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CONTENTS

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THE JOURNAL OF THE
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THE JOURNAL OF THE NATIONAL AGRICULTURAL SOCIETY OF CEYLON

Y. D. A. SENANAYAKE

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4. *Proofs sent to authors for correction should be returned within seven days of receipt.*

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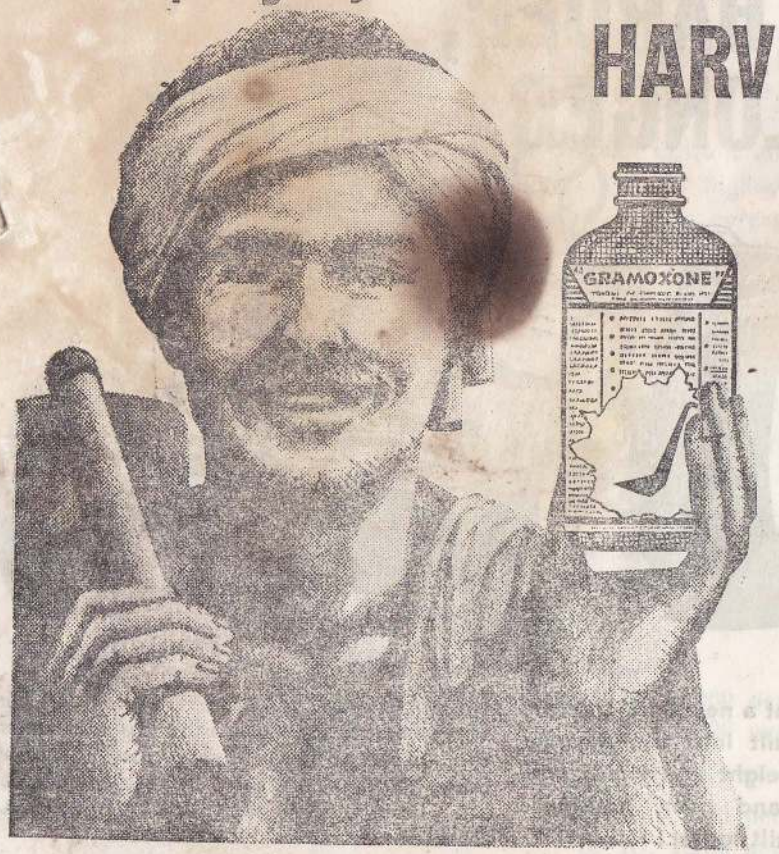

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THE EFFECT OF (2 — CHLOROETHYL) TRIMETHYL AMMONIUM CHLORIDE (CCC) AND TIME OF APPLICATION OF NITROGEN AND POTASSIUM ON THE GROWTH OF THE POTATO, VARIETY CRAIG'S ROYAL.

H. P. M. GUNASENA.

AS shown earlier (Gunasena & Harris, 1968, 1969) delaying the application of nitrogen had two negative aspects, firstly, the reduction in leaf area and hence the reduction in the tuber bulking rate in the early stages of growth and secondly, the increased proportion of total drymatter utilized for stem production compared with nitrogen applied at the time of planting. The latter effect could be successfully counteracted by spraying (2 - Chloroethyl) Trimethyl Ammonium Chloride (CCC). However early spraying leads to sub-optimal leaf area indicies for tuber production.

This paper reports an experiment designed to overcome the negative effects of (a) late nitrogen by splitting the nitrogen dressing rather than applying it at the time of tuber initiation, and (b) by delaying the time of application of CCC until leaf area index has reached a value almost near the suggested optimum for tuber production, ie. L = 3.

EXPERIMENTAL

Location and Soils

The experiment was carried out on the Reading University farm, Sonning-on-Thames in 1968. The soil was a freely drained sandy loam overlying a cinnamon brown sandy loam. The surface soil contained over 80% fine and course sand in equal proportions. The pH was 6.6. The phosphate status was moderately high and available potassium was medium. The soil type designated the Sonning Series has been described by Kay (1936).

Treatments

The nitrogen and potassium treatments consisted of a control and three times of application, ie. applied at the time of planting (early), applied at the time of tuber initiation (late), and applied both at the time of planting and tuber initiation, (split). Nitrogen and potassium were applied at a rate of 1.75 cwt. N or K_2O/acre, respectively; when split 0.75 cwt. N or K_2O/acre was applied at the time of planting and the remainder was applied at the time of tuber initiation. All treatments received a basal dressing of phosphorus at the rate 1.25 cwt. P^2O^5/acre at the time of planting.

Early dressings of fertilizer were rotavated in on the 16th March and the late nutrient dressings were top dressed on 11th May.

CCC was applied to the foliage as an aqueous solution at a concentration of 4 g. /litre (96.6 gl. / acre, 3.9 lb. /acre) on 11th June. Nitrogen and potassium treatments were combined factorially with and without CCC when the leaf area index was approximately 3.

Design, management and sampling procedures.

All treatment combinations were arranged in randomized blocks, replicated three times. The layout of the experiment was in essence similar to those reported earlier (Gunasena and Harris, 1968). Sampling procedures were also similar to those described earlier except that sampling was carried out from a predetermined end of a block. Only four plants per plot were sampled at each harvest except at the final harvest when eight plants per plot were harvested. The final sampling area constituted 1/2332 acres. The spacing adopted was 24 × 14 inches.

Chitted seed of the second early variety Craig's Royal was planted on 19/20th March.

Climate

Climatic data is given in Table 1. In general the weather conditions were satisfactory for plant growth throughout the whole growing season. The early part of the growing season was wet and the estimated drainage (calculated after the method of Stanhill, 1958 unpublished data) during the first two months after planting exceeded 2 inches.

TABLE 1. *Climatic data.*

Period	Rainfall (in)	Soil moisture (in)	Accumulated drainage (in)	Temperature (°F) Max	Min.	Soil 4"
14–27 March	0.49	0.22	–	52.2	28.9	42.7
28–10 April	0.27	0.39	–	53.2	32.1	43.0
11–24 „	1.07	0.26	0.33	58.5	37.5	46.4
25– 8 May	2.55	0.08	1.35	58.8	39.5	49.2
9 –22 „	1.14	0.10	0.33	55.8	42.2	49.8
23– 5 June	1.40	0.76	–	67.0	45.3	56.9
6 –19 „	0.10	1.58	–	70.1	50.2	60.9
20– 3 July	1.63	2.42	–	70.0	53.6	60.7
4 –17 „	2.72	2.30	–	67.1	46.9	60.4
18–31 „	1.42	2.17	–	68.3	51.6	61.0
1 –14 Aug.	1.59	1.13	–	65.7	52.8	59.9
15–28 „	1.05	0.79	–	70.0	52.5	59.1
29–11 Sept.	1.29	0.65	–	66.6	49.6	59.7

RESULTS

All results have been subjected to a detailed analysis of variance. The least significant differences refer to a probability level of 0.05. In figures these are represented by vertical straight lines.

Tuber data

The main effect of treatments on tuber fresh weight yield is given in Table 2. There was a marked response to nitrogen and all treatments receiveing none or moderate rates of nitrogen in the seedbed recorded higher tuber yields at the 2nd harvest compared with early applied nitrogen. Although late nitrogen gave higher tuber yields initially, yield was depressed by 21% and 11% at the 3rd and 4th harvests (P = 0.01), respectively. After the 5th harvest tuber growth was rapid with this treatment and at the final harvest yield was increased by 22% (P = 0.01) compared with early applied nitrogen. Split nitrogen seemed to take advantage of the

initial gain in tuber fresh weight and had a slight positive effect on yield through-out the entire growing season compared with early nitrogen. Similar to that of late nitrogen split nitrogen increased yield by 22% at the final harvest (P = 0.01).

TABLE 2. *The main effect of treatments on tuber fresh weight yield, (tons/acre).*

Treatments	Sample harvests						
	S_2	S_3	S_4	S_5	S_6	S_7	S_8
No N	.54	4.49	7.94	10.64	14.17	15.88	15.28
Late N	.45	4.50	9.75	17.85	23.04	29.08	33.00
Split N	.48	5.89	10.92	18.05	24.46	30.29	32.67
No K	.28	5.64	10.48	16.71	21.07	24.67	24.80
Late K	.32	6.05	11.32	18.95	21.63	25.60	28.28
Split K	.39	6.19	11.48	19.80	27.12	28.11	30.70
Early N/K	.30	5.73	10.92	18.04	22.16	25.82	27.00
LSD (P = 0.05)	N.S.	1.10	1.60	1.88	3.12	1.21	2.78
No CCC	–	–	11.04	17.15	22.31	25.87	27.47
CCC treated	–	–	9.76	17.14	21.60	25.40	27.31
LSD (P = 0.05)	–	–	.856	N.S.	N.S.	N.S.	N.S.
C. V. (%)	48.0	17.2	12.8	9.2	12.1	7.4	8.6

The response to potassium was less pronounced than the response to nitrogen and at the final harvest early potassium increased yield by 9% over the control. Tuber growth improved with late and split potassium up to the 5th harvest compared with early potassium but in the subsequent harvests only split potassium had a slight positive effect on tuber yield.

CCC reduced yield by 12% at the 4th harvest, after this harvest did not significantly effect tuber fresh weight yield.

Mean tuber bulking rates were calculated over a period of 10 weeks from the commencement of tuber growth (Table 3). The tuber fresh weight yields were closely correleted with bulking rate, the only exception being that of late nitrogen with which treatment due to prolonged growth of leaves duration of bulking is also involved in determining the final yield of tubers.

TABLE 3. *The main effect of treatments on mean tuber bulking rate.*

Treatments	Tons/acre/week	r	Increase over control due to treatment (%)	
			N.	K.
No N	1.55	.99	–	–
Late N	2.96	.99	90.9	–
Split N	3.03	.99	95.5	–
No. K	2.49	.99	–	–
Late K	2.58	.99	–	3.6
Split K	2.98	.99	–	19.1
Early N/K	2.62	.99	69.0	5.2
No CCC	2.63	.99	–	–
CCC treated	2.58	.99	–	–

Dry matter accumulation and distribution.

