PASTURE IMPROVEMENT AT NA PHENG, CENTRAL LAOS

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ABSTRACT

Some features of the environment of Na Pheng, Central Laos, are described. Experiences with pasture establishment indicate that stylo (Stylosanthes guyanensis), *Townsville stylo* (S. humilis), *centro* (Centrosema pubescens), *molasses grass* (Melinis minutiflora), *guinea grass* (Panicum maximum), *plicatulum* (Paspalum plicatulum) *and setaria* (Setaria sphacelata) *are adapted for sowing in this region. Pastures were established by conventional mechanised methods or by sowing with companion upland rice crops grown on handcleared "slash and burn" areas.*

INTRODUCTION

Laos is a net importer of meat and the demand for meat in neighbouring territories is unsatisfied. The low population density, the large tracts of unused forest land, the favourable climatic regime for the growth of tropical pastures and the scope for increased breeding performance of local cattle are all factors which create a potential for increased beef production. In addition, Lao farmers usually run cattle and buffaloes for draught, so that any improvement in ruminant nutrition is likely to give other benefits to the farm economy.

For these reasons it was decided to investigate the establishment and maintenance of improved pastures and to measure their productivity in terms of local cattle performance. Work was commenced early in 1966 on a Lao/Australian Livestock Improvement Project, using resources from the External Aid Branch of the Australian Department of External Affairs given under the Colombo Plan and from the Royal Lao Government.

THE LOCATION

The site selected for the project was near the village of Na Pheng, about 52 km N.N.E. of Vientiane, in the low foothills beneath the Phou Khou Kwi plateau on the edge of the Vientiane plain. About 93 ha (232 ac) of gently rolling land of mean altitude 200 m (660 ft) was fenced, and stock watering, residential and other improvements were effected.

Climate

The climate of the central Lao lowlands about Vientiane has been broadly classified as Tropical Savanna-wet-and-dry-climate = Koppen "AW" (Pendleton 1962), and is close to the boundary of the humid mesothermal zone = Koppen "CW" which occurs at higher elevations. Thornthwaite's classification places Vientiane in the humid tropical, rainfall-deficient-in-winter group = "B A^1 W", bordering on sub-humid tropical = "C A^1 W". Cairns and Cooktown, Australia, both fall in the former groups of both classifications. Frosts are not usually recorded.

Climatic homologues between Australia and Laos would help to predict pasture species performance in the latter country and a partial comparison between Vientiane, Cooktown and McDonnell is shown in table 1; January in Vientiane has been equated with July in Australia.

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TABLE 1

Climatic comparisons between Vientiane (Laos) and two north Australian stations

	Monthly Rainfall (mm)			Monthly Temperature (°C)			Relative Monthly Humidity (%)		
	Vien-tiane	Cook-town	McDon-nell	Vien-tiane	Cook-town	McDon-nell	Vien-tiane	Cook-town	McDon-nell
J*	3	25	13	20.8	22.3	22.9	70	76	80
F	8	33	10	23.4	23.0	23.2	68	73	75
M	18	15	5	26.6	24.4	24.4	68	70	70
A	104	28	15	28.6	26.0	25.9	71	69	67
M	277	66	74	28.4	27.1	27.0	80	69	67
J	264	170	218	28.5	27.8	27.4	84	73	75
J	244	368	452	27.6	27.6	26.8	83	78	85
A	345	345	373	27.6	27.4	26.7	83	79	84
S	406	389	315	27.1	26.8	26.4	85	79	86
O	119	224	150	26.4	26.6	25.7	81	77	83
N	3	74	36	24.8	24.4	24.8	77	76	80
D	3	51	15	22.0	23.0	23.9	74	77	81
Annual	1794	1788	1676	26.0	25.5	25.4	77	75	78

*January in Vientiane has been equated with July in Cooktown and McDonnell.

There are obvious similarities in the data from the three stations. Rainfall at Vientiane (Lat. 17°57'N, 168 m) exhibits a second late season peak, which also occurs at Cooktown (Lat. 15°28'S, 5 m), but not at McDonnell on Cape York Peninsula (Lat. 11°38'S, 57 m). Vientiane appears to have 7 months growing season. Cooktown may have slightly less, but more winter rain occurs (i.e. more winter shoots, more pasture deterioration). Temperature amplitude of variation is slightly greater in the more continental climate of Vientiane. Relative humidity is of similar magnitude, with some time displacement between stations.

