

Environmental adaptation of forages in Lao PDR

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In Lao PDR, livestock production is almost totally a smallholder farming practice and is a vital component of livelihood security. Animals generally graze on native forages (grasses, shrubs, legumes, and tree leaves) that are available in forests and grasslands. However, native grass is abundant only during the wet season. Dry season feed shortages are common, resulting in severe animal feeding problems for farmers throughout the country. There are currently few, if any, alternative feed sources.

For many years, some Hmong farmers, who live on the fertile highland soils in Luang Phabang and Xieng Khouang, have fed grazing animals Napier grass (*Pennisetum purpureum*) as a supplement. Some farmers in Xieng Khouang have recently started to use Ruzi grass (*Brachiaria ruziziensis*) for the same purpose. However, in general, very few farmers in Lao PDR plant forages. This does not mean that there is no demand. The severity of feed resource limitations in some provinces (especially Luang Phabang and Xieng Khouang) is creating a huge interest in planted forages among farmers.

To meet this demand, the Department of Livestock and Fisheries, in collaboration with the Forages for Smallholders Project, established forage nurseries at five different agro-ecological sites in four provinces to evaluate forage adaptation for subsequent on-farm testing at Namsuang (Vientiane municipality), Houakhoth and Houaphai (Luang Phabang), Ban Km 32 (Oudomxay), and Khinak (Champassak).

Site descriptions

The soil pH (1:5 water) at these sites varied from very acid to neutral (Table 1).

Table 1. Physical characteristics of sites for nursery evaluation.

Site	Latitude	Altitude (m)	Annual rainfall (mm)	Wet season	Number of wet months (>50 mm)	Soil characteristics	Farming system
Namsuang	18° N	150	1500 - 2000	May - Oct	6	pH 4.5 ¹ , sandy loam, well drained, infertile	Lowland rice (rainfed and irrigated)
Houakhoth	20° N	400	1600 - 1800	May - Oct	6	pH 5, silty loam, moderately drained, moderately fertile	Shifting cultivation in upland area, irrigated rice and home gardens in valleys
Houaphai	20° N	428	1600 - 1800	May - Oct	6	pH 5.9, loam, well drained, moderately fertile	Shifting cultivation in upland area, irrigated rice and home gardens in valleys
Ban km 32	21° N	900	1000 - 1600	Apr - Oct	7	pH 4.3, silty loam, moderately drained, moderately fertile	Shifting cultivation (rice), upland cropping (maize, cassava).
Khinak	14° N	85	1300 - 1500	May - Oct	6	pH 6, sandy loam, well drained, infertile	Lowland rainfed rice, lowland crops, and grazing of pek savannah

¹ pH measurement in 1:5 H₂O.

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Table 2. Soil analysis at each experiment site.

	Nam Suang	Houakhoth	Houapai	Ban km 32	Khinak
Soil texture	Sandy loam	Silty loam	Loam	Silty loam	Sandy loam
pH (1:5 water)	4.6	5.0	5.9	4.3	6.0
Organic carbon (%C)	0.5	1.4	1.3	1.6	0.6
Nitrate nitrogen (mg/kg)	4.2	16.6	16.9	33.0	12.4
Sulfur (mg/kg)	2	10	11	9	4
Phosphorus (BSES) (mg/kg)	7	13	19	7	12
Phosphorus (Colwell) (mg/kg)	3	9	7	7	6
Potassium (Amm. Ac.) (meq/100g)	0.05	0.39	0.46	0.15	0.13
Calcium (Amm. Ac.) (meq/100g)	0.25	3.34	7.19	0.46	1.42
Magnesium (Amm. Ac.) (meq/100g)	0.06	2.68	4.39	0.29	0.34
Cation Exch. Cap. (meq/100g)	1.29	7.62	12.26	4.07	2.04
Aluminium saturation %	71	16	-	77	-

Most soils were moderately to severely infertile (Table 2). Average annual rainfall at the five sites ranges from 1000 to 2600 mm, with peak rainfall from June to August (Fig. 1). The dry season at all five sites ranges from 5-6 months, with only 1-4% of total rainfall being received during this period. The topography of the sites is flat to rolling; with altitude ranging from 85 to 900 m above sea level. The farming systems are quite different and include shifting rice cultivation and intensive upland cultivation of maize and cassava in the mountainous regions and irrigated/rainfed rice and cash crops in the lowland areas (Table 1).

