

STUDIES ON THE PIONEER CROPPING OF DRY PATANA GRASSLAND IN THE UP COUNTRY OF SRI LANKA¹

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ABSTRACT

In view of the great potentialities of the dry patana grasslands, particularly the gently sloping areas, for food production based on improved pasture management, the replacement of the unproductive and poor quality native pasture with improved pasture following a soil fertility rebuilding pioneer cropping phase is imperative. In this context, an experiment was carried out over a period of 3 consecutive years, on virgin dry patana land to assess the performance of different pioneer crop combinations. The assessment was made in terms of direct economic returns during the pioneer cropping phase and in terms of dry matter and digestible organic matter production of the subsequently established *Paspalum dilatatum* (Poir.). The results of this experiment confirmed the possibility of obtaining direct economic returns from maize (*Zea mays* L.), horse gram (*Dolichos biflorus* (L.), kurakkan (*Eleusine coracana* (L.), and lemon grass (*Cymbopogon citratus*) crops. During the pioneer cropping phase (maha 1975/76 and yala 1976), highest gross economic returns were obtained from maize-horse gram combination and the lowest returns were recorded from lemon grass. Grain sorghum (*Sorghum vulgare* Pers.) did not produce grains during maha 1975/76 season. The benefits of pioneer cropping the land to increase the productivity of the subsequently established improved pasture were also realised.

KEY WORDS: Grassland, Patanas, Pioneer cropping.

INTRODUCTION

The dry patana grasslands which form the submontane grasslands of Sri Lanka (Perera, 1967), are distributed in the hill country intermediate zone, and occupy a total area of approximately 64,777 ha (de Rosayro, 1964 a). These lands are situated between the altitudinal limits of 610 m and 1,372 m (Pearson, 1899). The largest expanse of dry patanas occurs in the Uva basin, but small isolated areas are also found in the Western basin (de Rosayro, 1945; Holmes, 1951). These lands consist of gently rolling

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lands, steep slopes and all gradations of slopes between. It has been reported that the gently sloping lands (16,000 ha) have a great potential for food production (Appadurai, 1976) after replacing the unproductive and low quality native pastures with improved pastures.

The major constraint for developing these lands for improved pasture production is that the soil is shallow in depth and low in fertility. The organic matter status of the soil is extremely low as compared with the soil under the adjoining forest cover (Joachim and Kandiah, 1942; Moormann and Panabokke, 1961). This is due to the unique topographical nature and high rainfall intensities during the monsoonal periods (de Rosayro, 1945, 1946 a, 1946 b).

It has been successfully demonstrated in other countries that the native unproductive pastures could be replaced with fertilizer responsive spring sown pasture after growing pioneer crops like rape or kale (Burr, 1951) and where the native soils are extremely low in organic matter, re-seeding with improved pastures could be done after growing a perennial or even an annual soil fertility rebuilding legume pioneer crop (Tuley, 1968). Attempts were also made in Sri Lanka to replace the unproductive dry patana native grasses with improved fertilizer responsive grasses. This was effected by the interpolation of a brief fertility rebuilding pioneer cropping phase using different varieties of fodder sorghum, over a period of one year, between the ploughing-up of the native grasses and the establishment of superior pastures and fodder species (Sivasubramaniam, 1971). However, the performance of pioneer crops that could yield direct economic returns was not evaluated in these lands.

In view of the great potentialities of the hitherto neglected dry patana grasslands for food production and the likely importance of a pioneer crop phase in securing a rapid improvement in soil properties and thereby the successful establishment of the improved pastures, a 3-year research programme was conducted at Bindunuwewa. In this research programme, the assessment of the direct economic returns that could be realized from some of the pioneer crops tested during the pioneer cropping phase and the productivity and quality of the subsequently established improved pasture was made and reported in this paper.