Vientiane has warmer temperatures and less winter rain than Queensland stations further south or west, e.g. Cairns, Ingham, Malanda. On the other hand Darwin has a shorter growing season and a hotter climate with less variation between summer and winter temperatures than at Vientiane.

These comparisons suggest the use at Vientiane of heat loving plants such as stylo, centro, Townsville stylo, guinea grass (all of which are most successful at Na Pheng) rather than glycine (*Glycine wightii*), *Paspalum dilatatum*, green panic (*Panicum maximum* var. *trichoglume*), or Bambatsi panic (*P. coloratum* var. *makarikariense*).

Rainfall at Na Pheng is higher than at Vientiane, e.g. in 1967 rainfall at the experimental site exceeded the Vientiane recording by 18 percent.

The question arises as to how far species performance at Na Pheng may be extrapolated to other parts of Laos. The obvious limitations which might be expected are in the lower rainfall areas to the north, e.g. Luang Prabang, or in the cooler regions of higher altitude.

Soils

A soil survey report of the Vientiane Plain (Marinet, Seguy and Andre 1961) covers an area bordered by the Nam Ngum R. 20 km S. of the station, and includes soils and land forms very similar to those of the cattle station. According to these authors, geological history of the Thailand-Cambodian zone began at the end of the Primary and into the Triassic by the sinking of the primary peneplain, constituted by crystalline rocks more or less metamorphosed (granites, gneiss, and mica schists) and by sediments which were most often sandstones and limestones. The sedimentary deposits of the series schist-clay-sandstone called "Indosinias" indicate lagoon condition extending from Carboniferous to Cretaceous. During Tertiary time an overall uplift occurred, which exposes the top series of the Indosinias; these are gray and red sandstones with more or less fine facies or more or less conglomerates. The parent rocks under the station are sandstones of varying texture; these were also noted on the adjacent mountains to the north. Ferruginous accumulations are also present, overlying sandstone.

Marinet, Seguy and Andre (1961) distinguish alluvial, ferruginous tropical, hydromorphic and saline soils, of which the ferruginous soils are of prime interest for upland rice or pasture development. These are subdivided into slightly leached soils developed on colluvial deposits, deeply leached soils developed on pebbly deposits of intermediate stage, and eroded soils of shallow depth on a ferruginous cap.

Reeve and Hubble (1967) have reported analyses of some samples from the station. The surface layers of these soils are highly acid (pH 4.4-4.8), very low in total soluble salts (0.008-0.024%), very low in calcium (0.10-0.70 m.e.%) and in phosphorus (5-17 p.p.m. "available"), and marginal to low in potash (0.11-0.33 m.e. %). The grey sandy loams exhibit little change of texture or evidence of profile differentiation to 1 m; laterite is recorded at 1.5 m. Some water worn pebbles in the upper layers are of variable occurrence. The red and brown loams on more elevated sites show increasing fineness of texture with depth; ferruginous pebbles are usually encountered at about 15 cm-20 cm; these increase in frequency until the material is almost wholly composed of ferruginous pebbles and gravel with a light matrix of red clay. Internal drainage is more satisfactory in the deep grey sandy loams, but mottling is rare in the red loams. Both these soil types appear to be intermediate between the typical leached and slightly leached ferruginous tropical soil classes described by Marinet, Seguy and Andre (1961).

Vegetation

The moist monsoon forest in the Na Pheng area includes trees in the primary layer in excess of 30 m high; common elements are *Dipterocarpus alatus, D. costatus, Pterocarpus macrocarpus, Hopea ferrea, Irvingia harmandiana, Lagerstroemia angustiflora, L. tomentosa,* and *Anisoptera* sp. In the secondary layer are found *Peltophorum dasyrachis, Garuga pinnata, Dialium cochinchinense, Ficus* sp., *Vitex pubescens, Ormosia cambodiana, Garcinia diveri, Milletia* sp., *Elaeocarpus robustus, Xerospermum* sp. and *Mallotus barbatus*. In well developed forest, herbage gramineae are virtually absent; elements in the underbrush include many vines and *Cassia tora, Desmodium triguetrum, Indigofera galegoides, Urena lobata, Trema velutina* and *Grewia abutilifolia*. The incidence of legumes might be noted.