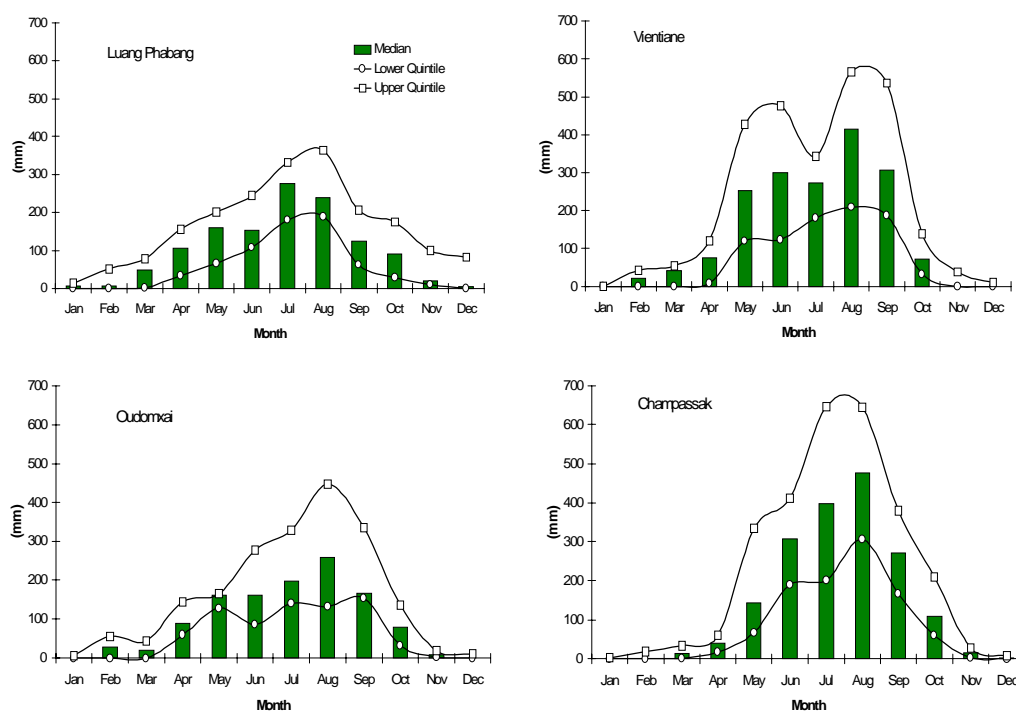


Fig. 1. Rainfall pattern in the four provinces (1985-95)

Results

A large range of forage species was evaluated over 2 years at each of the five sites. Three nurseries (Nam Suang, Houakhoth, and Houaphai) have already been completed and the other two (Ban km 32 and Khinak) are ongoing.

At each nursery, the species were planted in four plots consisting of single rows 3 m long. The forage nurseries were visually evaluated each month and the following information was collected:

Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

Pests and diseases: 0= no damage, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Maintains green leaf in dry season: 0=very poor, 1=poor, 2=average, 3=good, 4=excellent.

The number of species evaluated at each site varied, depending on the forage systems in the area and the availability of seeds. A complete list of species evaluated at each site is available from the authors.

Results showed that many grasses and legumes were well adapted.

Namsuang

Eighty-four forage species (64 legumes and 20 grasses) were planted in the middle of July 1995. The grass species which were well adapted to this site were *Andropogon gayanus* cv. Kent, *Brachiaria brizantha* (all accessions, including CIAT 6780, CIAT 16318 and CIAT 16835, *Brachiaria decumbens* cv. Basilisk, *Brachiaria humidicola* cv. Tully and *Panicum maximum* CIAT 6299. Only a few legumes showed good adaptation and performance to the acid and very infertile soil: *Stylosanthes guianensis* (various accessions but especially CIAT 184), *Chamaecrista rotundifolia* cv. Wynn and, to a lesser extent, *Centrosema acutifolium* CIAT 5277 and *Zornia latifolia* CIAT 728. The details of performance of each species at the Namsuang site are presented in Table 3.

Table 3. Performance of forage species at Namsuang.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Aeschynomene americana</i> cv. Glenn	3	3	1	3	0	0
<i>Aeschynomene americana</i> cv. Lee	4	3	1	3	1	0
<i>Aeschynomene americana</i> CPI 93667	3	2	1	1	0	0
<i>Aeschynomene brasilianum</i> CIAT 8628	3	2	1	2	1	0
<i>Aeschynomene histrix</i> CIAT 9690	2	2	2	1	0	0
<i>Aeschynomene histrix</i> CIAT 93595	3	3	1	3	2	0
<i>Aeschynomene villosa</i> CPI 93621	3	2	1	2	0	0
<i>Aeschynomene villosa</i> CPI 91209	2	1	1	2	0	0
<i>Alysicarpus monilifer</i> CPI 52343	1	1	1	1	0	0
<i>Alysicarpus rugosus</i> CPI 30034	1	1	1	1	0	0
<i>Alysicarpus rugosus</i> CPI 52348	0	0	0	0	0	0
<i>Alysicarpus vaginalis</i> CPI 100856	0	0	0	0	0	0
<i>Arachis pintoii</i> CIAT 18748	0	0	0	0	0	0
<i>Arachis pintoii</i> CIAT 17434 (Amarillo)	2	1	3	1	2	0