Total dry matter accumulation progressed steadily through the entire growing season. There were no significant interactions between treatments. Split nitrogen was superior to early nitrogen at all harvests except the 5th and increased yield of dry matter by 20% at the final harvest (Fig. 1 d). Late nitrogen was inferior to that of early nitrogen up to the 5th harvest, at the final harvest this treatment was significantly better than that of early nitrogen.

The pattern of leaf and stem dry matter accumulation (Fig. 1 a & b) was similar to the effect of treatments on total dry matter accumulation and both late and split nitrogen increased leaf and stem yield after the 5th harvest compared with early nitrogen.

Split nitrogen increased tuber dry matter (Fig. 1 c) by 60% at the 2nd harvest (P = 0.01) compared with early nitrogen and was also significantly better than early nitrogen at the final harvest (P=0.01). At the 2nd harvest late nitrogen increased tuber dry matter yield by 45%, but failed to take advantage of this initial gain in tuber weight produced in the absence of nitrogen. It depressed tuber dry matter yield up to the 5th harvest compared with early nitrogen but increased tuber dry matter yield by 31% at the final harvest.

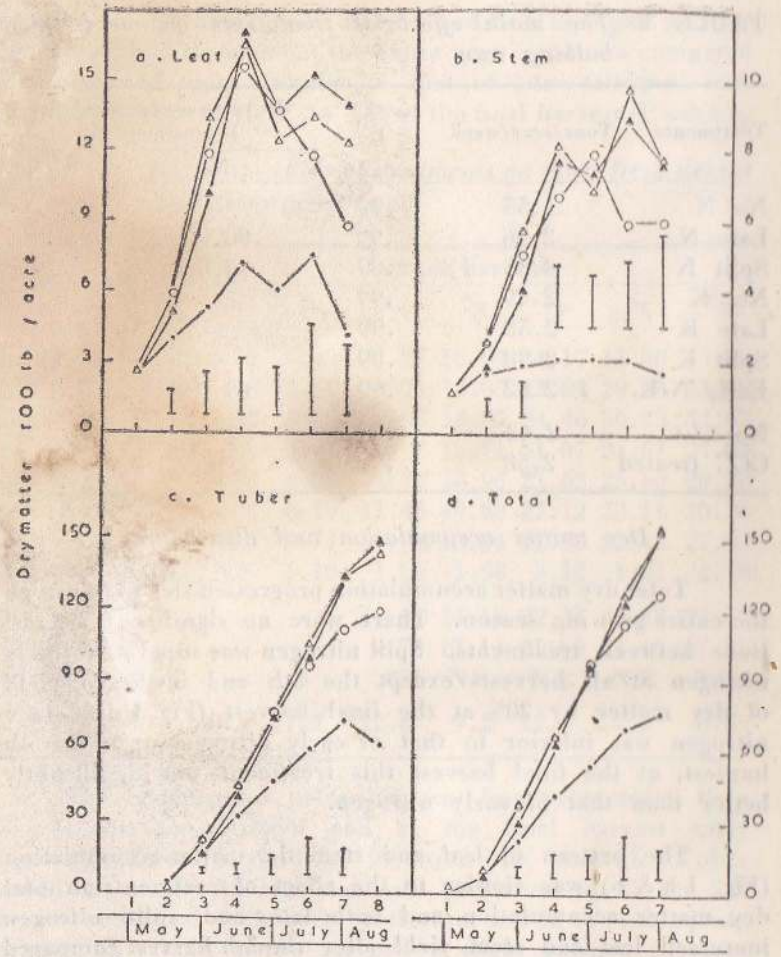

FIG. 1 MAIN EFFECTS OF NITROGEN TREATMENTS ON DRYMATTER ACCUMULATION.

• no N, ▲ Late N, △ Split N, ○ Early N.

The effect of potassium on total dry matter yield was much smaller than that of nitrogen, only split potassium increased yield by 22% (P = 0.01) at the 6th harvest compared with early potassium (Fig. 2 d).

Split potassium increased leaf and stem dry matter yield (Fig. 2a & b) at the 6th harvest and tuber dry matter yield (Fig. 2 c) at the 5th and subsequent harvests. The other potassium treatments had less effect on dry matter accumulation.

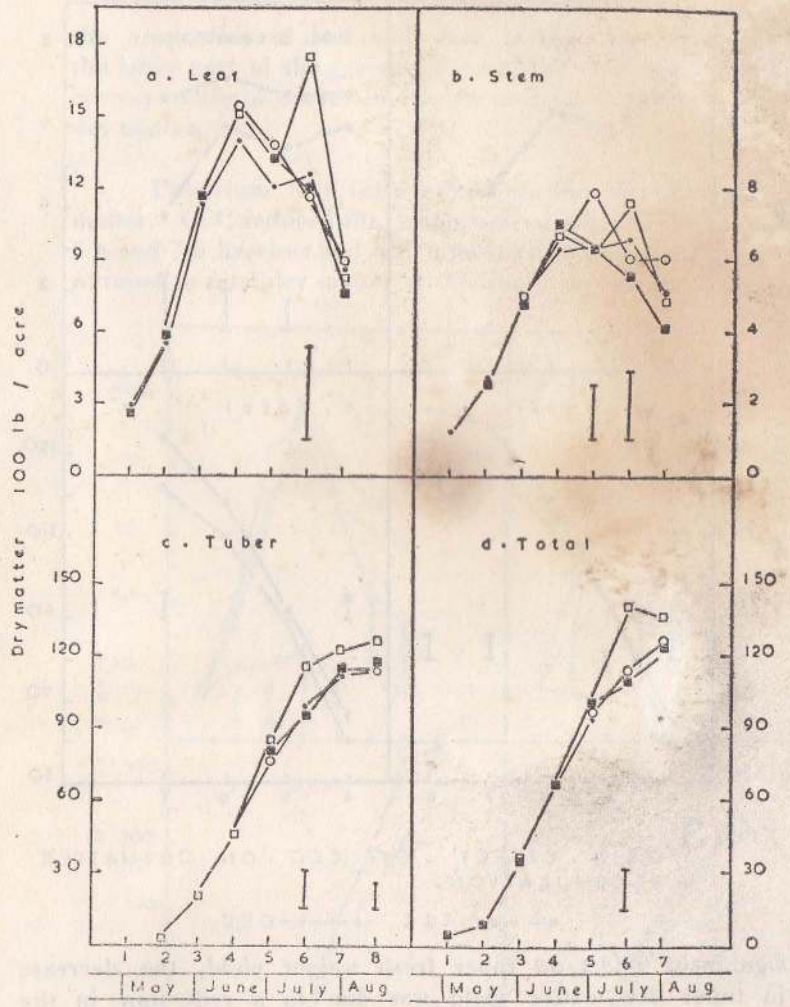

FIG. 2 MAIN EFFECT OF POTASSIUM TREATMENTS ON DRYMATTER ACCUMULATION.

• no K, ■ Late K, □ Split K, ○ Early K.

Due to an increase in the weight per unit leaf area (see Fig. 9) CCC had no significant effect on leaf dry matter yield (Fig. 3a), CCC had the greatest effect on stem dry matter yield and depressed it at the 5th, 6th and 7th harvests (Fig. 3b). CCC reduced the tuber dry matter yield at the 4th, 7th and 8th harvests (Fig. 3 c). As CCC had no

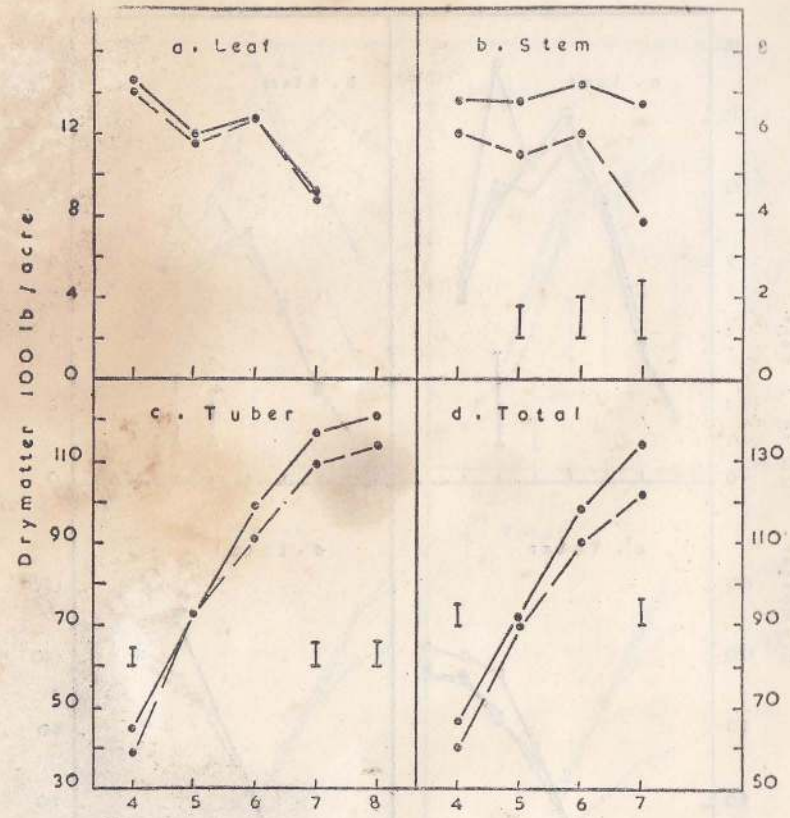

FIG. 3 MAIN EFFECT OF CCC ON DRYMATTER ACCUMULATION.