When this forest is degraded for slash and burn rice culture ("ray") or for timber exploitation, the secondary development is usually dominated by *Bambusa* spp. The western sector of the station was predominantly primary forest, the north-eastern sector was secondary. Bamboos on the station include *Bambusa tulda, Oxytenanthera albociliata, O. parviflora,* and *Shizostachyum zollingeri*. Areas of open woodland occur in the region; according to Marinet, Seguy and Andre (1961) these indicate shallow soils developed on a more or less hardened sheet of rock.

The ubiquitous *Eupatorium odoratum* and *Imperata cylindrica* are common on forest margins. In disturbed places, *Panicum incomptum, Centotheca lappacea,* and *Cyntoccum trigonum* and numerous legumes from the genera *Desmodium, Cassia, Phaseolus, Bauhinia, Galactia* and *Dunbaria* occur. There is a gradient of grazing pressure towards villages, where frequent species include *Cynodon dactylon, Paspalum conjugatum, Eragrostis* spp., *Chrysopogon aciculatus, Eleusine indica,* *Digitaria pruriens, Panicum repens,* and in wet places, *Hymenachne psuedointerrupta* and *Ischaemum* sp.

PASTURE IMPROVEMENT USING MECHANISED METHODS

Establishment

Areas of the station were cleared by bulldozer between 1966 and 1970; occasional trees were left for shelter and the fallen trees were pushed into windrows. The usual practice in 1966 and 1967 was for the soil between the windrows to be disc harrowed once or twice before sowing pasture mixtures through a disc drill. Bulk areas received at sowing 400 kg per ha of a fertilizer mixture made up in the approximate proportions 600 single superphosphate: 500 shell lime: 100 muriate of potash: 6 copper sulphate: 6 zinc sulphate: 6 borax: 0.5 sodium molybdate. In 1969 and 1970 firing of fallen timber and sowing of molasses grass constituted a pioneer phase in the establishment operation.

Initial legume sowings were made with seeds inoculated with rhizobium; some evidence was noted that this was beneficial for centro but not for Townsville stylo or Schofield stylo. Better establishment of Coloniao guinea grass resulted if the delivery hoses of the drill were removed from the boots, giving surface broadcasting rather than burial at about 3 cm; plant density five months after sowing was 0.86 plants per m^2 where seed was broadcast and 0.25 plants per m^2 where it was buried.

TABLE 2

Yield of pasture mixtures, November 29-30, 1967
(kg/ha air dry)

Mixture		Soil type and sowing date		
A		Grey sandy loam 21/6/67	Grey sandy loam 13/7/67	Brown clay loam 13/7/67
Stylo	(2)*	6260	2080	3730
Townsville stylo	(2)	130	1520	2110
Paspalum commersonii	(4)	320	890	1980
Weeds		510	510	360
Total		7220	5000	8180
B		Grey sandy loam 6/7/67		
Townsville stylo	(2)	2580		
Dolichos lablab	(5)	50		
Nandi setaria	(2)	360		
Rhodes grass	(2)	nil		
Weeds		1420		
Total		4410		
C		Grey sandy loam 22-27/6/67	Red loam 29/6/67	Brown clay loam 22-27/6/67
Centro	(8)	790	1640	1180
Coloniao guinea	(4)	180	1300	440
Weeds		2250	1170	1040
Total		3220	4110	2660
D		Alluvial clay loam 30/6/67		
Centro	(8)	240		
Siratro	(2)	320		
Nandi setaria	(4)	980		
Coloniao guinea	(0.5)	220		
Weeds		3410		
Total		5170		

*Sowing rate (kg/ha) is shown in parenthesis.

Species Performance

At the end of the 1967 growing season the yield of first season pastures was measured. On each pasture mixture area and on each of the main sowing or soil subdivisions, 10 random 0.4 x 0.4 m quadrats were cut at 1 cm from ground level on November 29-30, 1967. The samples were separated into the various sown species and volunteer weeds, dried in the sun for 9-10 days, and weighed. It is estimated that the final moisture content of the samples was about 10 percent. The results are summarized in Table 2.

There are several important features in these data. The air-dry yields of 5-8000 kg/ha obtained in the stylo based mixture are good figures by Australian standards for first year yields on low fertility soils. It will be noted that control of volunteer weeds was only achieved in the sowings which included stylo. The pasture was strongly legume dominant in this first year, an important consideration in view of the need for fertility building on these poor soils. Stylo dominance was greater in the areas early sown in June; a confounding factor is that depth of sowing was also greater. In subsequent years, heavy winter grazing caused severe loss of stylo density.

