Status of *Stylosanthes* development in other countries.

II. *Stylosanthes* development and utilisation in China and south-east Asia

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Abstract

Introduction of *Stylosanthes* species to south-east Asia commenced in 1949 and tended to follow the development of commercial cultivars in Australia. *S. guianensis* cultivars were introduced to humid and subhumid areas in Malaysia, Indonesia, southern Thailand, Philippines and China. *S. humilis*, *S. hamata* and *S. scabra* were introduced to drier areas in the region such as north-east Thailand, eastern Indonesia and southern China.

Anthracnose severely reduced growth and survival of many cultivars used in the region. In 1976, an outbreak of anthracnose in *S. humilis* prompted a change to *S. hamata* cv. Verano in Thailand. *S. guianensis* cv. Schofield was similarly affected in many countries and was replaced by Cook and Graham. Later Cook and recently Graham were similarly affected in many countries and are being replaced by *S. guianensis* CIAT 184.

The most widely used species today are *S. hamata* cv. Verano, and *S. guianensis* cv. Graham and CIAT 184. *S. hamata* is used mainly in north-east Thailand for inclusion in heavily grazed pastures. In 1995, 150 t of seed of *S. hamata* was produced in Thailand. *S. guianensis* cv. Graham and CIAT 184 are grown on more than 100 000 ha in monoculture, often associated with perennial tree crops in southern China. It is used as fresh feed for ruminants, or dried and processed as leaf meal. Recently, *S. guianensis* CIAT 184 has gained popularity in more countries in south-east Asia because of its broad adaptation, potential for multiple uses and high productivity in acid, infertile soils. Prospects for increased use of this species, particularly in smallholder farming systems, are excellent.

History of introduction and use of stylo

*Stylosanthes guianensis* was introduced to Malaysia as early as 1949. More widespread introduction and evaluation of *Stylosanthes* germplasm into China and south-east Asia occurred later and tended to follow seed availability of commercial cultivars in Australia. Early introductions occurred in the late 1960s and early 1970s and included *S. humilis* and *S. guianensis* cv. Schofield, Endeavour and Cook. Later introductions, partly prompted by the incidence of anthracnose, included *S. hamata* cv. Verano, *S. guianensis* cv. Graham and CIAT 184, and *S. scabra* cv. Seca. Other cultivars and accessions of *Stylosanthes* were also introduced and evaluated by various R&D organisations and projects in the region but any larger plantings tended to be restricted to the commercially available Australian cultivars. The only exception is *S. guianensis* CIAT 184 which recently has gained popularity in the region and seed of this accession is now being produced in several countries.

China

A range of *Stylosanthes* species was introduced from Australia into tropical southern China in the early 1980s (Hwang et al. 1986; Michalk et al. 1993). Stylos were found to be well adapted to the environment in Guangdong and Hainan Island, and are now grown on more than 100 000

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ha as an understorey in perennial tree plantations such as mango and rubber, as a monoculture for leaf meal or seed production, and in pastures in association with grasses (Devendra and Sere 1992).

Initially, *S. guianensis* cvv. Schofield, Cook and Graham, *S. scabra* cv. Seca, and *S. hamata* cv. Verano were planted as cover crops. This changed with time and now Graham is by far the most widely used stylo resulting from the Australian introductions. In 1982, a range of forage species was introduced from CIAT to the Chinese Academy of Tropical Agricultural Science (CATAS) in Hainan. Of these, *S. guianensis* CIAT 184 was outstanding and was released as cultivar “Reyen II — Zhuhuacao” in 1987. In Guangdong, CIAT 184 yields approximately 20% more than Graham and is now the second most widely used stylo after Graham in southern China (Devendra and Sere 1992). Annual sowings have increased from 11 ha in 1987 to a peak of over 10,000 ha in 1991, and have stabilised at about 5000 ha over the last few years (Figure 1).

