ESTABLISHMENT OF STYLO (STYLOSANTHES GUIANENSIS) IN KUNAI (IMPERATA CYLINDRICA) PASTURES AND ITS EFFECT ON DRY MATTER YIELD AND ANIMAL PRODUCTION IN THE MARKHAM VALLEY, PAPUA NEW GUINEA

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ABSTRACT

Grazing experiments conducted in the Markham Valley of Papua New Guinea indicated that the native grass kunai (Imperata cylindrica) *offers poor quality feed. While the yield of dry matter tends to increase until eight weeks, its protein content is reduced below seven per cent just after four weeks regrowth.*

Amongst the various methods of oversowing stylo (Stylosanthes guianensis) *broadcasting seed after burning the old growth of kunai at the onset of the wet season gave significantly better establishment than either heavy grazing or rolling the old kunai. Further significant improvement in stylo establishment in the burnt kunai was obtained by light discing before or ring-rolling after broadcasting.*

Oversowing of stylo and application of fertilizer nitrogen both increased the yield of total dry matter. Dry matter production of the pasture in the presence of stylo was equivalent to that of about 240 *kg N* ha^{-1} $year^{-1}$ *applied to the grass alone. Nitrogen application had little effect on the protein content of kunai but the high proportion of stylo* (30–35%) *in the mixed pasture is expected to improve the overall protein content and acceptability of the available feed.*

Over a period of two years when grazed at a common stocking rate of a beast to 0.8 *ha, average daily live weight gains of* 0.25 *and* 0.19 *kg* $head^{-1}$ *were obtained from kunai with and without stylo respectively, resulting in an annual increase of about* 22 *kg* $head^{-1}$ *or* 28 *kg* ha^{-1}. *Possible reasons for the low live weight gains may be the low digestibility of the feed or a mineral deficiency such as phosphorus or cobalt.*

INTRODUCTION

There is much scope in Papua New Guinea for animal production as vast areas of natural grassland are available for grazing, especially in the Markham Valley. The suitability of this valley for grazing and fattening cattle was realized in the late thirties (Marr, 1938). The native grassland of the Markham Valley is predominantly kunai (*Imperata cylindrica*) which, although well adapted, is a low quality feed. It seems reasonable, therefore, to attempt to improve its production and quality by introducing a suitable legume. *Stylosanthes guianensis* var. *guianensis* cv. Schofield (stylo) was chosen as it is well adapted to this region and it has been successfully used elsewhere (Carrie 1962). The importance of pasture legumes in increasing dry matter yield and quality, and animal production has been well established elsewhere (Stobbs 1969, Haggar *et al.* 1971) but there is no information available on these aspects from the kunai pastures in Papua New Guinea.

The experiments reported here were carried out on a heavy soil at the Beef cattle Research Centre Erap, about 45 km from Lae. The annual rainfall is about 1120 mm. The work was carried out over a period of four years and includes studies on the kunai plant characters, methods of establishing stylo, dry matter yield and animal production.

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CHARACTERISTICS OF KUNAI

Kunai is a perennial grass widely distributed in the tropics and subtropics. It is especially found in open country on abandoned cultivated lands and on deforested areas. Kunai tolerates a wide range of soil and climatic conditions which enable it to achieve such a wide distribution (Anon 1944).

Kunai is an erect plant which grows to a height of 50–100 cm. It has slender to stout stems with 1–2 nodes and the number of shoots varies between 3–5 or more depending on the variety. Leaves are linear lanceolate, variable in length and quite coarse to touch even at a young stage of growth. Coarseness increases as the plant matures and the plant becomes unpalatable. Spread of kunai is by seed, which is produced in abundance almost throughout the year, and by vegetative propagation of rhizomes. The light and fluffy seed is ideal for wind dispersal. The underground rhizomes enable the plant to survive fire. Surface burning destroys the aerial parts only and new shoots sprout again to produce fresh flowering stems. In fact burning has been observed to have a favourable effect on the regrowth of kunai. It is a usual practice in Papua New Guinea to burn off the old growth in order to get a new tender regrowth for grazing.