Centro yields were not high in this first year (which parallels north Queensland experience), but subsequent spread indicated that this species is well adapted to the environment.

Townsville stylo grew and seeded well in the mixture B, and subsequently became dominant. It has established and spread from many other sowing situations in the region, including graded road sides. Poor establishment of Rhodes grass (*Chloris gayana*), Nandi setaria and of surface broadcast *Dolichos lablab* occurred. In the mixture D, and in other places on the station, siratro (*Phaseolus atropurpureus*) showed good early growth, but was severely affected by disease, probably a *Rhizoctonia,* and by secondary pest attack on leaves.

In bulk sowings made in 1969, Hartley plicatulum, Kazungula setaria, molasses grass, greenleaf desmodium (*Desmodium intortum*) and silverleaf desmodium (*D. uncinatum*) gave satisfactory first year performance.

Grass species observation strips, each 0.4 ha in area, were sown in 1966 and 1967, and legume strips were oversown at right angles on a portion of the area. Comparative yields of the 1966 sown grasses are shown in table 3, and indicate excellent growth and weed suppression by molasses grass. Nunbank buffel grass (*Cenchrus ciliaris*) grew poorly. The 1967 strip sowings indicated only indifferent performance by paspalum (*Paspalum dilatatum*) Bambatsi panic, Rhodes grass, green panic and Nandi setaria. Elephant grass (*Pennisetum purpureum*), pangola grass (*Digitaria decumbens*) and para grass (*Brachiaria mutica*) were acutely nitrogen deficient, but para grass spread well from other plantings in swampy situations. Lotononis (*L. bainesii*) and glycine failed to establish satisfactorily.

TABLE 3

Pasture Yield December 1-2, 1967, from 1966 sown pastures

(kg/ha air dry)

Species	Sown Grass	Volunteer Weeds	Total
Common Guinea Grass	3420	1480 (30)*	4900
Coloniao Guinea Grass	1820	1340 (42)	3160
Nunbank Buffel Grass	340	1850 (85)	2190
Molasses Grass	11700	350 (3)	12050

*Percentage composition of weeds by weight.

From these experiences it is concluded that the most reliable general sowing mixture for this district would contain both pioneer, weed suppressing plants such as stylo and molasses grass, and longer lived plants such as centro and guinea grass. The latter might be replaced by plicatulum or Kazungula setaria. Townsville stylo should be added in heavily grazed situations.

Cattle Performance

It is too early to write in a definitive way about cattle performance on these pastures, and to state the extent to which the growth and reproduction of the local cattle may be improved by providing access to sown pastures based on tropical legumes. A small herd was provided by the Royal Lao Government in mid-1968 and supplemented by local purchases. These are small animals of the Yellow Asian variety; adult cows in good condition weigh about 250 kg. In the first year some difficulties were experienced with parasite control and with loss of young animals from tiger attack. Cattle were weighed regularly from early 1969 and unsupplemented calves grew at an average rate of about 0.5 kg per head per day.

PASTURE IMPROVEMENT USING NON-MECHANISED METHODS

A large proportion of farmers in the Na Pheng district grow both "wet" rice in the lowlands and upland rice in the sloping foothills; some farmers, notably of the Meo race, grow only upland rice. The latter is produced under a shifting cultivation regime in which the forest is hand slashed, the debris burnt and rice planted in the ashes. After one or two crops the land is allowed to revert to weeds and forest. Grist (1965) has estimated that over 200 million of the world's population obtain the bulk of their food by shifting cultivation. This form of production has been criticised for its wasteful use and degradation of forest resources, its associated soil erosion and fertility depletion, and for the community instability associated with discontinuous land occupation. Little research has been devoted to improving upland rice systems of production.

The possible use of areas hand cleared for upland rice for legume based pastures was considered worth investigation, since if successful, pastures might be established without the need for massive injections of machines and capital, and for the need of new sophisticated skills.

Demonstrations

A sloping ridge site was cleared of forest by hand early in 1967, burnt, and a Lao cooperating farmer hand-planted rice (without machine cultivation) on 0.3 x 0.3 m centres in the ashes on May 30, 1967. Three pasture strips, each 70 x 3 m, were planted on August 16-17, 1967, to the following pasture mixtures:—

(i) Molasses grass, stylo, Townsville stylo.
(ii) Pangola grass, centro, siratro, *Dolichos lablab*.
(iii) Para grass, centro, siratro, *Dolichos lablab*.

