TOWNSVILLE STYLO SEED PRODUCTION IN NORTH-EASTERN THAILAND

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ABSTRACT

Seed production of Stylosanthes humilis *was measured under both experimental and field conditions in North-eastern Thailand. In the field, a locally developed mechanical harvesting system was compared to a village seed production pilot scheme where hand harvesting techniques were employed. Very high yields were obtained under all systems, reflecting the high level of adaptation of* Stylosanthes humilis *to the North-eastern Thailand environment. Seed yield responded very significantly to phosphorus and sulphur fertilizer application and maximum yields of* 1850 *kg* ha^{-1}, 1255 *kg* ha^{-1} *and* 438 *kg* ha^{-1} *were obtained under experimental, hand harvesting and mechanical harvesting conditions respectively. During the* 1976 *season the cost of production of clean seed was US*\$0.70 *and US*\$1.11 *per kilogram for the hand harvesting and mechanical harvesting methods respectively. Under the village smallholder scheme, highest yields and highest levels of seed purity were obtained from small, intensively managed areas where close supervision of hired labour was possible. The hand harvesting method was highly labour intensive, and the economic and social benefits of a pasture seed industry in North-eastern Thailand based on underemployed labour during the dry season are discussed.*

INTRODUCTION

The oversowing of heavily grazed village native pasture or long fallow cropland areas with the legume Townsville stylo (*Stylosanthes humilis*) has been demonstrated to be a culturally and economically feasible method of improving unproductive village pastures in North-eastern Thailand (Crump 1972, McLeod 1972, Robertson 1975). There is currently an increasing and unsatisfied demand for Townsville stylo seed by both farmers and livestock improvement agencies in the region. This paper reports the yields of Townsville stylo seed obtained under experimental and field conditions at Khon Kaen and provides cultural details and an economic analysis of a small scale hand harvesting operation compared with a mechanized seed collection method.

North-eastern Thailand is a slightly elevated plateau of 17 million ha approximately 100 to 300 m above sea level. The area lies between 14° and 19°N latitude and experiences a tropical savannah climate (Köppen AW) with pronounced seasonal distribution of rainfall; 85 percent of the annual total at Khon Kaen (central North-eastern Thailand) of 1255 mm falls in the six months from mid-April to mid-October, through the influence of the southwest monsoon.

The upland soils which have formed on the old Triassic and Jurassic sedimentary deposits are largely grey podzolics, red yellow podzolics and red yellow latosols which are characterized by a sandy texture, acid reaction, low organic matter content, low cation exchange capacity and a low level of plant nutrients, particularly nitrogen, phosphorus and sulphur (Eyles *et al.* 1973, McLeod 1972).

Vegetation is characterized by an open dipterocarp forest with an understorey of bamboo grass (*Arundinaria pusilla* and *A. ciliata*). In heavily grazed areas around villages, the bamboo grass has been replaced by low growing, grazing tolerant species (Robertson and Humphreys 1976).

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TOWNSVILLE STYLO SEED YIELD RESPONSES TO APPLIED FERTILIZER

An experiment was established on a red latosol on the Khon Kaen University campus to ascertain the optimum fertilizer levels for Townsville stylo seed production in the Khon Kaen environment. A complete factorial design was used, with four levels of phosphorus (0, 18, 54 and 162 kg P ha^{-1}) as double superphosphate, two levels of sulphur (0 and 50 kg S ha^{-1}) as gypsum and two levels of potassium (0 and 50 kg K ha^{-1}) as potassium chloride. Four replications were used. Earlier results showed that phosphorus and sulphur were the major nutrient limitations for stylo growth in the area (McLeod 1972). Potassium deficiency has been reported (Eyles *et al.* 1973) but is not widespread. The experiment was planted on August 3, 1974 and continued for two years without additional fertilizer application. Plot size was 2 m × 12 m and a seeding rate of 37.5 kg ha^{-1} was used. Plots were hand harvested by first cutting and threshing all standing material. The threshed material as well as all seeds previously on the ground was then swept up, sieved, winnowed, and hand picked. Seed recovery was close to 100 per cent and is undoubtedly one reason for the very high yields reported below. Due to possible differences in harvesting methods and seed recovery, the yield comparisons made below may not be strictly comparable.