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MATERIALS AND METHODS

Experimental site

The investigation was conducted on gently sloping virgin dry patana land with typical native short grass vegetation at Bindunuwewa, during the period 1975 to 1978, for six consecutive growing seasons. The altitude of the location is 1,220m with an average annual rainfall of 1617mm of which approximately 980mm is distributed in the wet months October through January (maha season) and March through April (yala season) and the remaining is distributed during the rest of the months. The soil of the experimental site had the following characteristics: depth of A-horizon, 20—25cm; soil type, clay loam; colour, brown; pH, 5.4—5.5; electrical conductivity (EC), 0.02 dS/m; organic matter content, 5.2%; total nitrogen, 0.20%; available P_2O_5 , 2.25 kg/ha; exchangeable K, 0.06 me/100g soil.

Pioneer cropping

The pioneer cropping study commenced in maha 1975/76 and concluded at the end of yala, 1976. The treatments consisted of 6 pioneer crop combinations and control. The different pioneer cropping treatments before the establishment of the improved pasture in maha 1976/77 are detailed below:

- T_1 = Grain sorghum (var. IS 2941) in maha 1975/76 followed by sunnhemp in yala 1976.
- T_2 = Maize (var. Thai Composite) in maha 1975/76 followed by kurakkan (var. local) in yala 1976.
- T_3 = Maize (var. Thai Composite) in maha 1975/76 followed by horse gram (var. local) in yala 1976.
- T_4 = Lemon grass (var. OD 19) in maha 1975/76 and yala 1976.
- T_5 = Grain sorghum (var. IS 2941) in maha 1975/76 followed by kurakkan (var. local) in yala 1976.
- T_6 = Grain sorghum (var. IS 2941) in maha 1975/76 followed by horse gram (var. local) in yala 1976.
- T_7 = Pasture establishment without pioneer cropping (control) with fertilizer application three months prior to pasture establishment.

The experiment was laid out in a randomized complete block design with 3 replications. The plot size was 10m × 10m.

Pioneer crop production

With the rains in September 1975, the land was prepared and the maha 1975/76 pioneer crops were established at the beginning of the season. Muriate of potash and urea at the rate of 100 kg/ha each were applied as basal fertilizers one week prior to planting. Subsequently, urea at 100 kg/ha was applied as a top dressing 2 months after planting. Final grain yield of maize was recorded in March 1976. At the commencement of yala 1976 the plots which carried the maha 1975/76 pioneer crops were ploughed and the yala 1976 pioneer crops were planted. No fertilizers were applied during the yala season. In June 1976, sunnhemp (*Crotalaria juncea*) yield was measured and ploughed back into the soil. The horse gram and kurakkan were harvested in July 1976 and August 1976, respectively. In early August 1976 lemon grass which was carried through yala 1976 was harvested at a height of 25 cm and fresh grass yields were recorded in the field. Final grain yields of maize, horse gram and kurakkan, and fresh sunnhemp and lemon grass yields were recorded using an effective area of 64 m². Grain yields were determined by drying the grains to a constant weight and correcting to 14% moisture content. Sub-samples of fresh lemon grass (500g) were used for oil extraction by water—steam distillation method.

Improved pasture production

The pasture evaluation study commenced in maha 1976/77 and concluded at the end of yala 1978. In mid-August 1976, all plots including the control were ploughed and were incorporated with 1.0 t/ha of dolomite and 0.5 t/ha of rock phosphate. One week prior to planting, 50 kg/ha of urea and 100 kg/ha of muriate of potash were applied. In early October 1976, the entire experiment was uniformly planted with rooted cuttings of *Paspalum dilatatum* (Poir.) at a spacing of 25 cm between 10 cm within rows. Eight weeks after the first application, urea at 50 kg/ha was applied, and in July 1977, again urea (25 kg/ha) was given. Two harvests were taken, one in mid-January 1977 and the other in mid-March 1977. With the onset of the yala rains, urea was applied at 50 kg/ha and the third harvest was recorded in June 1977. At the beginning of maha 1977/78 grass in all plots was cut at 5 cm height and a mixture of rock phosphate (0.5 t/ha) and muriate of potash (0.25 t/ha) was applied. Two weeks later, urea at 75 kg/ha was also applied. A second application of 75 kg/ha urea was made in mid-November 1977 and the third application of 25 kg/ha urea was given in

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mid-December 1977. With the commencement of yala 1978 rains in March 1978, urea was applied at 50 kg/ha followed by another application (25 kg/ha urea) in mid-May 1978.