There is a large number of varieties of kunai which grow under varying agro-climatic regions (Santiago 1965) and some varieties have been considered to be a serious menace especially under plantation crops in many South-east Asian countries. However the variety *major* is the most common in Papua New Guinea (Henty 1969) and is said to have some grazing value. Besides its use for grazing, this plant is also used for thatching and paper making and also for soil and moisture conservation. A very comprehensive review on taxonomy, distribution, economic significance and its control was published by the Imperial Agricultural Bureau (Anon 1944).

METHODS AND RESULTS

Quality of kunai pastures

Experiment 1—Effect of age on dry matter yield and protein content of Kunai.

Early reports (Anon 1944) indicate a high variability in the nutritive value of kunai. In order to find out the effect of age on dry matter yield and its protein content an unreplicated trial was conducted on a uniform stand of kunai at Erap. The old stand was burnt, divided into eight plots, and frequency of cutting treatments ranging from two to 16 weeks were imposed. Dry matter yield was estimated by cutting four quadrats (50 × 50 cm) from each plot at 10 cm height in different treatments on the due dates. Samples were analyzed for nitrogen content and crude protein values were derived by multiplying these figures by 6.25. The results are presented in Table 1.

TABLE 1

Effect of cutting frequency on dry matter yield and protein content of kunai grass.

Cutting interval in weeks	Total dry matter yield kg ha^{-1}	Total growth period (weeks)	Number of harvests	Yield of dry matter per week	Crude protein percentage
2	2191	20	10	110	9.81
4	3059	12	3	255	7.00
6	4833	18	3	269	6.00
8	4960	16	2	310	5.00
10	3452	20	2	173	4.19
12	2078	12	1	173	4.19
14	2265	14	1	162	3.75
16	2255	16	1	141	3.75

Results

Protein content (Table 1) of kunai declined progressively with increased cutting interval from 9.81 per cent at two weeks to 3.75 per cent at 14 weeks regrowth. However, the rate of dry matter accumulation continued to increase up to an eight week cutting interval and then reduced to less than half at 16 week cutting interval.

Experiment 2—Effect of nitrogen application on dry matter yield and protein content of kunai.

In order to find out the effect of fertilizer nitrogen on dry matter yield and protein content, a trial was conducted in a randomized block design with five replicates for one year on an old kunai stand which was burnt before the treatments were imposed. Nitrogen was applied as urea after alternate harvests at a rate of 30 or 60 kg ha^{-1}. Dry matter yield was estimated by harvesting four quadrats (50 × 50 cm) per plot at 10 cm height every six weeks. Samples pooled over replicates were analyzed for nitrogen content. The results are presented in Table 2.

TABLE 2

Effect of nitrogen application on dry matter yield and protein content of kunai grass.

Nitrogen kg ha^{-1} yr^{-1}	Dry matter yield kg ha^{-1}	Percentage protein
0	6829	5.56–6.50
120	9391	5.94–7.30
240	11428	7.18–7.50

Values followed by different letters differ significantly ($P < 0.01$).

Application of nitrogen had little effect on improving the protein content of kunai. Yield of dry matter, however, responded markedly to increased nitrogen rates.

Methods of oversowing stylo in kunai pastures

The experiments described above indicated that protein content of kunai pastures is very low even at the young stage of growth (Table 1) and the application of fertilizer nitrogen had little effect (Table 2). The following experiments were carried out to find the effective methods of establishing a legume in kunai pasture. Commercially available seed of stylo was used after inoculation with appropriate rhizobium.

Experiment 3—Effect of burning, heavy grazing or rolling old kunai growth on establishment of stylo.

A large area of old kunai stand was selected and treated at the onset of rains by burning, rolling with ring rollers or heavy quick grazing. A control area was left untreated. A few days later inoculated seed of stylo was broadcast by hand at a rate of 6 kg ha^{-1}. Stylo plant population was counted two months after sowing and the results are given in Table 3.

TABLE 3

Effect of burning, heavy grazing and rolling old kunai on the establishment of stylo.

Treatments	Stylo plant population (m^{-2})
1. Control (non treatment)	0.3 b
2. Burning	10.58 a
3. Grazing	1.74 b
4. Rolling	0.62 b

Values followed by different letters differ significantly ($P < 0.001$).

Burning the old kunai gave the best establishment of stylo and the differences were highly significant over other treatments. Heavy grazing also improved establishment compared to the rolling and control treatments but the differences were not significant.