TABLE 1

Townsville stylo seed production on a red latosol soil at different levels of phosphorus and sulphur fertilizer applications (kg ha^{-1}).

Phosphorus level (kg ha^{-1})	1974 Sulphur level (kg ha^{-1}) 0	1974 Sulphur level (kg ha^{-1}) 50	1975 Sulphur level (kg ha^{-1}) 0	1975 Sulphur level (kg ha^{-1}) 50
0	1150	1550	840	1420
18	1300	1660	910	1400
54	1290	1710	1020	1440
162	1850	1570	1230	1400

1974 LSD ($P < 0{\cdot}05$) = 180 1975 LSD ($P < 0{\cdot}05$) = 65

Townsville stylo seed yield was significantly increased by both phosphorus and sulphur (Table 1). Potassium application had no effect on seed yield; thus potassium results are not presented. Sulphur alone very significantly increased seed yields, particularly in the second year. The response to added sulphur decreased with increasing phosphorus levels, probably due to the small amounts of sulphur in double superphosphate.

These very high seed yields reflect the high level of adaptation of Townsville stylo to the North-eastern Thailand ecological environment. We believe that these yields are the highest obtained anywhere in the world, greatly exceeding the previously recorded yields of 884 kg ha^{-1} (Fisher 1969), 630 kg ha^{-1} (Graham 1963), 119 kg ha^{-1} (Javier and Mendoza 1976), and 690 kg ha^{-1} (Shelton and Humphreys 1971). Robertson *et al.* (1976) in an experiment also conducted in North-eastern Thailand recorded a comparable seed yield of 1630 kg ha^{-1}.

HAND HARVESTING OF SEED BY VILLAGE FARMERS

During the 1975–1976 crop season, seven local farmers were selected for a Townsville stylo seed production pilot scheme. The objectives of this scheme were (a) to establish production parameters for village seed producers; (b) to ascertain the ability of local farmers to manage small scale seed production plots; (c) to adapt local harvesting methods to the production of Townsville stylo seed; (d) to establish the levels of seed purity which these methods could achieve; and (e) to assess the economic viability of establishing a seed production industry in North-eastern Thailand based on small scale village farming units using labour intensive production and harvesting techniques.

The scheme involved the Khon Kaen Pasture Improvement Project in supplying the equivalent of 125 kg ha^{-1} of double superphosphate, 125 kg ha^{-1} of locally obtained gypsum (18% S) and 18.75 kg ha^{-1} of seed. Fertilizer recommendations were derived from the seed production fertilizer experiment already described which was conducted on similar upland soils. The high seeding rate was recommended to ensure a plant density of around 250 plants m^{-2} necessary for maximum seed yields (Shelton and Humphreys 1971).

A guaranteed price of US$1.00 kg^{-1} was offered for all seed of 95% purity or greater. A base price of US$0.80 kg^{-1} was paid for all seed collected on the basis of 80% purity and, after testing, the balance was paid. The farmers supplied all other inputs in the form of land preparation, weeding, fertilizer application, sowing, harvesting and seed cleaning. By June, 1975, a total of 4.0 ha was planted to Townsville stylo.

CULTURAL PRACTICES

Land preparation followed the normal timing for upland crops in North-eastern Thailand. An initial ploughing in June by water buffalo (five farmers) or tractor (two farmers) was carried out. Four farmers ploughed a second time. Fertilizer was broadcast by hand and worked in by a buffalo drawn harrow. Seed was then broadcast sown on the harrowed soil during late June and July, 1975.

These were the only inputs prior to harvest (which began in January) other than limited weeding by some farmers. Complete weeding was never carried out. Those farmers who ploughed twice before planting achieved good weed control. Two farmers sowed the seed later than recommended and did not achieve adequate rain for germination for several weeks thus contributing to high weed populations.