•—•+CCC, ∘—∘−CCC

significant effect on tuber fresh weight yield, the decrease in tuber dry matter yield was due to a reduction in the percentage of tuber dry matter in the sprayed crop. This could be a great disadvantage when potatoes are produced for the industry.

The distribution of dry matter into leaf, stem and tuber followed the normal pattern in potatoes described earlier (Gunasena and Harris, 1968, 1969). The dominant feature was the decrease in the proportion of leaf and stem in total dry matter and the increase in the proportion of tuber from the time of their initiation. Late and split nitrogen tended to increase

the proportion of leaf and stem in total dry matter towards the latter part of the growing season, the consequence being a corresponding decrease in the proportion of tuber in the total dry matter.

Potassium had little effect on the distribution of dry matter. CCC reduced the proportion of stem dry matter at the 5th and 7th harvests and had a positive effect on the proportion of tuber in total dry matter at the final harvest.

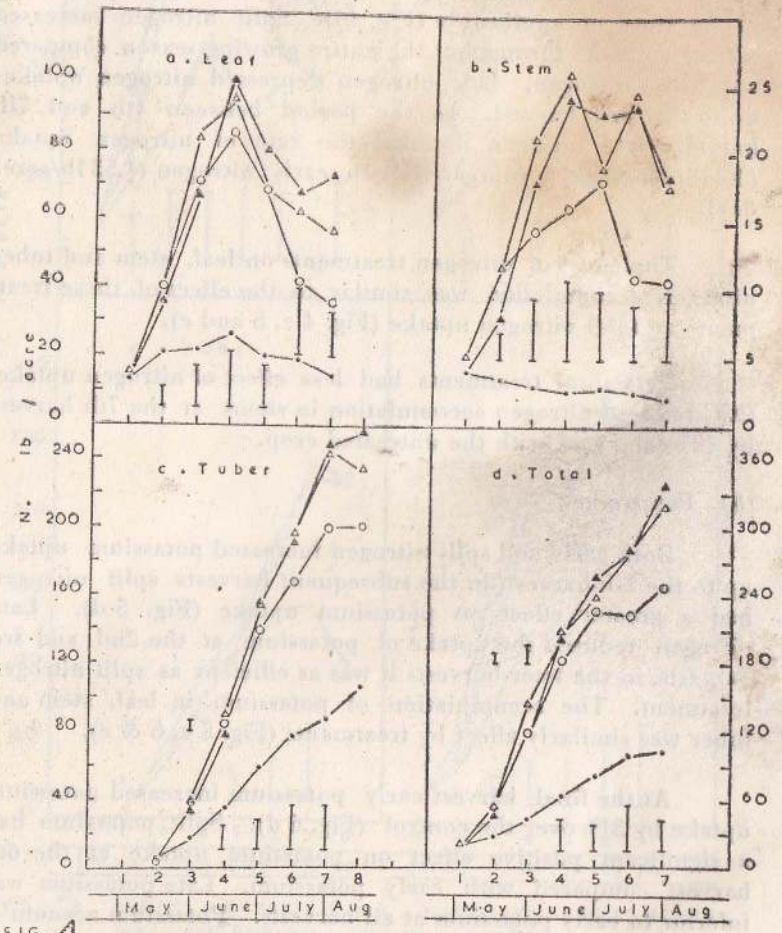

FIG. 4 MAIN EFFECT OF NITROGEN TREATMENTS ON NITROGEN ACCUMULATION.

• no N, ▲ Late N, △ Split N, ○ Early N.

The accumulation of nitrogen, potassium and phosphorus in the crop.

Nitrogen, potassium and phosphorus contents in pounds per acre were obtained from their concentration in and the dry matter yield of leaves, stems and tubers.

(a) Nitrogen

There was a good response to applied nitrogen irrespective of its time of application (Fig. 4d). Split nitrogen increased nitrogen uptake throughout the entire growing season compared with early nitrogen. Late nitrogen depressed nitrogen uptakes up to the 3rd harvest. In the period between 4th and 7th harvests late nitrogen doubled the rate of nitrogen uptake (3.25 lb/acre/day), compared with early nitrogen (1.53 lb/acre/day).

The effect of nitrogen treatments on leaf, stem and tuber nitrogen accumulation was similar to the effect of these treatments on total nitrogen uptake (Fig. 4 a, b and c).

Potassium treatments had less effect of nitrogen uptake. CCC reduced nitrogen accumulation in stems at the 7th harvest by 48% compared with the untreated crop.

(b) Potassium

Both early and split nitrogen increased potassium uptake up to the 5th harvest, in the subsequent harvests split nitrogen had a greater effect on potassium uptake (Fig. 5 d). Late nitrogen reduced the uptake of potassium at the 2nd and 3rd harvests, in the later harvests it was as efficient as split nitrogen treatment. The accumulation of potassium in leaf, stem and tuber was similarly effect by treatments (Fig. 5 a, b & c).

At the final harvest early potassium increased potassium uptake by 31% over the control (Fig. 6 d). Split potassium had a significant positive effect on potassium uptake at the 6th harvest compared with early potassium. Late potassium was inferior to early potassium at all harvests. Potassium accumulation in leaf, stem and tuber showed a similartrend to that of total potassium accumulation. (Fig. 6, b & c). CCC had no significant effect on potassium accumulation.

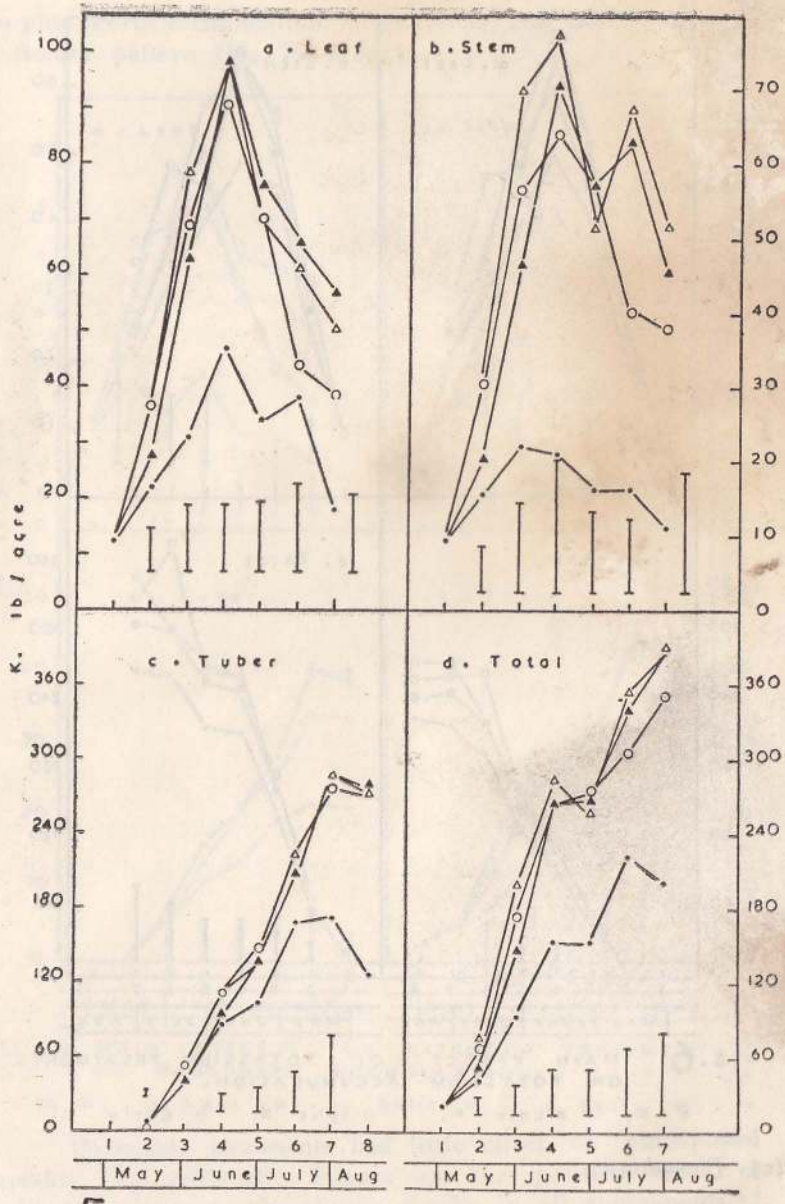

FIG. 5 MAIN EFFECT OF NITROGEN TREATMENTS ON POTASSIUM ACCUMULATION.

• no N, ▲ late N, △ Split N, ○ Early N.