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Table 3 (cont.). Performance of forage species at Namsuang.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Arachis pintoii</i> CIAT 18744	1	1	1	1	3	0
<i>Arachis pintoii</i> CIAT 18750	2	1	3	1	3	0
<i>Centrosema acutifolium</i> CIAT 5277	3	3	3	3	3	0
<i>Centrosema brasilianum</i> CPI55698	2	2	2	1	2	0
<i>Centrosema macrocarpum</i> CIAT 15014	2	2	3	1	2	0
<i>Centrosema pascuorum</i> cv. Cavalcade	3	1	1	1	1	0
<i>Centrosema plumieri</i> CPI 58567	2	2	1	1	2	0
<i>Centrosema pubescens</i> CIAT 438	0	0	0	0	0	0
<i>Centrosema pubescens</i> CIAT 15160	2	2	3	1	3	0
<i>Chamaecrista rotundifolia</i> Q 10057	2	2	2	2	2	0
<i>Chamaecrista rotundifolia</i> CPI 86127	3	3	2	4	2	0
<i>Chamaecrista rotundifolia</i> cv. Wynn	4	3	3	4	2	0
<i>Clitoria ternatea</i> cv. Milgarra	0	0	0	0	0	0
<i>Clitoria ternatea</i> CIAT 772	0	0	0	0	0	0
<i>Calopogonium mucunoides</i> CIAT 7722	2	2	1	3	0	0
<i>Desmodium distortum</i> CPI 38568	1	1	1	2	1	0
<i>Desmodium heterocarpon</i> CPI 86227	2	1	1	1	1	0
<i>Desmodium heterophyllum</i> CIAT349	2	2	1	2	1	0
<i>Desmodium ovalifolium</i> CIAT 3666	2	2	1	1	1	0
<i>Desmodium ovalifolium</i> CIAT 13098	2	2	2	2	1	0
<i>Desmodium cinerea</i> CPI 46562	0	0	0	0	0	0
<i>Desmodium subsericeum</i> CPI 78402	0	0	0	0	0	0
<i>Desmodium sericophilum</i> CPI 91147	2	1	1	1	1	0
<i>Desmanthus virgatus</i> ex. IRRRI	0	0	0	0	0	0
<i>Desmanthus virgatus</i> cv. Bayamo	0	0	0	0	0	0
<i>Desmanthus virgatus</i> cv. Mark	0	0	0	0	0	0
<i>Macroptilium atropurpureum</i> cv. Aztec	3	1	1	1	1	0
<i>Macroptilium atropurpureum</i> CPI 90844	2	1	1	1	1	0
<i>Macroptilium bracteatum</i> CPI 27404	0	0	0	0	0	0
<i>Macrotyloma daltonii</i> CPI 60303	1	1	0	1	0	0
<i>Macroptilium gracile</i> cv. Maldonado	2	1	1	1	1	0
<i>Macroptilium gracile</i> CPI 91340	2	1	1	1	1	0
<i>Macroptilium gracile</i> CPI 91049	2	1	1	2	0	0
<i>Macroptilium gracile</i> CPI 33498	2	1	1	2	1	0
<i>Stylosanthes capitata</i> CIAT 11280	2	2	3	2	3	0
<i>Stylosanthes hamata</i> cv. Amiga	2	2	1	3	1	0
<i>Stylosanthes hamata</i> cv. Verano	3	2	3	2	3	3
<i>Stylosanthes mexicana</i> CPI 87487	4	2	1	2	1	0
<i>Stylosanthes guianensis</i> SSD-12	4	3	4	3	4	0
<i>Stylosanthes guianensis</i> FM07-1	4	3	4	2	3	0
<i>Stylosanthes guianensis</i> FM05-3	3	3	4	2	3	0
<i>Stylosanthes guianensis</i> FM05-2	4	3	4	3	3	0
<i>Stylosanthes guianensis</i> FM05-1	4	2	4	2	3	0
<i>Stylosanthes guianensis</i> CIAT 184	4	4	4	2	4	0
<i>Teramnus uncinatum</i> CIAT 7315	1	1	1	1	1	0
<i>Vigna decipiens</i> CPI 73602	2	1	1	1	0	0
<i>Vigna oblongifolia</i> CPI 121699	1	1	1	1	0	0
<i>Vigna trilobota</i> CPI 13671	0	0	0	0	0	0
<i>Vigna vexillata</i> CPI 65484	1	1	1	1	0	0
<i>Zornia latifolia</i> CIAT 728	2	2	1	3	0	0

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Table 3 (cont.). Performance of forage species at Namsuang.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Andropogon gayanus</i> cv. Kent	3	3	3	3	2	0
<i>Bothriochloa inseupta</i> cv. Bisset	0	0	0	0	0	0
<i>Brachiaria brizantha</i> CIAT 6780	2	4	4	1	4	0
<i>Brachiaria brizantha</i> CIAT 16318	3	3	4	1	4	0
<i>Brachiaria decumbens</i> cv. Basilisk	3	3	4	1	4	0
<i>Brachiaria humidicola</i> cv. Tully	3	3	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 6133	3	2	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 16886	3	2	4	1	3	0
<i>Cenchrus ciliaris</i> cv. Biloela	1	1	1	1	1	0
<i>Dichanthium aristatum</i> cv. Floren	1	1	1	1	0	0
<i>Digitaria milanjana</i> cv. Jarra	2	2	3	1	2	0
<i>Digitaria milanjana</i> CPI 41192	2	1	3	1	2	0
<i>Digitaria milanjana</i> CPI 40700	3	2	2	1	2	0
<i>Panicum coloratum</i> CPI 16796	2	1	1	1	1	0
<i>Panicum maximum</i> cv. Petrie	1	1	2	1	2	0
<i>Panicum maximum</i> CIAT 6299	3	3	2	2	3	0
<i>Paspalum notatum</i> cv. Competidor	2	2	2	1	1	0
<i>Paspalum nicorae</i> CPI 37526	2	1	2	1	1	0
<i>Urochloa mosambicensis</i> cv. Nixon	2	2	2	2	2	0
<i>Urochloa stolonifera</i> CPI 60128	0	0	0	0	0	0

¹ Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

² Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

³ Maintains green leaf in dry season: 0=very poor, 1=poor, 2=average, 3=good, 4=excellent

⁴ Pests/diseases: 0= no pests/diseases, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Houakhoth

Sixty-one forage species (48 legumes and 13 grasses) were planted at the end of June 1995. The grass species adapted to this site were *Brachiaria brizantha* (CIAT 6780 and CIAT 16318), *Brachiaria decumbens* cv. Basilisk, *Brachiaria humidicola* CIAT 16886, and *Panicum maximum* CIAT 6299. Of the legumes, only *Stylosanthes guianensis* (various accessions) showed good adaptation and performance. The performance of each species at the Houakhoth site is presented in Table 4.