HARVEST AND SEED CLEANING PRACTICES

The long, reliable dry season in North-eastern Thailand provides an ideal environment for the maturation and harvest of Townsville stylo seed. December and January normally receive little precipitation and by mid to late December the seed crop was mature. Farmers used a four-step procedure. Firstly, the standing herbage was cut at the base with a machete and rolled into windrows. Most of the mature seed, leaves and some stem material dropped to the ground during this process and formed a dense litter on the surface of the ground. Secondly, by means of stick brooms, rakes, or hoes, the seeds, leaves, stems and some soil were gathered into small heaps which were then loaded into baskets and transported to the sieving-winnowing area. Thirdly, the mixed material was put through a coarse 3 mm sieve to separate out large stems and leaf material. Some farmers used a second sieve of flyscreen gauze to separate out small soil particles. Finally, the seed and any remaining material was tossed in bamboo winnowing pans about 0.5 m in diameter for 10–15 minutes to remove most of the additional foreign matter. During this winnowing much of the seed formed into balls of pure seed which were then picked from the pans. The larger stems were removed by hand from the remaining seed. The clean seed was then placed into baskets and gunny bags. Using this procedure, seed purity ranged from 76.5 per cent to 96.1 percent (by weight), although five farmers had purities of 93.0 percent and higher.

SEED YIELDS AND LABOUR USE

Seed yields and labour use are summarized in Table 2. From a total planted area of 4.0 ha, farmers harvested 1831 kg of clean seed. The mean yield was 460 kg ha^{-1}. The average labour use was 372 man-days per hectare or 78 man-days per 100 kg of seed collected. These labour inputs were concentrated in the low labour demand period of January and February when the harvesting operation was in progress.

TABLE 2

Seed yield and labour use summary of Townsville stylo seed production pilot scheme for 1975–1976 crop season.

Item	Farmer Number								
	1	2	3	4	5	6	7	Total	Mean
Area harvested (ha)	0·32	0·32	0·22	0·15	0·56	1·76	0·56	3·89	0·56
Seed harvested (kg)	357	415	259	123	356	345	175	2030	290
Clean seed (%)	94·8	95·3	96·1	94·0	93·0	76·5	78·0	—	89·7
Yield of clean seed (kg ha^{-1})	1065	1255	1112	753	575	150	218	—	460
Hired labour (man-days)*	260	240	180	64	154	160	72	1130	161
Family labour (man-days)	62	62	60	16	90	60	2	352	50
Labour use ha^{-1} (man-days)	1006	944	1091	533	421	125	117	—	372
Labour use 100 kg^{-1} clean seed (man-days)	95	76	96	69	74	83	54	—	78

*1 man-day = one 6 hour day.

Three factors were important in the production of high yields of clean seed: effectiveness of the initial cultural operations, fertilizer use, and the efficiency of the harvesting and cleaning operation. These factors were found to be related to the farmers' socio-economic situation. Farmers 1–5 were full-time farmers without extensive areas of land; to them the scheme offered the possibility of gaining high economic returns from limited upland crop areas which would otherwise have returned very little, if any, financial reward. They followed advice carefully, prepared their land well and maintained an adequate level of crop husbandry. These farmers also did a thorough job of harvesting by relying on large inputs of well supervised hired labour from their villages.

Farmers 6 and 7 had much different experiences as Table 2 shows. Farmer 6 was a village headman with extensive areas of land and other non-farming financial interests. He provided little direct supervision of cultural operations or harvesting. Seedbed preparation was inadequate, fertilizer was not properly incorporated, the stand of stylo was uneven and weeds and tree growth were not controlled. Harvesting was poorly organized and inadequately supervised. Farmer 7 was a non-agricultural worker who had some land available for seed production. Many of the same problems experienced by farmer 6 occurred; in addition, he did not use fertilizer and also permitted the field to be grazed during latter stages of growth and a great many inflorescences were lost.

Farmers 1–3 achieved the highest yields ranging from 1065 kg ha^{-1} to 1255 kg ha^{-1} (Table 2) and their hired labour payments contributed significantly to the local village economy during a period when agricultural employment opportunities have traditionally not been available. These results indicate that a viable seed industry need not be based on an extensive area of land but may instead be based on intensive smallholder units.

This experience shows that an expanded seed production project should concentrate on owner-operators living close to their fields and who would rely on seed production income for the majority of their yearly cash proceeds from agriculture. Upland fields with long cropping histories of kenaf or cassava should be preferred because better seedbeds are possible and weed and regrowth problems are less severe. Situations where lowland fields (invariably used for wet rice cultivation) and upland fields are long distances apart should be avoided. During the monsoon period farmers give priority to rice cultivation and management of distant upland fields becomes a problem.