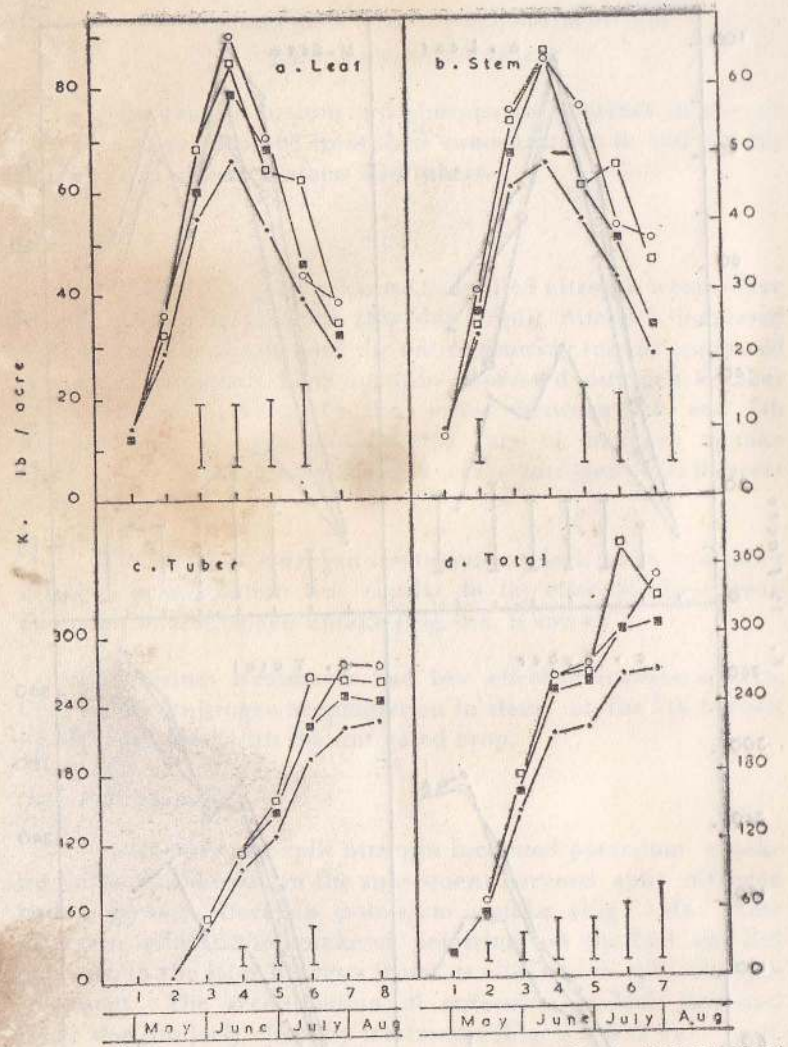

FIG. 6 MAIN EFFECT OF POTASSIUM TREATMENTS ON POTASSIUM ACCUMULATION.

o K, ■ Late K, □ Split K, ○ Early K.

(c) Phosphorus.

Split nitrogen increased the uptake of phosphorus over the whole growfng season compared with early nitrogen (Fig. 7 d). Late nitrogen increased phosphorus uptake towards the end of the growing season. The effect of nitrogen treatment on phosphorus accumulation in leaf stem and tuber followed a similar pattern (Fig. 7 a, b & c).

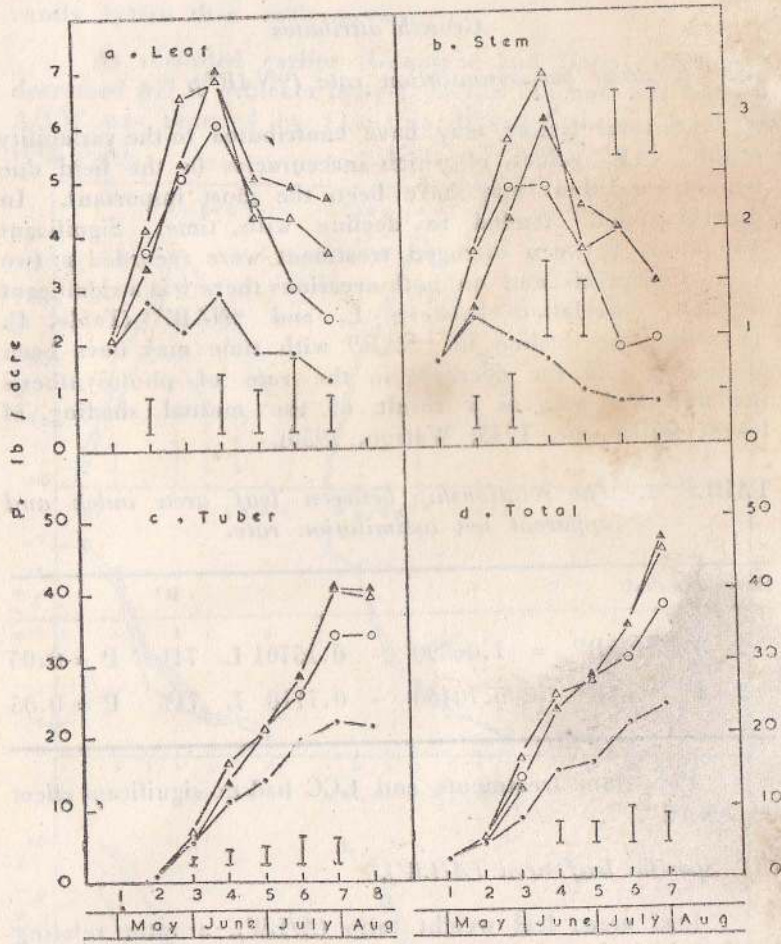

FIG. 7 MAIN EFFECT OF NITROGEN TREATMENTS ON PHOSPHATE ACCUMULATION.

• no N, ▲ Late N, △ Split N, ○ Early N.

Potassium treatments had little effect on phossphoru uptake, The noteworthy feature was the positive effect of split potassium on phosphorus uptake in all components of yield towards the latter part of the growing season.

CCC depressed the phosphorus accumulation in leaf and stem and increased that of the tuber substantially.

The pattern of distribution of all three nutrients closely followed the pattern of distribution of dry matter.

Growth attributes

(a) Apparent net assimilation rate ("NAR").

Several factors may have contributed to the variability of the "NAR" values, of which inaccuracies in the field due to wet conditions may have been the most important. In general "NAR" tended to decline with time. Significant differences between nitrogen treatment were recorded at two harvest intervals and on both occasions there was a significant negative correlation between L. and "NAR" (Table. 4). Therefore the decline in "NAR" with time may have been associated with the decrease in the rate of photosynthesis per unit leaf area as a result of the mutual shading of leaves (Milthorpe, 1945; Watson, 1956).

TABLE 4. *The relationship between leaf area index and apparent net assimilation rate.*

Harvest period					R^2	
2—3	"NAR"	= 1.06890	−	0.15701 L	74%	P = 0.05
3—4	"NAR"	= 0.70460	−	0.7118 L	71%	P = 0.05

Potassium treatments and CCC had no significant effect on "NAR".

(b) Specific leaf area (A/LW).

Leaf area: leaf weight ratio (A/LW), a ratio relating to the thickness of leaves calculated at each harvest is shown in Fig. 8 A. Applied nitrogen increased A/LW but the time at which each nitrogen treatment was most effective differed, eg. early nitrogen was more effective in the early stages of growth, split nitrogen had an effect through a greater part of the growing season while late nitrogen was more effective at the 4th and subsequent harvests.

Potassium treatments had less effect on this ratio than nitrogen (Fig. 8 A). Both late and split potassium increased A/LW at the 3rd, 4th, 5th and 6th harvests, the increase in A/LW with split potassium at the 4th harvest was significantly better than early potassium.

As recorded earlier (Gunasena and Harris, 1969) CCC decreased A/LW (thicker leaves), at the 5th and 6th harvests A/LW was reduced by 11%, this difference being significant (Fig. 8 A).

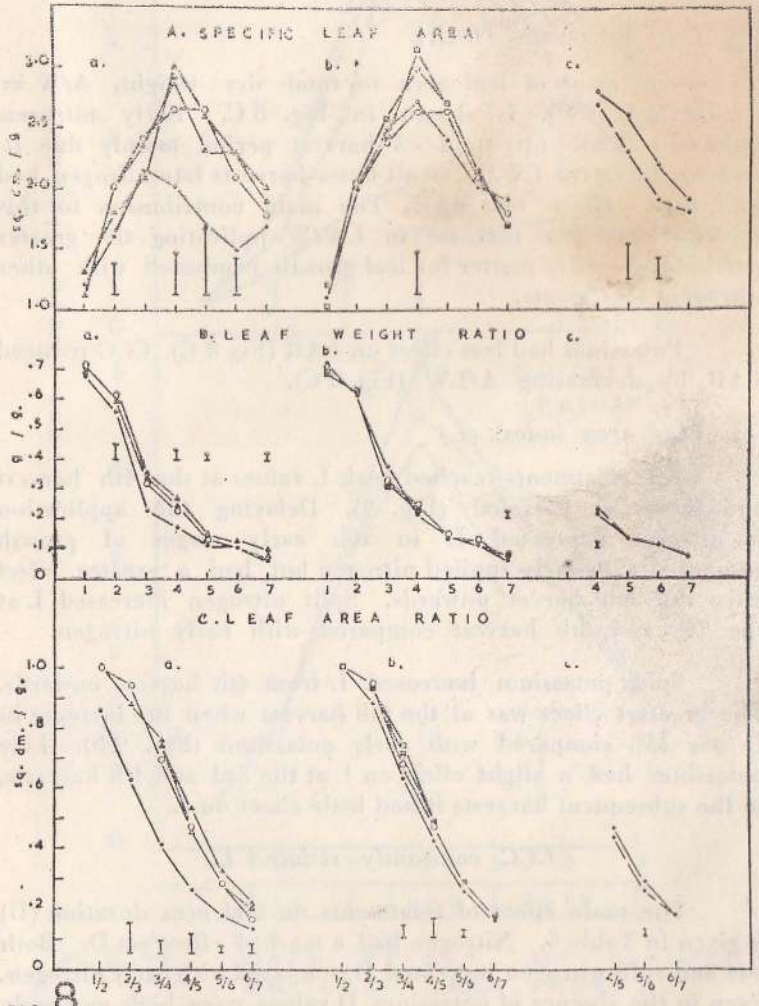

FIG. 8 MAIN EFFECTS OF (a) NITROGEN, (b) POTASSIUM AND (c) CCC ON SPECIFIC LEAF AREA LEAF WEIGHT RATIO AND LEAF AREA RATIO
• no N, ▲ late N, ▲ split N, • no K, ▲ late K, ▲ split K, ○ early N/K
○—○ +CCC ●—●—○ CCC

(c) Leaf weight ratio (L/WW).

The ratio of leaf dry weight to total dry weight (LW/W) calculated at each harvest is shown in Fig. 8 B. Early nitrogen increased LW/W up to the 2nd harvest. In all subsequent harvests late nitrogen increased the proportion of dry matter used for leaf growth compared with other nitrogen treatments. Both potassium and CCC had little effect on this ratio (Fig. 8 B).