Experiment 4—Effect of discing and rolling alone or in combination on stylo establishment in the kunai pasture.

Although burning old kunai (experiment 3) had given significantly better establishment of stylo, the establishment in general appeared to be poor for the seeding rate of 6 kg ha^{-1}. A further trial therefore was conducted on a burnt kunai stand where light discing and rolling with ring rollers alone or in combination were imposed respectively before and after broadcasting stylo seed by hand. These treatments were replicated four times in a factorial design with a plot size of 16 × 33 m. Inoculated stylo seed was broadcast by hand at a seeding rate of 6 kg ha^{-1}. Plant population for both stylo and kunai was assessed two months after planting. Effect of these treatments was also observed on the number of nodules in stylo. The results are presented in Table 4.

TABLE 4

Effect of discing and rolling alone or in combination on plant density (m^{-2}) of stylo and kunai and nodules per plant in stylo.

Treatments		No Discing		Discing		Mean	
		Plant Number	Nodule Number	Plant Number	Nodule Number	Plant Number	Nodule Number
No rolling	Stylo	8.6	16.9	26.0	21.7	17.3	19.5
	Kunai	54.0		50.0		52.0	
Rolling	Stylo	26.1	22.1	42.1	24.6	34.1**	23.2
	Kunai	48.0		60.0		54.0	
Mean	Stylo	17.3	19.3	34.0**	23.4		
	Kunai	51.0		55.0			

**Main effect significant $P < 0.01$.

Both discing and rolling improved stylo establishment and this was further increased when the two treatments were applied in combination but the interaction was not significant. Kunai plant density was not affected by either discing or rolling treatments. Number of nodules in stylo appeared to have been positively influenced by both treatments although differences were not significant.

Dry matter and animal production from kunai pasture

It has been confirmed in the previous experiments (3 and 4) that stylo can be easily established in kunai pastures. In order to find out the effect of stylo on yield of dry matter and animal production the following experiments were conducted.

Experiment 5—Effect of oversowing stylo on dry matter yield and botanical composition of kunai pasture.

The stand from experiment 4 described above was used for this purpose. Four harvests were taken over a period of 42 weeks and the results are presented in Table 5.

Discing had a significant positive effect on the dry matter yield of stylo and rolling had a negative effect on yield of kunai. Stylo contributed about 38 per cent of

TABLE 5

Dry matter yield of kunai and stylo (kg ha^{-1}) from a pasture oversown with stylo.

Treatments	Kunai grass	Stylo	Total
1. No rolling—no discing	7340	3840(34) a	11180
2. Discing alone	8022	5085(39) b	13107
3. Rolling alone	6517	3873(37) a	10390
4. Rolling and discing	7717 NS	5170(40) b	12887
Mean	7399	4492	11891

Values followed by different letters differ significantly ($P < 0.01$).
Figures in parentheses indicate percentage of stylo.

the average dry matter yield of 11890 kg ha^{-1} and this was equivalent to the yield of plots fertilized with nitrogen at 240 kg ha^{1-} in experiment 2. Although kunai growth at harvest was coarse due to longer harvesting interval and expected to be low in protein content, this would be compensated for by the high nitrogen content of stylo.

Experiment 6—Effect of oversowing stylo in kunai pasture on animal production.

An unreplicated grazing trial was conducted for two years on kunai with and without stylo with a common stocking rate and two systems of rotational grazing. A fairly uniform stand of kunai was selected and four paddocks each of 3.48 ha were fenced. Two of these paddocks were burnt in January 1973 and inoculated seed of Schofield stylo was oversown in February at the rate of 6 kg ha^{-1} and a satisfactory stand of stylo was obtained.

Kunai grass was lightly slashed twice at later dates to avoid smothering of stylo by kunai. Before commencing grazing one paddock of pure kunai and one of kunai and stylo were sub-divided into two blocks and were grazed for four weeks followed by a rest period of four weeks. The other two paddocks were each divided into four blocks to graze the animals for two weeks with a rest period of six weeks.