Three harvests during maha 1977/78 and two harvests during yala 1978 were taken. Soon after each sampling, the entire experimental plot was clipped uniformly similar to the sampling quadrat. At each sampling, the fresh grass yield was measured using 1m² quadrat. Dry matter determination was made by drying the entire herbage in an oven at 96°C for 24 hr. Digestibility was determined by *in vitro* technique (Tilley and Terry, 1963).

RESULTS AND DISCUSSION

Direct economic returns during maha 1975/76 pioneer cropping phase

Substantial economic returns were obtained from maize crop tested during maha 1975/76 and no economic returns were obtained from lemon grass and sorghum during the same season (Table 1). Although grain yield from maize was low compared with the yield generally obtained from the adjoining fertile low-lying tracts, the production level achieved from the dry patana sloping terrain was satisfactory considering the poor fertility status of this soil. The grain sorghum that was tested failed to produce grains possibly due to the low temperatures that prevailed during the latter part of maha 1975/76 season (January, 1976) at this high altitude. Plucknett *et al.* (1970) in their work reported similar behaviour of sorghum growing at high altitude with low temperatures. The failure of grain sorghum may also be attributed to the moisture stress that prevailed in the same period during which panicle initiation was observed. Hultquist (1973) found that moisture stress in sorghum at about 10—14 days after panicle initiation or near the start of peduncle elongation, killed completely the developing florets.

Direct economic returns during yala 1976 pioneer cropping phase

Returns in the form of grains, seeds and essential oil and green manure were obtained from pioneer crops tested during yala 1976 (Table 2). All crops tested during yala 1976 performed satisfactorily and this could be attributed to the adaptability of these crops to the dry patana agro-ecological conditions since these are extensively cultivated in this area during the yala season. In yala 1976, the yields from horse gram and kurakkan which followed maize were 55% and 80%, respectively, greater than that obtained

from the same crops which followed sorghum. This difference occurred in spite of not applying fertilizers during yala 1976. One possible reason could be the higher nutrient contribution of the crop residue produced by maize compared to sorghum (which itself grew poorly), which was ploughed into the land after the maha 1975/76 crop.

The contribution by the lemon grass in terms of oil yield was not significant due to the limited growth period. Lemon grass being a perennial grass, its full effect in terms of economic returns and soil improvement capacity could not be realised within the short period of one year. Sunnhemp crop did not give any direct return, instead it added approximately 3,608 kg/ha of green manure to the soil and its contribution in terms of direct cash value was nil.

Total direct economic returns from the two pioneer cropping phases

The total gross returns during the two pioneer cropping seasons viz. maha 1975/76 and yala 1976, from different pioneer crop combinations, are detailed in Table 3. The gross economic returns reached a maximum in maize-horse gram crop combination while maize-kurakkan and sorghum-horse gram combinations gave almost the same gross returns which were nearly half of the maximum returns obtained and about 4 times greater than that obtained from sorghum-kurakkan combination. Lowest economic gross returns were recorded from sorghum-kurakkan combination. No direct economic returns were obtained from sorghum-sunnhemp combination; instead the sunnhemp enriched the soil with green manure.

Pasture herbage dry matter production

The dry matter productivity of the improved pasture during the year of establishment (1st year) and second year is presented in Table 4. During the year of establishment, the mean dry matter production from *Paspalum dilatatum* (Poir.) was increased by 148% when pioneer cropping technique was practised as against the control. This trend is in general agreement with the findings of Burr (1951), Tuley (1968) and Sivasubramaniam (1971). Pasture dry matter yield during the 2nd year was increased by 204% when pioneer cropping technique was as compared imposed with the control. The mean pasture dry matter yield, during the second year was approximately 27% greater than that of the mean first year yield. This increment may be attributed to the increased nitrogen application during the 2nd year (250 vs 175 kg urea/ha).