One advantage of CIAT 184 is its higher tolerance to anthracnose which severely damaged Schofield in 1982 and Cook in 1987. Graham showed signs of anthracnose infection from 1990 and moderate damage has been recorded since 1993. In Hainan, seed production of Graham was stopped in 1993 and has been replaced by CIAT 184. Signs of anthracnose infection have been recorded on CIAT 184 for several years but there has been little damage.

**Thailand**

In Thailand, *S. humilis* was introduced into the north-eastern part of the country in 1966, where it showed promise in heavily grazed communal pasture areas. Seed of *S. humilis* was produced on government stations in the early 1970s and a pilot village seed production scheme was initiated in 1975. An outbreak of anthracnose severely affected *S. humilis* in 1976 and seed production was switched to *S. hamata* cv. Verano which had shown promise in experiments (Hare 1993). From 1990–1995, more than 1400 t of Verano seed was produced largely by smallholder farmers (Phaikaew 1996). Apart from Verano stylo, seed of *S. guianensis* cv. Graham was produced on government stations. Between 1990–1993, 40 t of Graham stylo seed was produced. Anthracnose severely damaged stands of Graham in 1994, reducing seed production to less than 2 tons. The Department of Livestock Development (DLD) decided to change seed production from Graham to CIAT 184 in 1996 (Chirawat Khemsawat, personal communication), which had shown promise in several experiments in north-east Thailand (Satijpanon et al. 1995). Apart from DLD, Khon Kaen University has conducted considerable research on stylo agronomy and seed production with support from Australia through the University of Queensland. Khon Kaen University released the anthracnose-tolerant *S. humilis* CPI 61674 as Khon Kaen stylo, as a replacement for Townsville stylo. It is reputed to

![Graph](image)

**Figure 1.** Area (ha) of *Stylosanthes guianensis* CIAT 184 planted annually in Guangdong between 1987 and 1995.
be more grazing-tolerant than Verano stylo but the amount of seed produced for commercial use is relatively small.

Philippines

In the Philippines, Australian commercial stylo varieties were introduced in the early 1970s. The Bureau of Animal Industry (BAI) selected S. guianensis cv. Schofield and, for several years, produced approximately 5 t/year of Schofield seed on government stations in Masbate and Bohol in the late 1970s (Alex Castillo, personal communication). This seed was distributed to ranchers for oversowing into native pastures or for sowing with introduced grasses such as Brachiaria decumbens. In the early 1980s, anthracnose damaged Schofield. Cook and S. scabra cv. Seca were introduced in 1983 to replace Schofield. Cook was preferred to Seca and, since 1984, BAI has produced approximately 500 kg/year of Cook stylo seed. This seed has been used mainly for sowings on government stations.

In 1992, S. guianensis CIAT 184 was introduced into the Philippines by the FSP (South-east Asian Regional Forage Seeds Project and its successor, Forages for Smallholders Project), a collaborative project of forage R&D workers in south-east Asia, which is funded by AusAID and is supported by CIAT and CSIRO. CIAT 184 stylo produced excellent growth in a wide range of environments in the Philippines (Lanting et al. 1995), as well as in other countries in the region (Stür et al. 1995). In 1995, Cook and CIAT 184 were included in pilot seed-production schemes of the regional Department of Agriculture in Isabela and Quirino in northern Philippines. At both locations, Cook was severely damaged by anthracnose, while CIAT 184 showed only minor signs of infection and produced good seed yields. Cook stylo is still used in Masbate and Bohol, where it has not yet been affected severely by anthracnose.

Indonesia

In Indonesia, the government-owned mini-ranches imported seed of S. humilis, S. hamata cv. Verano and S. guianensis cvv. Schofield and Cook for use in pastures in south Sulawesi in the early 1970s (Maimunah Tuhulele, personal communication). Further introductions were made by various forage and livestock R&D projects working in Java and eastern Indonesia. In 1978, Schofield stylo was introduced to south Sumatra where it was used to suppress Imperata cylindrica. In the early 1980s, Schofield was damaged by anthracnose, although some Schofield plants can still be found in south Sumatra.