(d) Leaf area ratio (LAR).

The ratio of leaf area to total dry weight, A/W = (A/LW × LW/W), is shown in Fig. 8 C. Early nitrogen increased LAR up to 2 – 3 harvest period mainly due to an increase in the LW/W, in all latter harvests late nitrogen had a greater effect on LAR, The main contribution to this increase was the increase in LW/W indicating the greater partitioning of dry matter for leaf growth compared with other nitrogen treatments.

Potassium had less effect on LAR (Fig 8 C). CCC reduced LAR by decreasing A/LW (Fig. 8 C).

(e) Leaf area index. (L)

All treatments reached peak L values at the 4th harvest and thereafter declined (Fig. 9). Delaying the application of nitrogen depressed L in the early stages of growth compared with early applied nitrogen but had a greater effect after the 4th harvet onwards. Split nitrogen increased L at the 7th and 8th harvest compared with early nitrogen.

Split potassium increased L from 4th harvest onwards. The greatest effect was at the 6th harvest when the increase in L was 35% compared with early potassium (Fig. 9 b). Late potassium had a slight effect on L at the 3rd and 4th harvests, in the subsequent harvests it had little effect on L.

CCC constantly reduced L.

The main effect of treatments on leaf area duration (D) is given in Table 5. Nitrogen had a marked effect on D. Both late and split nitrogen increased D compared with early nitrogen. Even in the absence of potassium D values were high and early potassium increased D only by 9%. Both late and split potassium gave higher value of D than early potassium. CCC reduced D.

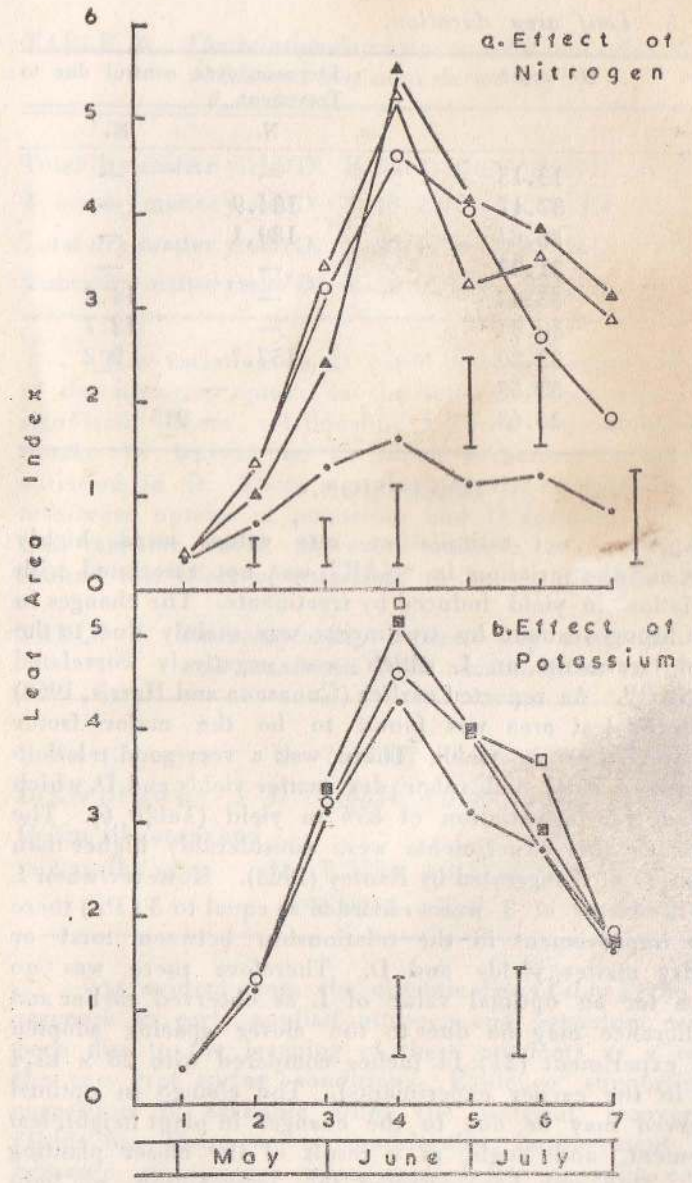

FIG. 9 MAIN EFFECT OF TREATMENTS ON LEAF AREA INDEX.

• no N, ▲ Late N, △ Split N, ○ Early N.

• no K, ■ Late K, □ Split K, ○ Early K.

TABLE 5. *Leaf area duration.*

Treatment	D—weeks	Increase over control due to Treatment %	
		N.	K.
No. N	13.15	—	—
Late N	37.47	184.9	—
Split N	36.84	180.1	—
No. K	31.03	—	—
Late K	35.44	—	14.2
Split K	36.84	—	18.7
Early N/K	33.89	157.7	9.2
No. CCC	33.55	—	
CCC treatment	30.63	— 9.5	

DISCUSSION.

Apparent net assimilation rate values were highly variable, and the variation in "NAR" was not associated with the variation in yield induced by treatments. The changes in "NAR" brought about by treatments was mainly due to the effect of treatments on L which was negatively correlated with "NAR". As reported earlier (Gunasena and Harris, 1968) variation in leaf area was found to be the major factor causing variations in yield. There was a very good relationship between total and tuber dry matter yields and D, which accounted for a variation of 85% in yield (Table 6). The L values in this experiments were considerably higher than optimum L of 3 suggested by Radley (1963). However when L values in excess of 3 were recorded as equal to 3 (D_3) there was no improvement in the relationship between total or tuber dry matter yields and D. Therefore there was no evidence for an optimal value of L as observed earlier and this differance may be due to the closer spacing adopted in this experiment (24 × 14 inches compared with 28 × 15.4 inches in the earlier experiments). The change in optimal L observed may be due to the changes in plant height, leaf arrangement, and angle as a result of the closer planting density. This may have affected the interception of light and its efficiency of utilization (Donald, 1963; Stern and Donald, 1962; Jewiss, 1967). This evidence suggests that the concept of an optimal L may have to be modified at least to take into account the effect of plant density.

TABLE 6. *The relationship between total and tuber dry matter yields and leaf area duration, (D).*

		R^2	
Total dry matter yield/D	Y–36.3326 + 2.84566D	85.2	P·0.01
Tuber dry matter yield/D	Y–40.2542 + 2.28268D	85.7	P·0.01
Total dry matter yield/D_3	Y–20.1798 + 4.09114D_3	77.6	P·0.01
Tuber dry matter yield/D_3	Y–26.0263 + 3.33013D_3	80.4	P·0.01

The variation in D could be largely explained in terms of the nitrogen uptake in the leaves. There was a highly significant linear relationship between maximum nitrogen uptake in leaves and D, which accounted for 84% of the variation in D. There was also a similar relationship between maximum uptake of potassium and D accounting for 74% of the variation in D; however multiple regression analysis showed this effect of potassium to be via nitrogen (Table 7).

TABLE 7. *The relationship between leaf area duration, (D) and maximum N/K accumulation in the leaves.*

		R^2	
D/Nm (lb./acre)	D – 7.47864 + 0.32633 Nm	84%	P·0.01
D/Km (lb./acre)	D – 0.6854 + 0.40576 Km	74%	P·0.01
D/Nm (lb./acre) and D/Km (lb./acre)	D – 7.5383 + 0.3278* Nm – 0.0218 + Km	* P·0.01 84% + N.S	

As evident from the climatic data (Table 1) the smaller response to early applied nitrogen and potassium may have been due to the leaching of these nutrients as a result of the very wet spring conditions. Evidence supporting this suggestion is available from the nutrient recovery data (Table 8). There was a considerable improvement in the recovery of nitrogen when applied late or split, compared with that applied early. The recovery values recorded for late and split nitrogen treatments were extremely high. This may probably be due to the increased root growth caused by the applied fertilizer (Williams, Cooks and Widdowson, 1963; Broadbent, 1965) or the application of nitrogen may have

increased the release of soil nitrogen (Legg and Allison, 1960). The recovery of potassium was improved only with the split application. However it is interesting to note the improvement in the recovery of early applied potassium when nitrogen was applied late or split. From this point of view it may be satisfactory to apply only nitrogen as a late top dressing.

TABLE 8. *Percentage of applied Nitrogen and Potassium recovered in the crops.*

Treatments	N.	K.
Late N	121	58
Split N	109	62
Late K	77	20
Split K	89	51
Early N/K	74	38

The increase in the yield of tubers with late and split nitrogen is a reflection of the maximization of foliar nitrogen through the greater efficiency of recovery of late applied nitrogen. Evidence presented also suggests the split application of nitrogen to be a more efficient way of applying a given quantity of nitrogen than applying it all at the time of planting or tuber initiation, firstly it avoids the delay in tuber initiation associated with the use of nitrogen applied at normal rates at the time of planting, secondly it eliminates nitrogen as a factor limiting leaf area in the early stages of growth which is a disadvantage when the total dressing of nitrogen is top dressed at the time of tuber initiation, and thirdly it increases the rate and prolongs the duration of tuber bulking by increasing L in the later stages of growth.

SUMMARY

Evidence suggested the greater efficiency in the recovery of split applied nitrogen to be due to the avoidence of leading losses. This improvement in the recovery of split applied nitrogen increased the nitrogen content in the leaves (Nm) and leaf area duration (D), hence the yield of tubers. Therefore a split application of nitrogen would be advantageous than an early or a late application at tuber initiation. CCC successfully reduced L but the tuber bulking rate was lower as an optimum L value was not recorded.

There was a significant linear relationship between total and tuber drymatter yields and D. However when L values were recorded as equal to 3 (D_3) the relationship between total or tuber drymatter and D was not improved. Reasons are put forward to account for these effects. The maximum nitrogen accumulation in the leaves was leniarly related to D.