Table 4. Performance of forage species at Houakhoth.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Aeschynomene americana</i> cv. Glenn	4	2	1	4	0	0
<i>Aeschynomene americana</i> cv. Lee	4	2	1	4	0	0
<i>Aeschynomene americana</i> CPI 93667	3	2	1	4	0	0
<i>Aeschynomene brasilianum</i> CIAT 8628	2	2	1	4	1	0
<i>Aeschynomene histrix</i> CIAT 9690	4	2	1	3	1	0
<i>Aeschynomene histrix</i> CIAT 93595	1	1	1	4	1	0
<i>Aeschynomene villosa</i> CPI 93621	1	1	1	3	0	0
<i>Aeschynomene villosa</i> CPI 91209	1	1	1	3	0	0
<i>Alysicarpus monilifer</i> CPI 52343	1	1	1	1	1	0
<i>Alysicarpus rugosus</i> CPI 30034	1	2	1	2	0	0
<i>Alysicarpus rugosus</i> CPI 52348	1	1	1	1	1	0

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Table 4 (cont.). Performance of forage species at Houakthoth.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests/diseases ⁴
<i>Alysicarpus vaginalis</i> CPI 100856	2	1	1	2	1	0
<i>Arachis pintoii</i> CIAT 18744	0	0	0	0	0	0
<i>Arachis pintoii</i> CIAT 18750	1	2	2	1	2	0
<i>Centrosema acutifolium</i> CIAT 5277	1	3	2	2	3	0
<i>Centrosema brasilianum</i> CPI 55698	1	2	1	1	1	0
<i>Centrosema macrocarpum</i> CIAT15014	1	2	1	1	2	0
<i>Centrosema pascuorum</i> cv. Calvacade	2	1	1	1	0	0
<i>Centrosema plumieri</i> CPI 58567	2	2	2	1	2	0
<i>Centrosema pubescens</i> CIAT 438	1	1	2	1	2	0
<i>Centrosema pubescens</i> CIAT 15160	2	2	2	2	3	0
<i>Chamaecrista rotundifolia</i> Q 10057	1	1	1	3	1	0
<i>Chamaecrista rotundifolia</i> 86127	2	3	2	4	2	0
<i>Chamaecrista rotundifolia</i> cv. Wynn	2	3	2	4	2	0
<i>Clitoria ternatea</i> cv. Milgarra	2	2	2	2	2	0
<i>Clitoria ternatea</i> CIAT 772	2	2	2	3	1	0
<i>Calopogonium mucunoides</i> CIAT 7722	2	2	1	3	1	0
<i>Desmodium heterophyllum</i> CIAT349	2	1	1	1	1	0
<i>Desmodium ovalifolium</i> CIAT 13098	2	2	2	2	2	0
<i>Desmodium cinerea</i> ex. Davao	3	2	2	2	2	0
<i>Macroptilium atropurpureum</i> cv. Aztec	1	2	1	2	2	0
<i>Macroptilium atropurpureum</i> CPI 90844	1	1	1	1	1	0
<i>Macroptilium bracteatum</i> CPI 27404	0	0	0	0	0	0
<i>Macrotyloma daltonii</i> CPI 60303	1	1	1	1	0	1
<i>Macroptilium gracile</i> cv. Maldonado	1	2	1	2	1	0
<i>Macroptilium gracile</i> CPI 91340	1	1	1	1	0	0
<i>Macroptilium gracile</i> CPI 91049	2	1	1	1	0	0
<i>Macroptilium gracile</i> CPI 33498	1	1	1	1	1	0
<i>Stylosanthes capitata</i> CIAT 11280	1	2	2	1	4	0
<i>Stylosanthes guianensis</i> FM05-3	3	3	3	3	4	0
<i>Stylosanthes guianensis</i> FM05-2	4	3	4	3	4	0
<i>Stylosanthes guianensis</i> FM05-1	3	3	3	3	4	0
<i>Stylosanthes guianensis</i> CIAT 184	4	4	4	3	4	0
<i>Vigna decipiens</i> CPI 73602	1	1	1	1	0	0
<i>Vigna oblongifolia</i> 121699	0	0	0	0	0	0
<i>Vigna trilobota</i> CPI13671	1	1	1	1	1	0
<i>Vigna vexillata</i> CPI 65484	1	1	1	1	0	0
<i>Zornia latifolia</i> CIAT 728	1	1	1	1	1	0
<i>Brachiaria brizantha</i> CIAT 6780	3	4	4	1	4	0
<i>Brachiaria brizantha</i> CIAT 16318	2	3	3	1	4	0
<i>Brachiaria decumbens</i> cv. Basilisk	3	4	4	1	4	0
<i>Brachiaria humidicola</i> cv. Tully	2	2	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 6133	2	2	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 16886	3	3	4	1	3	0
<i>Cenchrus ciliaris</i> cv. Biloela	1	2	2	1	1	0
<i>Digitaria milanjana</i> cv. Jarra	2	2	2	1	2	0
<i>Digitaria milanjana</i> CPI 41192	1	2	2	1	1	0
<i>Panicum coloratum</i> CPI 16796	1	2	2	1	2	0
<i>Panicum maximum</i> CIAT 6299	2	3	3	4	3	0
<i>Urochloa mosambicensis</i> cv. Nixon	2	3	2	3	3	0
<i>Urochloa stolonifera</i> CPI 60128	2	1	2	1	1	0