Seed production by farmers of several forage species was initiated as part of an International Fund for Agricultural Development (IFAD) cattle distribution program, in Lombok in 1982. The main species produced was Leucaena leucocephala, but small quantities of S. hamata cv. Verano and S. scabra cv. Seca were also included and distributed to farmers in the IFAD project. This project ended in 1994 and with it the demand for forage seeds. In 1993, S. guianensis cvv. Cook and Graham, and CIAT 184 were evaluated at several sites in Kalimantan (Tuhulele et al. 1995). Of these, CIAT 184 was selected for seed production and distribution to farmers, since it was best adapted to the acid and infertile soils. Cook was damaged by anthracnose at some sites but Graham and CIAT 184 were not affected. Small quantities of CIAT 184 seed are being produced on government stations.

Malaysia

S. gracilis (now S. guianensis — probably the later-released cv. Schofeld) was first introduced into Malaysia from Australia in 1949 (Vivian 1959). It was well adapted to many areas in Kelantan, was productive and successfully competed with weeds. Vivian (1959) reported that some 240 ha had been established by farmers in Kelantan and that the area was expanding rapidly. One draw-back was that stylo had to be propagated vegetatively from one-foot-long terminal cuttings as seed set was poor in the wet tropical environment. Since that time, many other Stylosanthes accessions have been evaluated by the Malaysian Agricultural Research and Development Institute (MARDI), and S. guianensis was identified as the most promising legume genus for Malaysia (Wong et al. 1982; Wong 1982). Despite early promise there has been little use of stylo. Anthracnose was never a big problem in Malaysian species-introduction plots and experiments (Wong Choi Chee, personal communication). It first appeared in the late 1970s in an experiment using Endeavour stylo
imported from Australia. Later anthracnose was also observed on *S. guianensis* cvv. Graham and Cook.

Recently, Ng *et al.* (1997) of the Rubber Research Institute of Malaysia evaluated a large range of legumes, including *S. guianensis* cvv. Cook, Endeavour and Graham, and CIAT 184, *S. scabra* cv. Seca, *S. hamata* cv. Amiga and *S. capitata* CPI 55843, for use in rubber plantations. Seca and CIAT 184 stylo were by far the most productive and persistent legumes in these experiments, but only CIAT 184 set seed successfully. Research on seed production of CIAT 184 was carried out in northern peninsular Malaysia as part of the FSP project by MARDI, and in 1994, the first 500 kg of CIAT 184 were produced by the Department of Veterinary Services for distribution to farmers in Malaysia (Chen *et al.* 1995).

**Other countries**

Stylo is not used extensively in other countries in south-east Asia. In Lao PDR and Vietnam, a range of stylos has been evaluated on experiment stations and several were found to be promising. Among these are Verano, Seca and CIAT 184.

**Current use of stylo**

In Thailand, Verano was used mainly for over-sowing communal grazing areas such as natural grassland, road sides, paddy bunds, forest land and other non-cropping areas during 1976–1990. Since that time, Verano is used mainly for sowing in association with grasses such as *Brachiaria ruziizensis* for grazing by cattle. In the future, DLD envisages the production of stylo leaf meal. The demand for forages has been fueled to a large extent by government programs such as the DLD Livestock Extension program, the project on “Increasing the Efficiency of Milk Production” and the current promotion of beef and dairy production as part of the “Restructuring the Agricultural System”. Although emphasis is generally on grasses, 150 t of Verano seed was produced in 1995 and will be used for sowing in 1996.

In tropical China, Graham and CIAT 184 are generally grown on marginal soils, frequently in combination with perennial tree crops such as mango, orange, young rubber, coconuts, coffee plantations and, more recently, in reforestation areas. They are grown by smallholder farmers, state farms and commercial farms, and are utilised either as fresh feed for ruminants, pigs and rabbits or for dried leaf-meal production. Only a small proportion of Graham (20%) is used in pastures. Small amounts of other stylos are also grown. Of these, Seca is used exclusively for pastures and Verano is used 50% for pastures and 50% under tree crops.