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THE EFFECT OF N-P-K — FERTILIZER COMBINATIONS ON THE YIELD AND JUICE QUALITY OF — CO. 775.

S. KUNARAJAH

INTRODUCTION

WITH the recognition of the variety Co. 775 for large scale adoption at Gal Oya, its fertilizer requirements under this condition had to be evaluated, to view its potentials economically. With these in view fertilizer trials were laid. N–P–K factorial trials with three levels of each element were laid from 1966 onwards to enlighten us, on the fertilizer requirements by this variety. The results of the data are summarised below:

MATERIALS AND METHODS

Design: $3 \times 3 \times 3$ Factorial

Variety: Co. 775

Treatments: 1966/1967 — 1. N at 0, 200 & 300 lbs./acre.
2. P_2O_5 at 0, 60 & 120 lbs./acre.
3. K_2O at 0, 100 & 200 lbs./acre.

1967/1968 — 1. N at 100, 200 & 300 lbs./acre.
2. P_2O_5 at 0, 60 & 120 lbs./acre.
3. K_2O at 0, 50 & 100 lbs./acre.

N in the form of Sulphate of Ammonia at 21% N.
P_2O_5 in the form of Triple Super Phosphate at 40% P_2O_5
K_2O in the form of Muriate of Potash at 60% K_2O.

Location: At Varipattanchenai Research Division.

Plot Size: 1966/1967 — 10 furrows of 50' in length.
1967/1968 — 8 furrows of 35' in length.

Age of Crop at harvest 1966/1967 — 14 months.
1967/1968 — 15 months.

RESULTS:

TABLE 1.

Yield in Tons/Acre and Pol % Juice of each Treatment 1966/67.

Treatments	K_0			K_{100}			K_{200}		
	P_0	P_{60}	P_{120}	P_0	P_{60}	P_{120}	P_0	P_{60}	P_{120}
N—0	7.1	15.52	18.10	12.44	11.30	20.97	15.07	17.02	19.35
Pol. % Juice	15.97	14.75	15.06	15.64	12.71	14.46	11.86	14.78	14.73
N 200	18.57	39.67	48.94	23.55	42.25	39.30	20.80	48.53	31.33
Pol. % Juice	15.51	16.13	15.14	14.58	17.10	14.25	17.70	15.37	14.51
N 300	19.45	32.71	38.82	25.72	29.35	36.41	23.35	49.80	46.22
Pol. % Juice	14.32	16.46	11.39	15.66	15.20	15.28	16.94	16.28	13.71

TABLE 2.

Yield in Tons/acre and Pol. % Juice / Treatment — 1967 / 68.

Treatments	K_0			K_{50}			K_{100}		
	P_0	P_{60}	P_{120}	P_0	P_{60}	P_{120}	P_0	P_{60}	P_{120}
N_{100}	34.0	22.4	27.0	40.0	41.0	32.3	41.0	29.0	31.0
Pol. % Juice	15.20	15.96	15.56	15.07	14.42	15.17	14.90	15.66	14.62
N_{200}	32.0	53.1	36.0	26.0	31.0	54.0	47.0	41.0	48.0
Pol. % Juice	16.69	12.19	13.81	15.10	15.48	14.87	15.48	14.64	15.15
N_{300}	41.0	31.1	43.0	36.0	52.0	31.0	36.0	52.4	38.0
Pol. % Juice	17.38	14.61	14.05	14.33	16.45	12.69	13.88	15.48	17.54

TABLE 3: *Average Yield (tons/acre) for two years.*

Treatments	K_0			K_{100}		
	P_0	P_{60}	P_{120}	P_0	P_{60}	P_{120}
N_{200}	25.3	47.0	42.5	35.5	42.0	43.6
Pol. % Juice	16.1	14.1	14.4	14.7	15.8	14.7
N_{300}	31.5	32.0	41.4	31.0	40.9	32.2
Pol. % Juice	15.8	15.6	12.7	14.0	15.9	16.4

DISCUSSION

Trial I — 1966/67.

From Trial 1 it is evident that there is an increasing response to nitrogen but it is severely limited by the absence of phosphate and potash which shows that the soil inherently lacks these elements to enhance a positive response. With the addition of 60 lbs. P_2O_5 / acre at 200 lbs. nitrogen, the yield increased to 39.67 tons from 15.52 tons at zero nitrogen, indicating clearly the effect of phosphate on nitrogen, and at 120 lbs. P_2O_5 a further increase is noticed, indicating a rise of 33% from 0 to 60 P_2O_5 and 27% increase from N_{200} P_0 to N_{200} P_{120}. This clearly indicates a response to P_2O_5 addition, whereas at 300 lbs. N though there is a positive response to yield by nearly 20% at 120 P, it affects Pol. % Juice drastically in the absence of potash, but at 60 lbs. P_2O_5 level, juice quality is improved.

With the addition of potash at 100 lbs./acre with 200 lbs. N + 60 lbs. P_2O_5 gave the best result yielding 42.3 tons cane and 17.1 pol. % juice which incidently is the best combination effect on both juice and cane response. The effect of K_2O on yield is not striking, thereby indicating no specific response by potash but materially shifts the juice pol. balance with varying combinations of nitrogen and phosphate.

At 200 lbs. potash, a clear indication is noted on improvement to juice quality with increasing nitrogen dosages.

The 200-0-200 gave the best juice pol. of 17.7% whereas at 200-120-200 it dropped to 14.5% and at 300-120-200 to 13.7% but yield responses are noticed in direct proportion to the higher nitrogen levels.

This clearly indicates that at higher nitrogen levels a more judicious potash balance is required at varying levels of phosphate which is noticed at 300-60-200 giving a yield of 49.8 tons and 16.2% pol. while 200-60-200 gave a yield of 48.5 tons and 15.4% pol. There is no increasing response between 200 and 300 lbs. nitrogen at varying phosphate and potash levels.

Therefore the best combination effects on yield and juice quality are 200-120-0; 200-60-100; and 200-60-200.

Trial 2 — 1967/68.

Here again an increasing response is noticed for nitrogen from 100 to 300 lbs. per. acre without materially affecting the juice quality at 300 lbs. nitrogen, indicating the variety is a fertiliser responsive variety. A 20% increase in yield is noticed.

At 100 lbs. nitrogen level, there seems to be a maximum response yielding peak of 40 tons per acre, as shown by combinations of 100-0-50; 100-60-50 and 100-0-100. This shows that at lower level of nitrogen, the phosphate and potash influence is less on yield response. Hence potash effect on yield is revealed than phosphate. 50 lbs. potash materially shifts the yield by nearly 20%. At 200 lbs. nitrogen phosphate influence on yield is noticed at 60 lbs. phosphate. 200-60-0 yields 53 tons but affects juice quality, Pol. being 12.2%. By addition of potash it brings back this quality. With 50 lbs. potash there is an increasing response to phosphate at 120 lbs. per acre, yielding 54 tons per acre and improving juice quality, pol. being 14.87%. While a higher level of potash of 100 lbs. does not indicate an increasing response it does influence quality as noticed in that section, where a steady yield juice quality is maintained.

Though at 300 lbs. nitrogen, there has been an increasing yield response, between 200 and 300 lbs. nitrogen there is no positive response at higher levels. 300-60-50 gave 52 tons with 16.4 pol. %, while 300-60-100 gave 52.4 tons with 15.5 pol. %.

Here again, it substantiates the earlier trend in this regard. Therefore, the best combination effects on yield and cane are from 200-60-0; 200-120-50 and 200-0-100.

A maximum response is noticed at 300 lbs. nitrogen at 60 lbs. phosphate, at both 50 and 100 lbs. potash.

It is evident that a maximum of 60 lbs. of phosphate is sufficient to maintain an increase in yield response at both 200 and 300 lbs. nitrogen levels and also maintain a good juice quality.

CONCLUSIONS

Both these fertiliser trials indicate that the maximum response is at:—

1. 200 lbs. nitrogen level.
2. No positive increasing response is indicated between 200 and 300 lbs. nitrogen levels.
3. There is positive response to phosphate at 60 lbs. level and varying at 120 lbs. level. But between 60 and 120 lbs. levels there is no positive response.
4. There is a striking influence of potash at 50 lbs. level.
5. At higher nitrogen levels of 300 lbs., higher potash and phosphate levels are required to maintain the same quality and yield potentials as at 200 lbs. level.
6. Maximum yields are shown by the following combinations:—

N-P-K. Lbs./acre	Yield per acre	Pol. % Juice
100 - 0 - 50	40.0	15.1
100 - 60 - 50	41.0	14.4
100 - 0 - 100	41.0	14.9
200 - 60 - 0	53.1	12.2
200 - 120 - 50	54.0	14.9
200 - 0 - 100	47.0	15.5
200 - 60 - 100	41.0	14.6
200 - 120 - 100	48.0	15.2
200 - 120 - 0	48.9	15.1
200 - 60 - 100	42.3	17.1
200 - 60 - 200	48.5	15.4
300 - 60 - 200	49.8	16.3

N-P-K. Lbs./acre	Yield per acre	Pol. % Juice
300 - 120 - 200	46.2	13.7
300 - 60 - 50	52.0	16.5
300 - 60 - 100	52.4	15.5
300 - 0 - 0	41.0	17.4
300 - 120 - 0	43.0	14.0

7. The best combination effects on yield and Juice as follows:-

200 - 120 - 50	54.0	14.9
200 - 120 - 100	48.0	15.2
200 - 120 - 0	48.9	15.1
200 - 60 - 100	42.3	17.1
200 - 60 - 200	48.5	15.4
300 - 60 - 50	52.0	16.5
300 - 60 - 200	49.8	16.3

The current N-P-K fertiliser application in the plantation for light soils is 180-75-120 and for heavy and medium soils is 160-60-120.