Grazing commenced in January 1974 with a common stocking rate of a beast to 1.2 ha but it was increased to a beast to 0.8 ha after three months, as the pastures appeared to be under-grazed. Cross bred Brahman heifers with an average live weight of 210 kg were used. The first lot of animals was replaced in October 1974 with new ones which remained until the termination of the trial in December 1975. The animals were weighed every four weeks after an overnight fast. Yield estimates for dry matter on offer were made on eight occasions over the two year period by harvesting 20 quadrats (50 × 50 cm) from each sub-block. The first three harvests included both dry and green kunai but weight of dry kunai was not included in later estimates as it was not eaten by the animals.

Pure kunai blocks were invaded by volunteer legumes Siratro (*Macroptilium atropurpureum*) and *calopo* (*Calopogonium mucunoides*) and the grass *Dichanthium sericeum*. One block was so seriously invaded by *Dichanthium* that it was replaced with a new block in the second year. *Dichanthium* and the legumes provided good quality feed and must have affected the weight gains in these treatments. The first year was wetter than the second year which had an adverse effect on pasture growth. No fertilizer was applied and growth of stylo appeared to be less vigorous in the second year. As there was little difference between the two grazing systems the results were combined.

The results are presented in Table 6 and in Figures 1 and 2 and should be interpreted with caution as they are from an unreplicated trial.

Available dry matter. Available dry matter yields and botanical composition are presented in Figure 1. Mean dry matter yield with and without stylo was about 3380 and 2478 kg ha^{-1} respectively and mean percentage of stylo was about 33 per cent.