Leaf meal is incorporated in small quantities (2–5%) in mixed feed rations for poultry and pigs, but is also used for cattle, ducks and fish. Devendra and Sere (1992) estimated that 113 000 ha are planted with stylo by 108 000 farm families in Guangdong province. For leaf-meal production, stylo is grown in a pure stand with moderate fertiliser applications. Mature plants are cut whenever the weather is suitable for drying and the equipment for processing is available. Stylo is cut, sun-dried for several days, and the dried plant material is ground with a hammer mill to a fine powder.

**Seed production of stylo**

Commercial seed production of *Stylosanthes* species occurs only in China and Thailand, although recently seed production of CIAT 184 has commenced on a small scale in northern Malaysia and northern Philippines. Likewise, small amounts of CIAT 184 are produced on government stations in Indonesia for on-farm testing.

**China**

In tropical China, stylo seed crops are managed as annual crops. At the beginning of the rainy season (June), seedlings are raised at high density (40–50 kg/ha seed) in fertilised nursery plots and transplanted manually into the field, 45–50 days after sowing. Seedlings are planted at a spacing of 0.8 × 0.8 m and weeded regularly for the first 2 months. Fertiliser is applied at transplanting at approximately 5000 kg/ha fresh farm manure and 20 kg/ha P. A 15 m² nursery of stylo seedlings is sufficient for planting 1 ha.

CIAT 184 commences flowering in November or December, and seed matures into the dry season in January and February. Once all seeds are ripe, plants are cut close to ground level and
threshed to recover seed. Then, plants are stacked in rows and the ground is swept to recover fallen seed. Approximately 70% of the total seed harvested is recovered from the ground. Cleaning is done by hand and, if necessary, seed is dried further to a seed moisture content of less than 12%. Clean and dried seed is packaged in labelled 50 kg bags for marketing. Seed is tested for purity and viability before sale to farmers.

The total area used for seed production of stylos varies from 100–200 ha/year, and on average, 43 t/year stylo seed has been produced during the last 9 years in southern China. Seed yields of Graham and CIAT 184 are generally around 250–300 kg/ha (Table 1). The harvesting method ensures that seed quality is very good.

<table>
<thead>
<tr>
<th>Species and cultivar</th>
<th>Mean (kg)</th>
<th>Range (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. guianensis cv. Graham</td>
<td>250</td>
<td>40–470</td>
</tr>
<tr>
<td>S. guianensis CIAT 184</td>
<td>290</td>
<td>75–520</td>
</tr>
<tr>
<td>S. hamata cv. Verano</td>
<td>390</td>
<td>240–1020</td>
</tr>
<tr>
<td>S. scabra cv. Seca</td>
<td>280</td>
<td>100–520</td>
</tr>
</tbody>
</table>

**Table 1.** Clean seed yield of stylos in southern China (Guodao et al. 1995).

**Thailand**

In Thailand, more than 3700 t of legume seed, mostly of Verano stylo, have been produced since 1976. This has declined from a high of 430 t/year in 1989 to 150 t/year in 1995 (Figure 2). The high demand for Verano in the late 1980s was due to the Government program of oversowing public land with Verano stylo.

