
Raising furrows		125			125	
Fertilizer	375	415	210	210	210	210
Labour for weeding		125	65	125	125	65
Labour for harvesting	125	210	125	210	210	125
Hire digger to dig up tubers		125				
Labour for cleaning/threshing	125	125	65	125	125	65
Transport	80	105				
Total direct costs	830	1355	590	795	920	590
Sale price US\$/kg	0.50	0.09	3.00	6.00	3.35	3.35
Yield kg/ha	2500	25000	565	500	810	500
Gross Income	1250	2250	1695	3000	2714	1675
Net Income	420	895	1105	2205	1794	1085

Table 2. Estimated yield and net income (US\$/ha) from rice and Mulato II seed in Nga district, Odumxay district, Laos.

	Rice	Cassava	Maize + Soybean		Mulato II
			Maize	Soybean	
Sale price US\$/kg	0.25	0.05	0.08	0.30	4.00
Yield kg/ha	1500	25000	3500	1500	300
Net Income	375	1250	280	450	1200

Farmers in Nga district, Laos, do not hire any outside labour for their agricultural production. Crops are sown by hand, seed is free, no fertiliser, insecticides and herbicides are used, cultivation is by hand and no machinery is hired or used. No costs are incurred except for family labour and time which are common to all these crops. Mulato II seed production is very profitable compared to upland glutinous rice grown on the sides of steep hillsides, producing 6 times the income (Table 2).

The major advantage of Mulato II seed is its relatively high value per kg and less bulk, which helps offset high transport costs from remote areas like Nga district to Thailand. In Laos, Mulato II is also proving to be a sustainable and environmentally friendly agricultural crop in Nga district, because it prevents erosion by providing a dense vegetative cover on the hill slopes and growing for many years, unlike upland rice and maize which die after seed harvest and do not provide a ground cover.

Export

Ubon Forage Seeds at UBU has achieved an international reputation for very high quality tropical forage seed, emphasizing high purity, high vigour and high germination. The seeds from ground-harvested Mulato II and Ubon stylo are acid scarified to remove soil particles and increase seed germination.

Mombasa, Tanzania and Ubon paspalum seed are all cleaned by the farmers to over 99% purity and dried to 10% seed moisture. Farmers groups are supplied with free seed cleaners to help them reach the required purity and seed-weight standards we set. We also supply the farmer groups with small scales and measuring jugs and they are instructed carefully on how to sample to test seed weight against volume. During the past three years, nearly 140,000 kg of seed have been exported to 22 countries and 6,000 kg have been sold within Thailand. The main markets have been in Central America (84,000 kg), Asia (32,000 kg) and the Pacific region (23,000 kg). Africa is becoming an emerging market.

Conclusion

Forage seed production in northeast Thailand and northern Laos has become an economically viable and sustainable cash crop for more than 1000 smallholder village farmers. This seed is predominantly exported to dairy and cattle smallholder farmers in other tropical countries in Asia, Africa, the Pacific and Central and South America.

References

- Hare MD (1993) Development of tropical pasture seed production in Northeast Thailand - two decades of progress. *Journal of Applied Seed Production* **11**, 93-96.
- Hare MD, Wongpichet K, Tatsapong P, Narksombat S, Saengkham M (1999) Method of seed harvest, closing date and height of closing cut affect seed yield and seed yield components in *Paspalum atratum*. *Tropical Grasslands* **33**, 82-90.
- Hare M.D, Kaewkunya C, Tatsapong P, Wongpichet K., Thummasaeng K, Suriyantratong W (2001a) Method and time of establishing *Paspalum atratum* seed crops in Thailand. *Tropical Grasslands* **35**, 19-25.
- Hare MD, Wongpichet K, Saengkham M, Thummasaeng K, Suriyantratong W (2001b) Juvenility and long-short day requirement in relation to flowering of *Paspalum atratum* in Thailand. *Tropical Grasslands* **35**, 139-143.
- Hare MD, Horne PM (2004) Forage seeds for promoting animal production in Asia. *APSA Technical Report No. 41*. (The Asia & Pacific Seed Association, Bangkok, Thailand).
- Hare MD (2007) Successful seed production of South American forages in Ubon Ratchathani province, Thailand: Research, development and export. In: "Forages: A Pathway to Prosperity for Smallholder Farmers" (Eds MD Hare, K Wongpichet). *Proceedings of an International Forage Symposium*. pp. 35-60. (Faculty of Agriculture, Ubon Ratchathani University, Thailand).
- Hare MD, Tatsapong P, Saiprasert K (2007a) Seed production of two brachiaria hybrid cultivars in north-east Thailand. 1. Method and time of planting. *Tropical Grasslands* **41**, 26-34.
- Hare MD, Tatsapong P, Saiprasert K (2007b) Seed production of two brachiaria hybrid cultivars in north-east Thailand. 2. Closing date. *Tropical Grasslands* **41**, 35-42.

- Hare MD, Tatsapong P, Saiprasert K (2007c) Seed production of two brachiaria hybrid cultivars in north-east Thailand. 3. Harvesting method. *Tropical Grasslands* **41**, 43-49.
- Hare MD, Tatsapong P, Phengphet S, Lunpha S (2007d) *Stylosanthes* species in north-east Thailand: dry matter yields and seed production *Tropical Grasslands* **41**, 253-255.
- Hare MD, Tatsapong P, Phengphet S (2008) Effect of seed storage on germination of brachiaria hybrid cv. Mulato *Tropical Grasslands* **42**, 224-228.
- Phaikaew C, Pholsen P, Chinosang W (1995) Effect of harvesting methods on seed yield and quality of purple guinea grass (*P. maximum* T.58) produced by small farmers in Khon Kaen. *Proceedings of the 14th Annual Livestock Conference, Department of Livestock Development, Bangkok, Thailand.* 14-22.
- Phaikaew C, Pholsen P, Tudsri S, Tsuzuki E, Numaguchi H, Ishii Y (2001) Maximising seed yield and seed quality of *Paspalum atratum* from different methods of harvesting. *Tropical Grasslands* **35**, 11-18.
- Pizarro E, Hare MD, Mutimura M, Changjun B (2013) *Brachiaria* hybrids: potential, forage use and seed yield. *Proceedings of the 22nd International Grassland Congress* xxxx.
- Risso-Pascotto C, Pagliarini MS, Valle CB do (2005) Meiotic behavior in interspecific hybrids between *Brachiaria ruziziensis* and *Brachiaria brizantha* (Poaceae). *Euphytica* **145**, 155-159.