COSTS AND RETURNS

Table 3 summarizes the economic performance of the seven pilot scheme farmers for the first year. The variables of most interest in assessing the viability of commercial seed producing units are gross margin per hectare (Col. 7), total cost per kilogram of clean seed (Col. 11) and return per man-day to family labour (Col. 12).

Column 11 indicates that the first five farmers could produce seed at below US\$0.74 kg^{-1} with farmers labour valued at the cost of hired agricultural labour. The difference between the price received by these farmers (between US\$0.89 and \$0.99 kg^{-1}) and the cost of producing clean seed represented pure profit, or a return to the farmers labour and management over and above its market value. The wage rate for hired labour during harvesting was US\$0.74 per day for male workers and US\$0.59 per day for female workers. Thus, with one exception, the farmers own efforts returned at least three times the agricultural wage rate. The return to farmer 7 has little meaning as his labour input was only two man-days and this return should more properly be imputed to land as a rental value.

Column 7 is most relevant in comparing the farmers' land use decisions. For upland areas of the North-east, kenaf (*Hibiscus sabdariffa* var. *altissima*) and cassava (*Manihot esculenta*) are the main competitors for land. Continuous cropping of both these crops is rarely possible as yields normally reach uneconomic levels following four to six years of continuous cropping after which a fallow phase is necessary. In

TABLE 3

Costs and returns for Townsville stylo seed production pilot scheme for 1975–1976 crop season (US$).

Farmer Number	Cash Costs	Non-Cash Costs	Opportunity Cost of Family Labour	Total Cost (1) + (2) + (3)	Total Revenue	Total Gross Margin (5) — (1)	Gross Margin Per Hectare	Total Profit (5) — (4)	Total Profit Per Hectare	Cash Cost Per kg Clean Seed	Total Cost Per kg Clean Seed	Return Per Man-Day To Family Labour
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	179	18	40	237	347	168	525	110	344	0·53	0·70	2·41
2	174	18	40	232	405	231	722	173	541	0·44	0·59	3·45
3	130	14	40	184	253	123	559	69	314	0·52	0·74	1·82
4	57	9	9	75	121	64	427	46	307	0·49	0·65	3·50
5	132	32	42	206	340	208	359	134	231	0·40	0·62	1·97
6	219	57	71	347	260	41	23	—87	—49	0·83	1·31	—0·30
7	82	31	1	114	135	53	84	21	33	0·60	0·83	11·38

addition, kenaf requires access to fresh water for retting the fibre. In the areas participating in the pilot scheme, water was not available and cassava was the preferred upland crop. Gross margins from cassava are in the range of US$220 ha^{-1} to US$340 ha^{-1}. Referring to Column 7 in Table 3, we find stylo seed production a very attractive proposition, particularly since nitrogen accretion to these low fertility soils is an added benefit not accounted for in the budgets. In addition, fallow periods are not needed for stylo production while fallowing is necessary for competing upland crops. Kenaf gross margins are generally lower as the price relationships between kenaf fibre and cassava roots has recently turned distinctly in favour of cassava. Kenaf gross margins would be in the range of US$180 to US$250 ha^{-1}, and would offer a much lower return to fixed resources than stylo seed production.

MECHANIZED HARVESTING AS AN ALTERNATIVE FORM OF SEED HARVESTING

During the period of the pilot scheme some alternative methods of seed harvesting were developed at the Borabu Land Development Centre, a pasture and forage research station under the Department of Land Development, Ministry of Agriculture and Cooperatives. The station is located about 75 km south-east of Khon Kaen and conditions are very similar to those of the pilot scheme. A detailed description of stylo seed production and harvesting at Borabu is given by Hare (1976).