About 90% of the total stylo seed has been produced by smallholder farmers (Figure 2). Farmer seed production is supported by the DLD which, apart from research, training and extension, acts as a buyer and marketing agent for farmers. Usually DLD contracts farmers to produce 100 kg/year of Verano seed; excess is sold privately by the farmer. In 1995, the contract price for 1 kg of good quality, clean seed was Australian $3.20/kg. Some 3000 farmers produce forage seed for DLD on this basis. Verano seed crops are often treated as annual crops. These are sown in the early wet season in May or June. A moderate amount of fertiliser is usually applied at planting and crops are weeded during the establishment phase. Seeds mature into the dry season and are allowed to drop on the ground. In late January or early February, stylo is cut close to the ground, any remaining seed on the plants is

![Figure 2. Seed production of *Stylosanthes hamata* cv. Verano in north-east Thailand from 1984 to 1995. □ = seed produced on government stations; □ = seed produced by smallholder farmers.](image-url)
thresed, and the fallen seed is swept from the ground and cleaned. Harvesting is done manually and is very labour intensive.

Graham seed has been produced mainly on government stations since the demand was relatively small. Farmers were first contracted to produce 5 t Graham seed in 1992–1993. Unfortunately, anthracnose affected this species in 1994, destroying this new cash crop for farmers. Seed production of CIAT 184 will commence in 1996, initially on government stations, and subsequently also by farmers.

Seed yield of Verano averages 800 kg/ha on farmers' fields, which is considerably higher than in southern China (mean 390 kg/ha).

Constraints and prospects

There are several factors which have limited widespread use of stylo. These are: (i) anthracnose damage; (ii) lack of persistence of *S. guianensis* ecotypes; and (iii) low seed yields in the low latitude, humid tropics.

Anthracnose has damaged several promising *S. guianensis* cultivars such as Schofield and Cook. Although countries were able to find replacements for anthracnose-affected cultivars, CIAT 184 is currently the "last" line of defence for countries such as China and Thailand. A replacement for CIAT 184 is required urgently. It is imperative to have cultivars with durable resistance or tolerance to anthracnose as frequent replacement of cultivars is expensive for farmers and it reduces the adoption of new cultivars.

Lack of persistence of *S. guianensis* in grass-legume associations has also affected its acceptability to farmers. In China and south-east Asia, *S. guianensis* is being used increasingly as leaf meal, fallow improvement, cover crops and cut-and-carry feed. Although long-term persistence is not usually required in these systems, regrowth of *S. guianensis* is often poor under cutting, particularly when cut at a mature stage for leaf-meal production and other cut-and-carry systems. This can be overcome partly by improved cutting management but the lack of resilience remains a problem with this species.

Low seed yield, particularly in the more humid tropics near the equator, has been a major obstacle for more widespread use of stylos. This is unfortunate, particularly since *Stylosanthes* is by far the most productive legume in these areas. In Malaysia, this problem may have been overcome with the start of seed production of CIAT 184. Future cultivars need to have the ability to set seed at low latitudes.

On the other hand, prospects for the use of stylos are good. *S. guianensis* continues to be the most productive and broadly adapted species in the acid infertile soils of humid and subhumid Asia. The use of CIAT 184 for leaf-meal production in tropical China has great potential in other countries in the region and is under investigation in several countries. In Thailand, research is directed to developing pelleting techniques for legume leaf meal, and this could open a much larger market than is being targeted in China. CIAT 184 has also shown potential as a legume for fallow improvement in upland cropping systems and this is being tested by farmers in the Philippines. In Indonesia, the Directorate General of Livestock Services and the Provincial Livestock Services in East Kalimantan has shown the ability of CIAT 184 to rehabilitate degraded *Imperata cylindrica* uplands, and is now testing this method with farmers in two areas in East Kalimantan. Pilot seed of CIAT 184 is being produced in several countries to ensure the supply of seed as demand for this ecotype increases.

Conclusions

There are excellent prospects for *Stylosanthes*, and *S. guianensis* in particular, to play a much greater role in upland agriculture in tropical China and south-east Asia. Although CIAT 184 has not been affected by anthracnose so far, a replacement with long-term resistance or tolerance to anthracnose is needed urgently. This new ecotype will need to incorporate positive features of CIAT 184 such as high productivity, broad adaptation and high seed production in the region and, if possible, be more resilient to variable cutting regimes.

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References