It appears that these combinations are not very conducive to either maximum yield or to improve juice quality. For the variety Co. 775, these combinations indicate an imbalance.

SUMMARY AND RECOMMENDATIONS

Varieties respond differently to fertiliser combinations in relation to soil and climatic conditions. Hence fertiliser trials were conducted to evaluate these response values. The indications have been discussed. The combined data revealed (Table 3) that either 200-120-50 or 200-60-100 should be the best choice for standard adoption till verified further to the variety Co. 775 and to all improved varieties. Recommended split applications would be an N-P-K mixture of 42-120-50 or 42-60-100 at planting time as basal dressing and the balance of 158 lbs. nitrogen to be split into two applications. The 2nd of 84 lbs. nitrogen at 60 days after planting and the final as 3rd dose of 74 lbs. nitrogen on the 90th day after planting. These dressings should be for all soil groups for the present. In very heavy soil types, where adequate irrigations are available with good drainage 300-60-50 could be applied. But at this juncture, this dosage need not be embarked upon, till clarified further. At present 200-60-100 is the combination recommended for application to the variety Co. 775 and to all improved varieties, as an irrigated crop, under conditions at Gal Oya Sugar Cane Plantation.

AGRICULTURAL DEVELOPMENT IN CEYLON: A STUDY IN THE PROBLEMS OF THE SMALL FARMERS*

S. SELVANAYAGAM

THE importance of the agricultural sector in the Ceylon economy is evident from its contribution to the Gross Domestic Product and the employment of the workforce. Agriculture provides employment to the largest number of the gainfully occupied population and accounts for about 90% of the total foreign exchange receipts (Table 1).

TABLE 1. *Agriculture in the economy*

Year	Gross Domestic Product (Million Rs.)	% of agri culture's share in GDP	Total export earnings (Million Rs.)	% export earnings from agri-culture	Total gainfully employed	% in agri-culture to total employed
1966	7,870	36.0	1,700	91.8	3,455,722	52.9
1967	8,226	36.9	1,690	89.3	3,535,476	52.9
1968	8,900	36.5	2,035	89.6	3,614,324	52.9

The percentage contribution of agriculture to the GDP has been over 36%. Besides the agricultural sector has recorded a significant increase during the last few years. The increase is attributed partly to an expansion in the real output and partly to an increase in prices. At constant factor cost prices, the increase in 1968 has been 6.9% in the agricultural sector and 8.2% in the GDP.

* *Based on a field investigation of agricultural conditions in the dry zone of Ceylon conducted in 1968—69. The information gathered in the survey will be used in a major study relating to dry zone development. The author gratefully acknowledges the financial assistance received from the University of Ceylon for the field research.*

Agriculture in Ceylon is broadly divided into two sectors, namely 'export agriculture' and 'domestic agriculture'. Tea, rubber and coconut are the main components of the export sector, and these plantation crops account for about 90% of the total foreign exchange receipts. Compared to other Asian countries, Ceylon, in a sense, is fortunate that it has a fairly well organised export sector. This export sector is alone responsible for the relatively higher income per head enjoyed in Ceylon in comparison to her neighbours (Table 2).

TABLE 2. *Income per head at constant prices*

	1963—64 (Two year average) in U. S. Dollars
Burma	68.77
India	73.56
Pakistan	78.01
Thailand	102.15
Ceylon	128.84
Taiwan	154.32
Philippines	208.88

Source: Economic Survey of Asia and the Far East, 1966, United Nations, (Bangkok, 1967), p. 55.

The three main plantation crops together with a few other minor export crops contribute to almost the entire foreign exchange receipts. The general policy has not been to encourage any substantial expansion of acreage under tea, rubber and coconut, but attempts have been made to increase the productivity of these crops through more intensive cultivation in the existing areas. The plantation sector by providing the bulk of the export earnings continues to sustain a fairly high level of living by the import of large quantities of food, textiles and manufactured goods. Annual imports of consumption goods generally account for about 65% of the total imports, and food accounts for nearly 40%. Thus export agriculture is of crucial importance and for this reason every effort must be made to increase its productivity in order to maximise the level of export earnings.

The peasant sector is primarily concerned with the cultivation of food crops for domestic consumption. Although some encouragement has been given to the cultivation of subsidiary food crops in recent years, the concentration is still on the production of paddy. Paddy is not only the basic staple but also the most important crop for economic and traditional reasons. Ecologically too it is the most suitable crop for the irrigated lowlands in Ceylon. However, throughout the colonial period attention was directed towards the expansion of the export agricultural sector, while domestic agriculture virtually remained in a state of neglect. During the colonial period plantation interests influenced government policy regarding agricultural development, and the domestic sector was considered unimportant for it offered little prospect of earning a return. Further, much of the dry zone during this long period was derelict, malarial and jungle covered and sparsely peopled. In the favourable areas where peasant crops were raised there were various problems inhibiting productivity. Holdings were often small and uneconomic; technology was backward and hence productivity was low. Heavy incidence of rural indebtedness, the lack of transportation, marketing and credit facilities further acted against any attempt to improve productivity. Landlessness too was a serious problem especially in the southwestern lowlands and central highlands and in the Jaffna peninsula. The attention of the government was drawn to these problems at various times, and the government was gradually persuaded to abandon its avowed *laissez faire* policy and to take a more positive step to improve the lot of the peasantry. The conditions of the peasantry were such that the colonial government was compelled to view this problem with some sympathy and initiate a policy of land settlement by gradually restoring some of the ancient irrigation works in the dry zone of Ceylon. It was in the 1870's and 1880's that irrigation really got under way, and much of the new impetus in this direction was due to Sir William Gregory whose concern for the peasantry was unquestionable. The restoration of most of the village tanks and a fair proportion of the major irrigation works was completed between 1870 and 1900. Although a great deal of useful work was done in the sphere of irrigation in the dry zone in the last quarter of the nineteenth century, early efforts at colonization were not fruitful. Malaria, cheap imports of food, the lack of

transportation and credit and marketing facilities were potent factors, and these no doubt contributed to their failure. The development of the dry zone as a means of relieving the population pressure and of offering better economic opportunities to the landless peasants, did not make much headway until the 1930's. By the 1930's the condition of the peasantry became worse; the decline in the earnings of the export agricultural sector further depressed the peasantry. The food shortage caused by the war, unemployment, population pressure and landlessness forced the government to adopt a more meaningful policy regarding colonization in the dry zone. Consequently by the mid 1930's and especially after 1939, there has been a systematic colonization and land settlement in the dry zone, owing largely to the 'considerable assistance' given irrespective of the return. In 1967 there were in all about 80 major peasant colonization schemes in the dry zone with a total population of over 220,000 people and 178,000 acres under paddy cultivation and 104,000 acres under highland. A much larger extent had also been developed under the village expansion and middle class schemes in the dry zone. At the end of 1967, a total extent of 689,000 acres had been alienated under village expansion schemes and 146,000 acres had been alienated under middle class schemes.

Despite the systematic colonization of the dry zone and the measures adopted to modernize the peasant agriculture, the level of productivity has remained substantially below expected standards.[1] While there have been significant gains made in paddy production and in some subsidiary products the overall expansion in the domestic sector has

[1] The following reference made in relation to the productivity of agricultural holdings in the colonization schemes, is applicable to the large majority of the peasant holdings in Ceylon. Compared with the high productivity trends in some of the countries in Southeast Asia and the Far East, holdings in Ceylon are generally inefficiently exploited. '..... in the existing holdings — old and the new alike — the factors of production are inefficiently exploited. This goes for soil, water, labour and capital. Production is very low, and hence the holdings do not pay their way, so that their contribution to the national economy is insignificant.' Yehoshua Arbel, *Report on a survey of the arid zone of Ceylon, (Jerusalem, 1964), p. 5 (mimeographed).*

been inadequate. This traditional but massive sector still remains inevitably poor, and because it is poor it tends to spend much of its income on food. But when this agricultural sector is transformed into a more productive and modernized sector like that of Japan or Israel or Denmark by investing in agriculture, food becomes more abundant, income rises and less of the income of the country is spent on food.[2]

Transforming the traditional agricultural sector in Ceylon is important for a variety of reasons. The persistently unfavourable trends in the export trade in the recent years often imposes strains on the economy and creates problems of balance of payments. The inadequate foreign exchange imposes restrictions on the quantum of food and capital goods imported and thereby impairs living standards and economic growth. As imports of food account for about 40% of the total imports and 45% of the country's export earnings, import substitution in agriculture would help to conserve scarce foreign exchange for investment purposes. There is considerable scope in the field of foodstuffs as much of the foods including rice and subsidiary foodstuffs, fish and milk products can be produced locally. Domestic production of food is important in the context of Ceylon's rapidly increasing population, and unless steps are taken to increase food production to keep pace with increasing population Ceylon will have no alternative other than to continue to draw on her limited foreign exchange earnings to stave off hunger.[3] Considering the present rate of increase in population, the country will have to increase its food output by more than 3% per annum. Expansion in domestic agriculture is also important to promote industrialization. The development of the domestic sector will help save substantial foreign exchange necessary for investment in industrialization in addition to making available domestic food supply and in some cases agricultural raw materials. These economic arguments will demonstrate that there is a great and urgent need for a rapid

[2] Theodore W. Schultz, *Transforming traditional agriculture, (New Haven and London, 1965), p. 4.*

[3] Thambapillai Jogaratnam and Thomas T. Poleman, *Food in the economy of Ceyon, Cornell International Agric. Develop. Bull. No. II., (New York, 1969), p. 6.*

transformation of the traditional peasant sector. The gravity of the problem has been now realized and consequently the government has been recently taking constructive steps to improve the productivity levels in domestic agriculture. Already some of these measures have borne good results especially in the production of paddy. Table 3 shows the relative imports and domestic production of rice.[4]

TABLE 3. *Production and imports of rice*

	Domestic production (tons)	Imports (tons)
1957	437,000	556,332
1958	511,000	579,590
1959	508,000	518,530
1960	600,000	532,173
1961	603,000	496,560
1962	672,000	514,975
1963	687,000	550,702
1964	705,200	640,616

Source: *Agricultural Development Proposals, 1966–1970,* Ministry of Planning and Economic Affairs, Ceylor, (Colombo, 1966), p. 76.