The harvesting procedure involved three stages and was developed by Mr. R. D. Coombs and Mr. M. D. Hare with assistance from Mr. G. Wickham. Field harvesting was carried out by a Gallagher flail type forage harvester which blew the harvested material into two large rotating concentric cylinders mounted on a trailer which was pulled behind the harvester. The outer cylinder was 1.22 metres in diameter, both cylinders rotated at between 30 and 32 rpm, and sloped towards the rear of the trailer. The inner cylinder was made of coarse wire mesh while the outer cylinder consisted of steel sheets with 3 mm perforations which permitted the stylo seed and other fine material to pass through while coarse material tumbled down the mesh and fell from the rear of the rotating cylinder. The collected material was about 17 percent pure seed by weight. When the trailer was full, the material was transferred to another trailer and taken to a central area for winnowing. Five conventional rice winnowers were connected in tandem to a small motor. Between 700 and 800 kg of 46 percent to 50 percent pure seed per day was obtained. The third stage involved putting the winnowed seed through a reel cleaner which was constructed locally utilizing the principle reported by Harrison (1975). This machine was a rotating cylinder composed of stainless steel straps 5 cm apart and bolted onto circular end pieces 50 cm in diameter. The straps, when rotated, catch the hooks of the seed and carry them over where they drop onto a vibrating screen which permits the seed to fall through onto a collector pan while stems which are caught by the reel pass to the outside. A diagrammatic representation of the rotating cylinder and reel cleaner is shown in Figure 1.

This system substitutes capital and machinery operating expenses for labour. An estimate of the cost breakdown for the Borabu operation is given below:

Item	*Cost (US$ ha^{-1})*
Fertilizer	24.63
Harvesting labour	11.72
Winnowing cleaning labour	36.95
Machinery running costs	257.98
Burning straw	1.32
Total	332.51