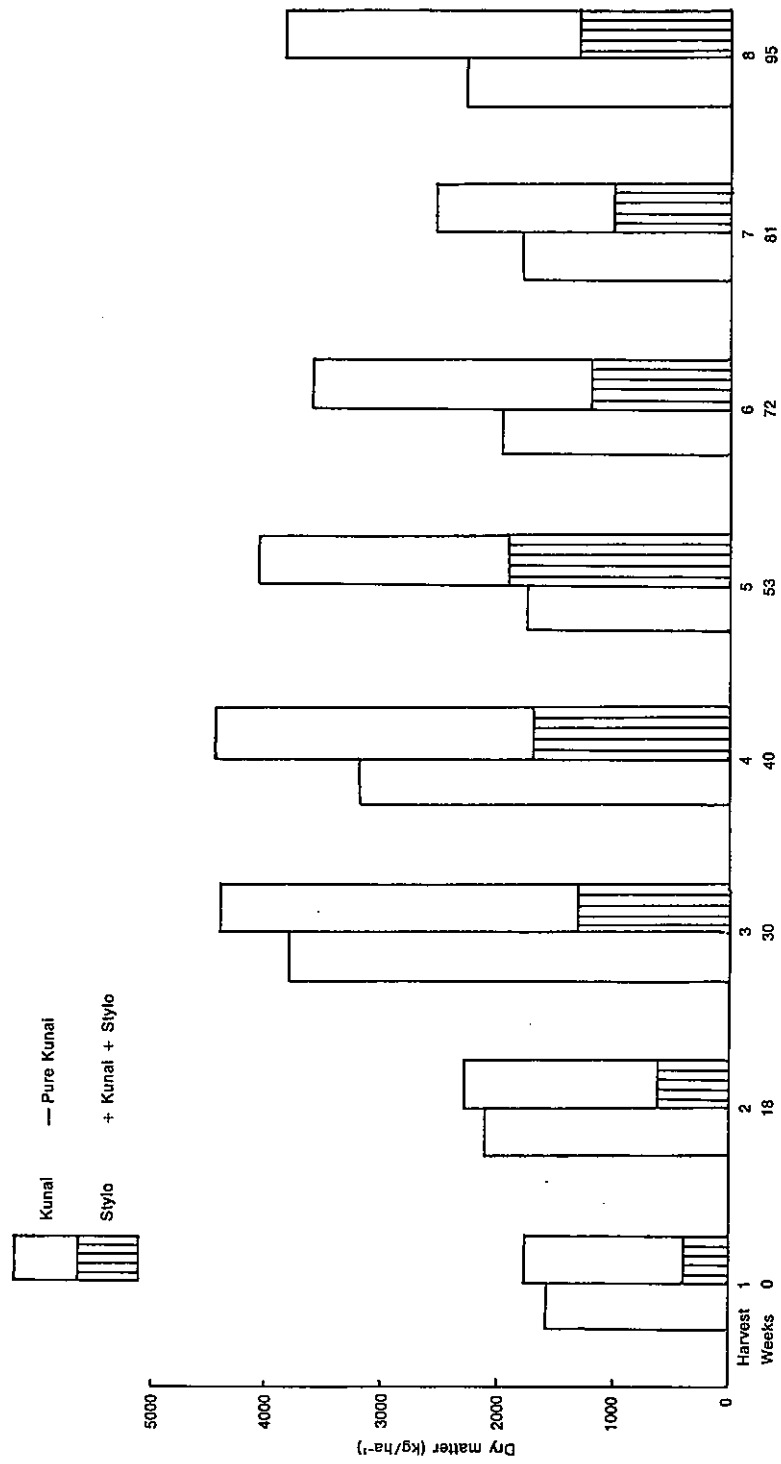

FIGURE 1
Dry matter on offer in pure kunai and kunai + stylo pastures over a period of two years.

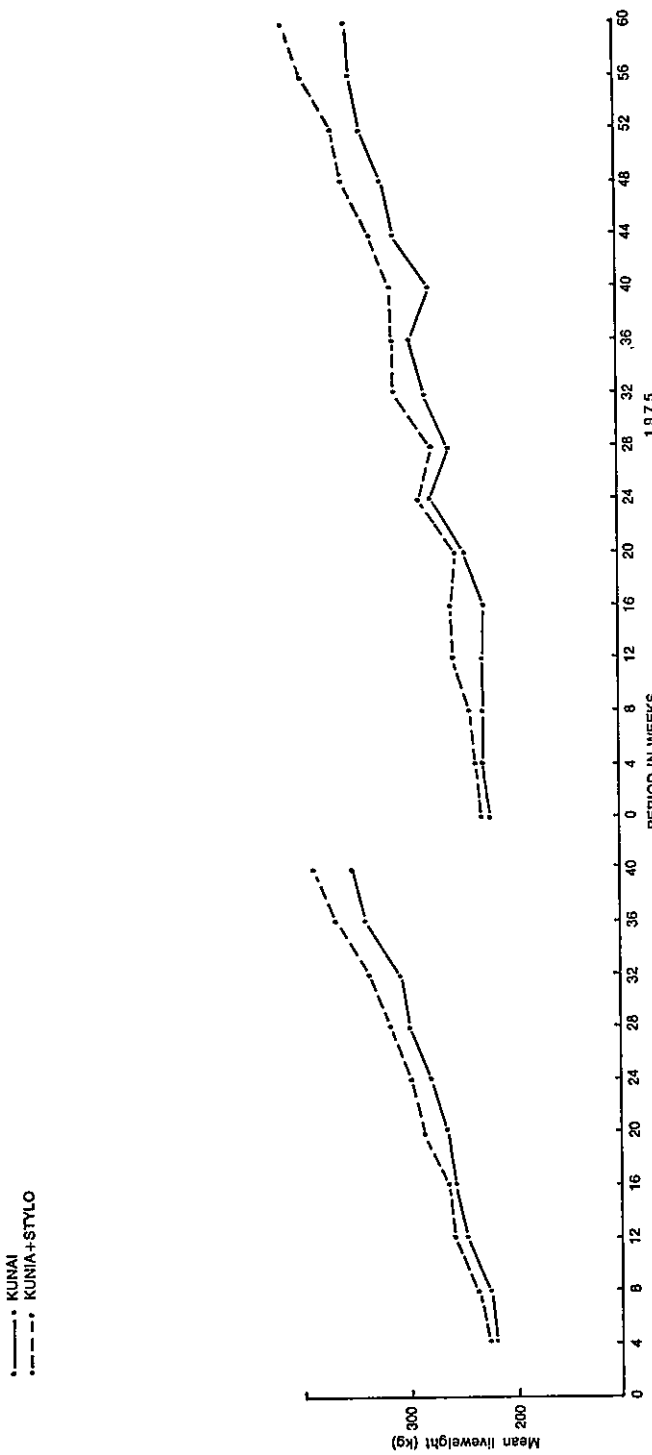

FIGURE 2
Mean liveweight changes (kg head^{-1}) on pure kunai and kunai + stylo pastures.

Yield of kunai increased up to 40 weeks and then showed a gradual decline until 95 weeks. The variation in dry matter yield was mainly due to variation in rainfall which was lower in the second year of the trial. Invasion of pure kunai by *Dichanthium*, Siratro and *Calopogonium* ranged between 5–15 per cent of the dry matter on various occasions.