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Pasture herbage digestible organic matter production

The mean yield of pasture herbage digestible organic matter during the second year was 23% greater than the first year (Table 5). This increase may be attributed to the increase in dry matter production due to increased nitrogen application (Ashford and Troelsen, 1965) during the second year. Increased nitrogen application had no general trend on the per cent digestible organic matter and this is in general agreement with the findings of Minson *et al.* (1960) and Chestnutt *et al.* (1977).

CONCLUSIONS

Among the pioneer crop combinations tested, maize-horse gram and maize-kurakkan combinations could generate first and second highest direct economic returns, respectively, during the pioneer cropping phase indicating the suitability of dry patana agro-climatic conditions for these crops. Further, direct economic returns from grain sorghum could not be obtained during maha 1975/76 season due to its inability to produce grains at low temperatures. This study had also revealed the advantage of pioneer cropping of these lands before the establishment of the improved pasture for high herbage dry matter production.

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Table 1. Economic returns from pioneer crops during maha 1975/76

Pioneer crops	Yield (kg/ha)	Price/Unit (Rs)	Gross returns/ha (Rs)
T ₁ Sorghum	—	—	—
T ₂ Maize	1,212	4*	4850
T ₃ Maize	1,167	4*	4668
T ₄ Lemon grass	—	—	—
T ₅ Sorghum	—	—	—
T ₆ Sorghum	—	—	—
T ₇ No pioneer crop (control)	—	—	—

*Farm gate price in the Badulla district, 1988

Table 2. Economic returns from pioneer crops during yala 1976

Pioneer crop	Yield (kg / ha)	Price / Unit (Rs)	Gross returns / ha (Rs)
T ₁ Sunnhemp	—	—	—
T ₂ Kurakkan (grain)	884	4†	3537
T ₃ Horse gram (seed)	1,148	10†	11484
T ₄ Lemon grass (oil)	8	385*	3245
T ₅ Kurakkan (grain)	492	4†	1968
T ₆ Horse gram (seed)	742	10†	7421
T ₇ No pioneer crop (control)	—	—	—

† Farm gate price in the Badulla district, 1988

* Ceylon Chamber of Commerce, 1988

Table 3. Total economic gross returns from the pioneer crops over the two seasons (maha 75/76 and yala 1976)

Pioneer crop combination		Gross returns/ha (Rs)
maha 1975/76	yala 1976	
T ₁ Sorghum*	Sunnhemp	—
T ₂ Maize	Kurakkan	8387
T ₃ Maize	Horse gram	16153
T ₄ Lemon grass	Lemon grass	3245
T ₅ Sorghum*	Kurakkan	1968
T ₆ Sorghum*	Horse gram	7421
T ₇ Control	—	—

*No yield from sorghum

Table 4. Effect of different pioneer crop combination on pasture dry matter (DM) production during 1st and 2nd years (kg/ha)

<i>Treatment</i>	<i>1st Year</i>	<i>2nd Year</i>
T ₁	3,251	4,502
T ₂	2,525	4,276
T ₃	3,230	3,095
T ₄	3,119	4,102
T ₅	3,346	4,148
T ₆	2,931	3,505
T ₇	1,236	1,293
LSD (P=0.05)	770	1,401

Table 5. Effect of different pioneer crop combinations on the digestible organic matter (DOM) productivity during the 1st and 2nd years

<i>Treatment</i>	<i>1st Year</i>		<i>2nd Year</i>	
	<i>DOM (%DM)</i>	<i>DOM (kg/ha)</i>	<i>DOM (%DM)</i>	<i>DOM (kg/ha)</i>
T ₁	55.5	1,804	54.9	2,472
T ₂	54.8	1,383	50.3	2,150
T ₃	58.1	1,876	57.1	1,771
T ₄	57.5	1,793	56.7	2,325
T ₅	55.3	1,850	56.2	2,331
T ₆	54.3	1,591	51.0	1,787
T ₇	54.4	672	54.4	703
LSD (P=0.05)	ns	431	ns	761

ns=not significant