Seeds were hand broadcast uninoculated; each legume was sown at 6 kg/ha. At this stage the rice was 0.8 m high and vegetative.

On December 8, 1967, percentage frequency of occurrence in 0.4 x 0.4 m random quadrats was 55, 48, 37, 17 and 3 for stylo, Townsville stylo, centro, siratro and dolichos respectively. Molasses grass established well, and showed superior vigour to para and pangola grasses. These sowings had no obvious detrimental effect on rice yield. In subsequent years the molasses grass, stylo and Townsville stylo mixture developed into an excellent pasture: when sampled on January 16, 1969, it yielded 11220 kg per ha, of which legumes constituted 41 percent and weeds only 7 percent.

An adjacent area of 0.6 ha was hand slashed from February 20-March 4, 1968, and the debris burnt on April 11. After removing some residual brambles the area was sown from May 7-9 with the Khou Non Khou rice variety, using a pointed digging stick on 0.3 x 0.3 m centres. Stylo was broadcast at 5 kg per ha at the same time as the rice sowing in one section; in other areas molasses grass was broadcast at 4 kg per ha 30 or 60 days after rice sowing. Strips testing the effects of 50 kg per ha triple superphosphate or 300 kg per ha 16:16:8 NPK fertiliser were laid down. The area was hand weeded on three occasions.

The sowing of companion pasture species had little effect on rice grain yields. These were 960, 1015, 940 and 1150 kg per ha in the areas respectively sown to rice alone, rice plus stylo, rice plus molasses grass sown 30 days later, and rice plus molasses grass sown 60 days later. In these ash sowings, rice yields were slightly less from areas receiving triple superphosphate or complete fertiliser; in the latter case increased incidence of rice blast disease and grub attack were noted.

In both these demonstrations, pastures were readily established in companion rice crops. A program was commenced in 1969 to examine the mechanisms involved in competition between rice and undersown pasture and to provide refinements in method leading to minimum reduction in rice yield compatible with successful legume establishment and weed suppression. This work is also being carried out on another site at the University of Khon Kaen, Thailand, and will be reported separately.

CONCLUSION

This report indicates that productive legume based pastures may be established on poor soils in central Laos, using either conventional mechanised techniques or hand methods in associating with upland rice production. Some pasture species well adapted to sowing in the area may now be recommended. It is hoped that future work at this centre will provide more information on the following unresolved issues:

1. The degree to which legume based pastures improve the growth, calving percentage, survival and stocking rate of the local cattle. This will only be known by carefully recording the performance of cattle actually conceived on sown pastures.
2. The means by which the natural pressure on these pastures to revert to forest and their infestation with *Eupatorium* may be overcome. It is believed that adequate presowing cultivation to destroy existing and regenerating vegetation, inclusion of pioneer species in the sowing mixture, good maintenance fertiliser practice and correct stocking pressure will eliminate this problem. The use of the rotary chain slasher is of assistance, but some regenerating woody species may need special investigation. More also needs to be known of the specific nutrient needs of the local soils; in the sowings reported, complete fertiliser mixtures or forest ash were successful but individual mineral requirements were not identified.

ACKNOWLEDGEMENTS

We are indebted to officers of the Australian Department of External Affairs involved in the project, especially Mr. Robert Kahl; to officers of the Royal Lao Government, particularly the late Mr. Douangchanh Solyphanh, Mr. Phaysouk and Mr. Khampha Bounmak; to workers in the U.S.A.I.D. organisation in Laos; to officers of the C.S.I.R.O. Cunningham Laboratory, Brisbane, especially Mr. R. J. Williams; to officers of the staff of the Queensland Government Botanist; to Mr. A. J. Vasey; and to the University of Queensland for releasing the junior author to make visits to this project in 1967 and 1969.

REFERENCES

GRIST, D. H. (1965). Rice. 4th ed. Longmans p. 163.

MARINET, J., SEGUY, J., and ANDRE, P. (1961). Agricultural and Soil Study. Development of the Plain of Vientiane. S.O.G.R.E.A.H. (Transl. 1963 Harvard Transl. and Editorial Service for U.S. Bureau of Reclamation).

PENDLETON, R. L. (1962). Thailand. Aspects of Landscape and Life. Duell, Sloan and Pearce, New York.

REEVE, G., and HUBBLE, G. D. (1967). Analysis of some soils from Laos. C.S.I.R.O. Division of Soils. Technical Memorandum 33/67.

[Accepted for publication July 27, 1970]