¹ Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

² Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

³ Maintains green leaf in dry season: 0=very poor, 1=poor, 2=average, 3=good, 4=excellent

⁴ Pests/diseases: 0= no pests/diseases, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Houaphai

Fifty-six forage species (42 legumes and 14 grasses) were planted at the end of June 1995. Grass species, which were well adapted to this site were *Brachiaria brizantha* CIAT 6780 and CIAT 16318, *Brachiaria decumbens* cv. Basilisk, *Brachiaria humidicola* CIAT 16886 and Tully, and *Panicum maximum* CIAT 6299. Of the legumes, only *Chamaecrista rotundifolia* cv. Wynn and *Stylosanthes guianensis* (especially CIAT 184), were well adapted. The details of performance of each species at the Houaphai site are presented in Table 5.

Table 5. Performance of forage species at Houaphai

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Aeschynomene americana</i> cv. Glenn	2	2	1	4	0	0
<i>Aeschynomene americana</i> cv. Lee	2	2	1	4	1	0
<i>Aeschynomene americana</i> CPI93667	2	2	1	3	0	0
<i>Aeschynomene brasilianum</i> CIAT 8628	2	2	1	2	1	0
<i>Aeschynomene histrix</i> CIAT 9690	3	2	2	1	1	0
<i>Aeschynomene histrix</i> CIAT 93595	2	1	1	3	1	1
<i>Aeschynomene villosa</i> CPI 93621	3	1	1	3	0	0
<i>Aeschynomene villosa</i> CPI 91209	0	0	0	0	0	0
<i>Alysicarpus monilifer</i> CPI 52343	1	1	1	2	0	0
<i>Alysicarpus rugosus</i> CPI 30034	3	3	1	2	0	1
<i>Alysicarpus rugosus</i> CPI 52348	2	2	1	2	1	0
<i>Alysicarpus vaginalis</i> CPI 100856	4	2	1	2	1	1
<i>Centrosema acutifolium</i> CIAT 5277	1	1	1	1	0	0
<i>Centrosema brasilianum</i> CPI 55698	1	1	1	1	1	0
<i>Centrosema macrocarpum</i> CIAT 15014	1	2	1	1	2	1
<i>Centrosema pascuorum</i> cv. Calvacade	2	2	1	1	0	0
<i>Centrosema plumieri</i> CPI 58567	2	1	3	1	1	1
<i>Centrosema pubescens</i> CIAT 438	2	2	2	1	2	0
<i>Centrosema pubescens</i> CIAT 15160	1	1	3	1	2	0
<i>Chamaecrista rotundifolia</i> Q 10057	3	2	2	4	1	0
<i>Chamaecrista rotundifolia</i> cv. Wynn	4	3	3	2	2	0
<i>Clitoria ternatea</i> CIAT 772	3	3	1	2	1	0
<i>Calopogonium mucunoides</i> CIAT 7722	3	3	1	1	0	0
<i>Desmodium ovalifolium</i> CIAT 3666	0	0	0	0	0	0
<i>Desmodium ovalifolium</i> CIAT 13098	1	1	1	1	1	0
<i>Macroptilium atropurpureum</i> cv. Aztec	1	1	2	1	1	0
<i>Macroptilium atropurpureum</i> CPI 90844	1	1	1	1	1	0
<i>Macroptilium bracteatum</i> CPI 27404	1	1	1	1	0	0
<i>Macrotyloma daltonii</i> CPI 60303	1	1	1	1	0	0
<i>Macroptilium gracile</i> cv. Maldonado	1	1	1	1	1	0
<i>Macroptilium gracile</i> CPI 91049	1	1	1	1	0	0
<i>Macroptilium gracile</i> CPI 33498	1	1	1	1	0	0
<i>Stylosanthes capitata</i> CIAT 11280	1	1	1	1	1	0
<i>Stylosanthes guianensis</i> FM05-3	4	3	4	2	4	0
<i>Stylosanthes guianensis</i> FM05-2	4	4	4	2	4	0
<i>Stylosanthes guianensis</i> CIAT 184	4	4	4	3	4	0
<i>Teramnus uncinatum</i> CIAT 7315	2	2	1	1	1	0
<i>Vigna decipiens</i> CPI 73602	0	0	0	0	0	0
<i>Vigna oblongifolia</i> CPI 121699	0	0	0	0	0	0
<i>Vigna trilobota</i> CPI 13671	2	1	1	1	0	0
<i>Vigna vexillata</i> CPI 65484	0	0	0	0	0	0
<i>Zornia latifolia</i> CIAT 728	3	2	1	3	0	0