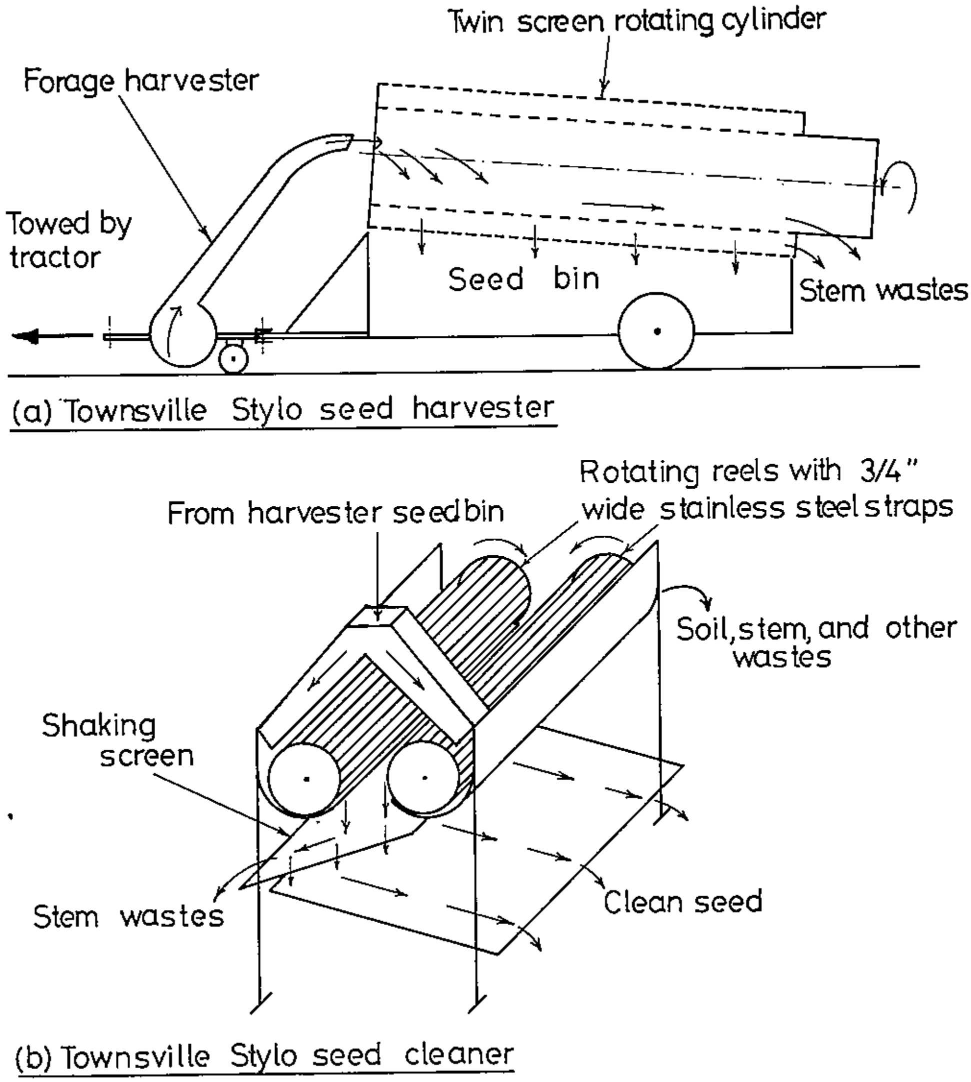

FIGURE 1

Diagramatic representation of harvesting and cleaning operation.

During the 1975–1976 harvesting season, this method produced an average of 300 kg ha $^{-1}$ of clean seed giving an average cost for fertilizer and harvest expenses of US$1.11 per kg of clean seed harvested (Table 4). The better paddocks yielded up to 438 kg ha $^{-1}$ which would reduce the cost in these paddocks to about US$0.89 per kg clean seed. These calculations do not include the costs of seed and land preparation which were included in the pilot scheme farmer's budgets.

TABLE 4

Comparison of yields, labour use and costs between mechanized harvesting and hand harvesting (average for 1975).

	Yields	Labour use		Cash cost	Non-cash cost	Total cost	
	(kg clean seed ha^{-1})	(hr ha^{-1})	(hr kg clean $seed^{-1}$)	(US\$ kg clean $seed^{-1}$)	(US\$ kg clean $seed^{-1}$)	(US\$ ha^{-1})	(US\$ kg clean $seed^{-1}$)
Hand harvesting and cleaning	460	2208	4·8	0·51	0·20	324	0·70
Mechanical harvesting and cleaning	300	55	0·2	0·31	0·80	332	1·11

N.B. Labour use excludes labour used for land preparation, fertilizing, and sowing seed. Costs exclude costs associated with seed and land preparation. Fertilizer costs have been included. Non-cash costs for hand harvesting and cleaning include the opportunity cost of family labour.

DISCUSSION

Results show that the North-eastern Thailand environment is well suited to the large scale production of Townsville stylo seed. Table 4 presents a comparison between hand harvesting and mechanical harvesting methods. The yields for hand harvesting were about 50 percent higher reflecting the higher recovery ratios possible by hand labour. Excluding the two pilot farmers who did poorly, the other five participants averaged 900 kg ha^{-1} of clean seed. This was well above the 438 kg ha^{-1} achieved by the machine in the best paddock at Borabu. The costs per hectare shown in Table 4 are similar but the breakdown into cash and non-cash costs reflects great differences. The mechanical harvesting method involved large depreciation, maintenance and interest charges which must be charged against large machinery investment. The higher cash cost for the pilot scheme farmers reflected their heavy use of hired labour.

Improvements in the efficiency of both systems appear feasible as neither method achieved seed yields comparable to those obtained experimentally. The recovery of seed by the mechanized method was low and seed was lost at all stages of the operation. Improvements in technique would greatly increase recovery without increasing running costs, and reduce the cost per kilogram of seed. The introduction of simple and inexpensive hand operated cleaning equipment to the village operation would reduce the very high requirement of hired labour during the cleaning process and permit individual farmers to expand their areas for seed production as this bottleneck was overcome.

In balance, however, a village seed industry has potentially the greater social, economic, and agronomic benefits for North-eastern Thailand. Unemployment and underemployment are serious problems in rural areas of Thailand; labour is readily available during the seed harvesting period and the economic benefits of a new labour intensive seed industry would be considerable. Cash returns are better than for cassava or kenaf and improvement of soil fertility through nitrogen accretion from the legume crops would be an added benefit. This is not to say that a partially or totally mechanized system does not have its place; on research stations heavily involved in seed multiplication where large areas must be quickly harvested, the three stage operation described earlier has advantages, owing to the difficulties in quickly mobilizing and supervising the very large labour force which would be needed to hand harvest the large areas involved.

For commercial production, however, hand harvesting seems desirable because of the high efficiency and low investment involved and the multiplier effects of increased farm net cash income on the local economy.

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