TABLE 6

Average liveweight gains with and without stylo in kunai pasture in 1974 *and* 1975.

Pasture type	Live weight gains (kg)					
	Per head day^{-1}		Total head^{-1}		Total ha^{-1}	
	1974*	1975**	1974*	1975**	1974*	1975**
Pure kunai	0.23	0.15	63	63	78	78
Kunai and stylo	0.29	0.22	81	90	101	112

*1974—over ten months period.
**1975—over fourteen months period.

Animal production. Mean live weight changes and cumulative weight gains are presented in Figure 2 and Table 6 respectively. The results in Figure 2 indicate higher live weight gains in kunai with stylo as compared to pure kunai. Average daily weight gains per head over a period of two years were 0.25 kg and 0.19 kg with and without stylo respectively. Although weight gains were generally low, comparatively higher daily weight gains were obtained in the first year than in the second year (Table 6). Improvement in weight gains as a result of including stylo in kunai pasture were 45 kg head^{-1} or 56 kg ha^{-1} over a two year period in the two grazing systems. Differences between the two systems of rotational grazing were very small but grazing for four weeks with a rest period of four weeks was slightly better than grazing for two weeks with a rest period of six weeks.

DISCUSSION

The results from these trials confirm the poor quality of kunai pastures as has also been reported elsewhere (Lim 1968, Sen and Ray 1971) and application of fertilizer nitrogen showed little improvement. However substantial improvement in kunai pasture seemed possible by establishing a suitable legume as has been reported with other native pastures (Stobbs 1969, Hagger *et al.* 1971).

The advantage of burning the old growth of kunai before broadcasting stylo appeared to be twofold. It allows the broadcast seed to reach the soil surface, ensures better penetration of rain and the ash acts as a receptacle for the broadcast seed (Graham 1968, Granier *et al.* 1972). A very significant improvement in stylo establishment was also obtained by either discing before or rolling the soil after broadcasting the seed. The advantage of discing is to loosen the soil to reduce competition and for better placement of the seed (Stonnard and Bisset 1970) and that of rolling is to press and bring the seed in contact with the soil. Tothill (1970) reported that rolling the seed was beneficial especially when soil moisture was not favourable.

There was quite a high proportion of stylo and this increased the total dry matter yield of kunai pasture almost equivalent to that of 240 kg N ha^{-1} yr^{-1} which is a very significant gain. Inclusion of legumes in natural pastures in order to increase animal production has been well established in many African countries (Stobbs 1966, Hagger *et al.* 1971) and the present trial confirms the suitability of stylo in kunai pastures.

Although comparatively small increases in annual live weight gains (22 kg hd^{-1} or 28 kg ha^{-1}) due to stylo were recorded, these results confirm the advantage of

establishing stylo in kunai pasture for increased animal production. The lower response in presence of stylo appeared to be due to two main reasons. Firstly, due to the presence of the volunteer grass *Dichanthium* and the legumes Siratro and *Calopogonium* which were selectively grazed in "pure" kunai pastures, and, secondly, because of using a common stocking rate, although available dry matter was far higher in the presence of stylo. Thus a further increase in live weight gain per ha could be expected by increasing the stocking rate according to available dry matter. Although the weight gains in the present trial are low they are comparable with those of Hagger *et al.* (1971) who obtained an increase of only 14 kg ha^{-1} yr^{-1} as a result of including stylo in savannah grasslands in Nigeria at the low stocking rate of a beast to 2.2 ha^{-1}. Stobbs (1969), however, reported very high live weight gains (279 kg ha^{-1} yr^{-1}) from an unfertilized natural pasture sown with stylo in Uganda but his stocking rate was adjusted to available dry matter. The third possible reason is that in the second year stylo growth was poor in the absence of any fertilization although responses to phosphorus were obtained in another trial under similar conditions. Stobbs (1969) has emphasized the need for adequate fertilization for the legume to function efficiently. The low gains per animal are indicative of a low intake of digestible nutrients. This may have been caused by low digestibility of the feed or by a mineral deficiency such as phosphorus or cobalt. These aspects were not considered and should be investigated in future experiments in the Markham Valley.

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