(continued next page)

Table 5 (cont.). Performance of forage species at Houaphai.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Brachiaria brizantha</i> CIAT 6780	4	4	4	1	4	0
<i>Brachiaria brizantha</i> CIAT 16318	3	3	4	1	4	0
<i>Brachiaria decumbens</i> cv. Basilisk	3	3	4	1	4	0
<i>Brachiaria humidicola</i> cv. Tully	3	2	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 6133	3	2	4	1	3	0
<i>Brachiaria humidicola</i> CIAT 16886	3	2	4	1	4	0
<i>Cenchrus ciliaris</i> cv. Biloela	3	2	3	1	1	0
<i>Dichanthium aristatum</i> cv. Floren	3	2	3	1	1	0
<i>Digitaria milanjiana</i> cv. Jarra	3	2	3	1	2	0
<i>Digitaria milanjiana</i> CPI 41192	2	1	2	1	1	0
<i>Panicum coloratum</i> CPI 16796	1	2	1	2	1	0
<i>Panicum maximum</i> CIAT 6299	3	3	3	2	3	0
<i>Urochloa mosambicensis</i> cv. Nixon	3	2	3	2	2	0
<i>Urochloa stolonifera</i> CPI 60128	1	2	1	1	1	0

¹ Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

² Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

³ Maintains green leaf in dry season: 0=very poor, 1=poor, 2=average, 3=good, 4=excellent

⁴ Pests/diseases: 0= no pests/diseases, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Khinak

Fifty-two forage species (25 legumes and 27 grasses) were planted at the end of June 1996. Of the grass species, *Brachiaria brizantha* (including CIAT 6387, CIAT 6780, CIAT 16318, CIAT 16827, CIAT 16835, CIAT 26110), *Brachiaria decumbens* cv. Basilisk, and *Panicum maximum* CIAT 6299 were well adapted and productive. Only a few legumes showed good adaptation and performance: *Centrosema pubescens* CIAT 15160, *Chamaecrista rotundifolia* cv. Wynn, *Stylosanthes guianensis* CIAT 184, and *Stylosanthes hamata* cv. Verano. The details of performance of each species at the Khinak site are presented in Table 6.

Table 6. Performance of forage species at Khinak.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Pests /diseases ³
<i>Aeschynomene histrix</i> CIAT 9690	2	2	2	2	1
<i>Arachis pintoii</i> CIAT 17434 (Amarillo)	0	0	0	0	0
<i>Arachis pintoii</i> CIAT 22160	1	2	3	1	0
<i>Centrosema acutifolium</i> CIAT 5277	1	1	1	1	0
<i>Centrosema macrocarpum</i> CIAT 25522	1	1	3	1	1
<i>Centrosema pubescens</i> CIAT 15160	2	3	3	1	0
<i>Chamaecrista rotundifolia</i> Q 10057	1	2	2	3	0
<i>Chamaecrista rotundifolia</i> CPI 86127	2	3	2	2	0
<i>Chamaecrista rotundifolia</i> cv. Wynn	3	2	2	3	0
<i>Desmodium heterophyllum</i> CIAT 349	2	2	1	1	0
<i>Desmodium ovalifolium</i> CIAT 13305	2	2	3	1	0
<i>Desmodium cinerea</i> CPI 46562	1	1	2	1	0
<i>Flemingia macrophylla</i> CIAT 17403	3	3	3	1	0

(continued next page)

Table 6 (cont.). Performance of forage species at Khinak.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Pests/diseases ³
<i>Macroptilium atropurpureum</i> cv. Aztec	1	1	1	1	0
<i>Macroptilium atropurpureum</i> CPI 90844	1	1	1	1	0
<i>Macroptilium gracile</i> cv. Maldonado	2	1	1	1	0
<i>Macroptilium gracile</i> CPI 33498	2	1	1	1	0
<i>Stylosanthes capitata</i> Multiline 5	2	1	2	1	0
<i>Stylosanthes hamata</i> cv. Verano	3	3	3	3	0
<i>Stylosanthes guianensis</i> FM05-1	2	3	4	2	0
<i>Stylosanthes guianensis</i> CIAT 184	3	4	4	2	0
<i>Stylosanthes scabra</i> cv. Siran	1	3	4	2	0
<i>Stylosanthes scabra</i> cv. Seca	2	3	4	2	0
<i>Vigna parkeri</i> cv. Shaw	1	1	1	1	2
<i>Zornia latifolia</i> CIAT 728	0	0	0	0	0
<i>Andropogon gayanus</i> cv. Kent	0	0	0	0	0
<i>Bothriochloa inseupta</i> cv. Bisset	1	1	3	1	0
<i>Bothriochloa bladhii</i> cv. Swann	1	2	2	3	0
<i>Bothriochloa pertusa</i> cv. Medway	1	2	3	2	0
<i>Brachiaria brizantha</i> CIAT 6387	1	4	4	2	0
<i>Brachiaria brizantha</i> CIAT 6780	2	4	4	1	0
<i>Brachiaria brizantha</i> CIAT 16318	1	3	4	1	0
<i>Brachiaria brizantha</i> CIAT 16827	1	3	4	1	0
<i>Brachiaria brizantha</i> CIAT 16835	1	4	4	2	0
<i>Brachiaria brizantha</i> CIAT 26110	2	4	4	1	0
<i>Brachiaria decumbens</i> cv. Basilisk	1	4	4	1	0
<i>Brachiaria humidicola</i> cv. Tully	1	2	4	1	0
<i>Brachiaria humidicola</i> CIAT 6133	0	0	0	0	0
<i>Brachiaria humidicola</i> CIAT 26149	1	2	4	1	0
<i>Brachiaria ruziziensis</i> ex. Thailand	2	2	3	3	0
<i>Cenchrus ciliaris</i> cv. Biloela	2	2	3	1	0
<i>Dichanthium aristatum</i> cv. Floren	1	2	2	1	0
<i>Digitaria milanjiana</i> cv. Jarra	3	2	3	2	0
<i>Digitaria milanjiana</i> cv. Strickland	2	2	3	1	0
<i>Panicum maximum</i> TD 58	2	2	3	1	0
<i>Panicum maximum</i> CIAT 6299	2	4	3	1	0
<i>Paspalum atratum</i> BRA 9610	2	3	3	1	0
<i>Paspalum guenoarum</i> BRA 3824	1	2	3	1	0
<i>Urochloa mosambicensis</i> CPI 46876	3	2	3	1	0
<i>Urochloa mosambicensis</i> CPI 60128	1	1	3	1	0
<i>Urochloa mosambicensis</i> CPI 60147	2	2	3	1	0
<i>Urochloa mosambicensis</i> cv. Nixon	1	3	3	2	0

¹ Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

² Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

³ Pests/diseases: 0= no pests/diseases, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Ban Km 32

Forty-five forage species (25 legumes and 20 grasses) were planted in the middle of July 1996. *Brachiaria brizantha* (CIAT 6780, CIAT 6387, CIAT 16827, CIAT 16835 and CIAT 26110), *Brachiaria decumbens* cv. Basilisk, *Brachiaria ruziziensis* ex. Thailand, and *Panicum maximum* CIAT 6299 all performed well. Only a few legumes showed good adaptation to the local conditions: *Stylosanthes hamata* cv. Verano and *Stylosanthes guianensis* CIAT 184. The details of performance of each species at Ban Km 32 site are presented in Table 7.

Table 7. The performance of forage species at Ban Km 32.

Species	Establishment success ¹	Yield potential ²	Persistence ²	Seed production ²	Maintains green leaf in dry season ³	Pests /diseases ⁴
<i>Aeschynomene histrix</i> CIAT 9690	3	2	2	1	1	0
<i>Aeschynomene histrix</i> CIAT 93595	3	2	2	2	1	1
<i>Arachis pintoii</i> CIAT 17434 (Amarillo)	0	0	0	0	0	0
<i>Arachis pintoii</i> CIAT 22160	1	1	3	1	3	1
<i>Centrosema acutifolium</i> CIAT 5277	2	2	2	1	2	0
<i>Centrosema brasilianum</i> 55698	3	2	3	1	2	0
<i>Centrosema macrocarpum</i> CIAT 25522	2	1	3	1	3	0
<i>Centrosema pascuorum</i> cv. Calvacade	3	2	2	2	2	0
<i>Centrosema pubescens</i> cv. Cardillo	3	1	3	1	2	0
<i>Centrosema pubescens</i> CIAT 15160	2	2	2	1	2	0
<i>Desmodium heterophyllum</i> CIAT 349	4	2	4	2	2	0
<i>Desmodium ovalifolium</i> CIAT 13305	4	1	4	1	1	0
<i>Desmodium cinerea</i> CPI 46562	4	2	4	2	3	0
<i>Flemingia macrophylla</i> CIAT 17403	2	2	3	1	3	0
<i>Macroptilium atropurpureum</i> cv. Aztec	3	1	2	2	2	0
<i>Macroptilium atropurpureum</i> CPI 90844	2	1	2	1	2	0
<i>Macroptilium gracile</i> cv. Maldonado	3	2	3	2	2	0
<i>Macroptilium gracile</i> CPI 33498	3	1	2	1	2	0
<i>Stylosanthes hamata</i> cv. Verano	4	3	3	2	3	0
<i>Stylosanthes guianensis</i> FM05-1	2	3	4	2	4	0
<i>Stylosanthes guianensis</i> CIAT 184	4	4	4	3	4	0
<i>Stylosanthes scabra</i> cv. Siran	2	2	4	2	3	0
<i>Stylosanthes scabra</i> cv. Seca	3	2	4	1	3	0
<i>Vigna parkeri</i> cv. Shaw	3	1	2	1	1	0
<i>Zornia latifolia</i> CIAT 728	1	1	1	2	1	0
<i>Andropogon gayanus</i> cv. Kent	0	0	0	0	0	0
<i>Brachiaria brizantha</i> CIAT 6387	1	4	4	2	4	0
<i>Brachiaria brizantha</i> CIAT 6780	1	3	4	1	4	0
<i>Brachiaria brizantha</i> CIAT 16318	0	0	0	0	0	0
<i>Brachiaria brizantha</i> CIAT 16827	1	3	4	2	4	0
<i>Brachiaria brizantha</i> CIAT 16835	1	3	4	3	4	0
<i>Brachiaria brizantha</i> CIAT 26110	1	3	4	1	4	0
<i>Brachiaria decumbens</i> cv. Basilisk	1	3	4	1	4	0
<i>Brachiaria humidicola</i> cv. Tully	1	2	4	1	4	0
<i>Brachiaria humidicola</i> CIAT 6133	0	0	0	0	0	0
<i>Brachiaria humidicola</i> CIAT 26149	1	1	3	1	4	0
<i>Brachiaria ruziziensis</i> ex. Thailand	3	3	3	4	3	0
<i>Panicum maximum</i> TD 58	2	3	3	3	3	0
<i>Panicum maximum</i> CIAT 6299	2	4	3	3	3	0
<i>Paspalum atratum</i> BRA 9610	1	2	3	1	2	0
<i>Paspalum guenoarum</i> BRA 3824	3	2	2	1	2	0
<i>Urochloa mosambicensis</i> CPI 46876	2	3	2	2	3	0
<i>Urochloa mosambicensis</i> CPI 60128	1	1	3	1	3	0
<i>Urochloa mosambicensis</i> CPI 60147	3	2	3	2	3	0
<i>Urochloa mosambicensis</i> cv. Nixon	1	1	3	2	3	0

¹ Establishment success: 0=did not emerge, 1=poor, 2=moderate, 3=good, 4=excellent.

² Yield potential, persistence, and seed production: 1=poor, 2=moderate, 3=good, 4=excellent.

³ Maintains green leaf in dry season: 0=very poor, 1=poor, 2=average, 3=good, 4=excellent

⁴ Pests/diseases: 0= no pests/diseases, 1=little impact, 2=moderate impact, 3=severe impact, 4=plants killed.

Discussion

Across all sites, some grass species proved to be persistent, productive, and broadly adapted. These included *Brachiaria brizantha* CIAT 6780, *Brachiaria brizantha* CIAT 16318, *Brachiaria decumbens* cv. Basilisk, and *Panicum maximum* CIAT 6299. They grew well in a wide range of soils – from very acid (at Namsuang) to more fertile (at Ban km 35). They were tolerant of drought and showed high yield potential in the wet season. However, these species had only poor to moderate establishment at some sites. This may have been due to ant theft of seed, as reported by some technicians, or poor seed quality. *Andropogon gayanus* appears to have potential but it was not planted at all sites because of lack of seed.

The main limitation for many of the legumes was surviving the long and severe dry season. Growth of the legumes was generally vigorous in the first wet season, but many did not survive the dry season. Only *Stylosanthes guianensis* CIAT184 persisted and grew vigorously at all sites. *Chamaecrista rotundifolia* cv. Wynn was reasonably successful, but is largely annual.

Some species performed well and persisted in some locations but not in others. These were *Brachiaria humidicola* (cv. Tully, CIAT 16886 and CIAT 6133), *Urochloa mosambicensis* cv. Nixon, *Zornia latifolia* CIAT 728, and *Centrosema acutifolium* CIAT 5277.

Conclusions

The nurseries have identified a small range of broadly adapted forage species for Lao PDR (especially *Brachiaria brizantha* CIAT 6780, CIAT 16318, *Brachiaria decumbens* cv. Basilisk, *Panicum maximum* CIAT 6299 and TD58, and *Stylosanthes guianensis* CIAT 184). There is no shortage of grass species for farmers to evaluate, but there are few legumes adapted to the poor soils and long dry season typical of much of Lao PDR.

Some species need further evaluation for various reasons: either because they have not been tried, were only tried at some sites, did not establish well (because of poor seed/ant predation), or may have specific adaptation to particular conditions (for example, higher altitude areas of the northern provinces). These include *Andropogon gayanus* (which is well adapted to the acid and poorly drained soil of the Namsuang site), *Brachiaria humidicola* (which established poorly from seed at most sites but is easily propagated vegetatively), *Setaria sphacelata* cv. Solander and cv. Kazungula (which have performed well in the cooler areas of Xieng Khouang), *Chamaecrista rotundifolia* cv. Wynn and other leafier accessions, *Zornia latifolia* CIAT 728 and *Centrosema acutifolium* CIAT 5277.

The lack of adapted legumes points to the need for more work on tree legumes. At Ban km 32, for example, *Calliandra calothyrsus* has performed extremely well. *Leucaena* is generally not well adapted to most of Lao PDR because of the acid soils. However, some of the cold-tolerant *Leucaena* varieties should be tried in the more fertile soils of the northern provinces. *Gliricidia sepium* appears to have potential in the moderately fertile soils of Luang Phabang but has not performed well on either the poorer soils or in areas with low winter temperatures.

Acknowledgements

The authors thank the provincial and district officers (Mr. Bounthong, Mr. Daosadet, Miss Thongbay, Mr. Sengpasith, Mr. Simuang, Mr. Sisomvang) and Mrs. Kaysone for their assistance in the management of the nursery and in data collection. We also thank Miss

Soukanhya for her assistance in data management. The assistance and financial support of the Forages for Smallholders Project and the Division of Livestock Development, Department of Livestock and Fisheries, MAF are much appreciated.