Import substitution in foodstuffs necessitates a coordinated development strategy. Though the government has already made some gains in paddy production, it is important that in order to achieve the ultimate target of self sufficiency in food requirements it is essential that the problems in the

[4] It is significant that the domestic production of paddy has increased substantially in the last few years. The total production of paddy in the years 1966, 1967 and 1968 were respectively 45.7 million bushels, 54.9 million bushels and 64.2 million bushels. The increased domestic production of paddy has led to a considerable reduction in the imports, and in 1968 rice imports amounted to only 250,000 tons. The expansion in the domestic production has been brought about by various measures such as price support (The GPS price was increased from Rs. 12 to Rs. 14 per bushel of paddy from November 1967), inputs subsidies and improvements in the agricultural, administrative and field service machinery.

traditional agricultural sector should be correctly diagnosed and suitable measures adopted to remedy them. An effective agricultural policy in this regard requires simultaneous action on three fronts.

(1) The low productivity in the domestic agricultural sector is largely due to the traditional methods of production. In the words of Schultz "the man who farms as his forefathers did, cannot produce much food no matter how rich the land or how hard he works."[5] It is only the farmer who has access to modern techniques can produce an abundance of food even though the land is poor. Therefore to increase the rate of productivity there should be an effective transmission of the knowledge about the new techniques to peasant farmers. This matter has been given considerable attention in Ceylon, and it is carried on as agricultural extension service.

(2) The adoption of new techniques would require certain basic conditions with regard to inputs and finance. Irrigation water, fertilizers, certified seeds, agro-chemicals, and farm implements must be available to peasants at the right time of cultivation. It is also important to provide the necessary credit facilities so that farmers would be able to make a profitable investment of such inputs.

(3) The transmission of knowledge about the new techniques and the provision of inputs and finance are themselves not adequate to promote productivity in the traditional sector. While making available these facilities, it is also necessary to create the right conditions for the peasant farmers. These conditions relate chiefly to land tenure reforms, price supports and marketing and transportation facilities.

New techniques of Production

The transmission of knowledge about the new techniques is carried on through the extension service which covers the educational aspects as well as the functional aspects of credit,

[5] Theodore W. Schultz, op. cit., p. 3.

supplies and marketing. There are four major government departments that are directly linked in extension work, namely Departments of Agriculture, Agrarian Services, Co-operative and Land Commissioner's Departments. Besides, Irrigation and Rural Development Departments too are associated with the improvement of paddy production. Further, extension work is organised at the district, divisional and village levels, and various officers handle extension work within their ranges with the main emphasis on paddy. The two basic cultivators' organisations established at the village level are the multipurpose co-operative society (MPCS) and the cultivation committee. The former is concerned with the provision of credit, agricultural supplies and marketing, while the latter is charged with the responsibility of organising and improving paddy cultivation. But the deficiencies in the Paddy Lands Act have however slowed down the activities of the cultivation committee. Moreover, there is little coordination in the services provided by the various government departments and the field level cultivators' organisations. These difficulties ultimately result in the disorganisation of the extension service facilities. It is nevertheless true that there has been a marked increase in paddy production due to the adoption of improved techniques. Unlike in the other developing countries, peasant cultivators in Ceylon enjoy a reasonable level of good education and this has afforded them the willingness to learn and innovate. Practical demonstrations in cultivators' fields too facilitated the spread of agricultural knowledge. In Ceylon the extension service programme has been reorganised from time to time, and recently paddy extension work has been given the greatest emphasis. This has no doubt helped to increase the per acre yield of paddy as shown in Table 4.

TABLE 4. *Paddy production in Ceylon, 1954—1967*

	1954—56 average	1959	1961	1962	1963	1964	1965	1966	1967
Acreage ('000 acres)	1,280	1,330	1,472	1,536	1,562	1,585	1,616	1,638	1,712
Production (million bushels)	31.4	36.5	43.2	48.1	49.2	50.4	—	54.9	64.2
Yield per acre (bushels)	31.1	35.0	36.2	37.9	37.9	38.6	—	41.4	45.7

Source: *Statistical Abstracts of Ceylon.*

There are still several factors which continue to slow down the progress of the extension services. The personnel involved in the extension services are inadequate, their qualifications and attainments and attitudes are far from being satisfactory, their understanding of the peasants' conditions and welfare is insufficient and the communication media between these personnel and peasants is poor. Field work conducted by the author in a number of *purana* villages and peasant colonization schemes in the dry zone (Unnichchai, Kantalai, Vavunikulam, Iranamadu) clearly reveals the situation regarding paddy extension services. The condition was worse in the tradition bound *purana* lands. The number of extension personnel at the various levels was inadequate (the special projects are an exception) to cope with the present drive for increased production of food crops. The technical efficiency of many of these officers was reported poor; though some had the 'prescribed' course of training they rarely had the benefit of in-service training and refresher courses. From what the peasants described it appeared that the majority of the extension workers lacked the enthusiasm and aptitude required for this work and the capacity to communicate with the peasants.[6] Field investigations

[6] A personal communication from an administrative officer in charge of agricultural production at the divisional level revealed that the Agricultural Instructor in charge of the area was often not available in the station, and of all he was the least concerned about anything connected with increased agricultural production. Of the five officers at the village level, three were beyond the active working age for village level work, and hence contributed little to extension work. Of the remaining two, one was deeply involved in a domestic problem and was never available for any serious field work. Only one young overseer showed sufficient enthusiasm and was willing to contribute his share to production work. The technical efficiency of these extension personnel was considered to be low. The same administrative officer felt that a very much similar situation prevailed in most districts in Ceylon.

in the dry zone revealed that the districts of Amparai, Batticaloa, Trincomalee and Puttalam were somewhat conspicuous for the relative inadequacy of extension work. During the field survey the author came across a significant number of peasant cultivators who had not witnessed a field demonstration in modern techniques or received any useful advice pertaining to improved cultivation practices. At the same time there were also cultivators who were reluctant to use inputs such as fertilizers and agro-chemicals. For instance the peasant farmers in Tampalakamam, Kinniya and Toppur areas in the Trincomalee district thought that their soils were naturally endowed with enormous amounts of plant nutrients and therefore required no chemical fertilizers. Though the lower lying clayey and muddy tracts contained humus, the soils were not rich in all the important minerals. Consequently the per acre yields of paddy were about the average or less than the average. There were also cultivators who did not have the financial resources or credit facilities to obtain the necessary farm supplies. For some these supplies were not made available at the required time of cultivation. Thus, apart from the shortcomings in the matter of transmitting agricultural knowledge, the deficiencies in the provision of farm supplies too hamper the efficiency in cultivation. However, field information gathered from over 400 peasant farm holdings in the various parts of the dry zone showed that the large majority of the cultivators have now adopted the improved techniques. Certified seeds, fertilizers and agro-chemicals are generally used. Among the selected seed varieties, the Ceylon hybrid H_4 is the most widely used in the dry zone fields. In the irrigated colonization schemes it is used in both the *maha* and *yala* seasons. H_7 and H_8 are also used in smaller extents in certain parts. The H varieties are well suited to conditions in Ceylon. IR_8 also has been introduced recently but it is now cultivated in restricted acreages in the dry zone. This is a high yielding variety and its performance in Ceylon has been promising. The use of this variety is likely to increase provided of course the right technology and management practices are adopted. In addition to these certified seed varieties, there are also others such as *paravakalayan, pachchaiperumal, uvarkaruppan, moddaikaruppan, uthan samba* and *murungakayan*. While the long age H varieties (4 – 4½ months) are used in the *maha* season, short age varieties

such as *pachchaiperumal* (3 months) are used in the *yala* when water becomes a serious problem. The certified seeds generally possess the approved minimum standards of quality. The cultivators are generally expected to obtain a new supply of certified seed once in every three years. This is necessary in order to prevent the deterioration of the seed paddy due to admixture with other local varieties and weeds. From field evidence it became clear that few in practice paid any heed to such an advice. It is therefore reasonable to assume that a good proportion of the certified seed varieties in use is old, and must have deteriorated in quality. Further the present supply of certified seed paddy is also insufficient to meet the needs of farmers whose one main complaint has been that it is hard to obtain certified seeds even for purposes of seed renewal. It is therefore important that while inducing the peasant farmers to use certified seeds, the government should at the same time make available the required certified seed varieties. The practice of using fertilizers is widely in evidence. Nitrogenous fertilizers such as ammonium sulphate and urea, and phosphates and potash are used for paddy and other subsidiary crops. The use of fertilizers in paddy production has increased in recent years. For instance, in 1964–65 a total of 42,424 tons of fertilizers was used for paddy in Ceylon. This amount increased to 82,859 tons in 1967–68. On the basis of detailed surveys conducted on soil types and their responses to fertilizers, varying quantities of fertilizers have been recommended for each of the districts in Ceylon. But the quantities used in actual practice are far below the recommended amounts. The per acre consumption of fertilizer in 1967–68 was 35 pounds; it was higher compared with the amounts consumed in the previous years. Irrigation water is relatively scarce in the *yala* and consequently the amount of fertilizers used is also limited. Besides, the lack of credit facilities and finance also restrict the amount of fertilizers used. It is nevertheless true that the fertilizer subsidy scheme that was initiated in 1951 is still in operation on an improved basis, and the subsidy costs the government over Rs. 10 million annually. Further a much higher amount of fertilizers has been recommended recently but it is unlikely that the cultivators would use such increased amounts as they are often reluctant to incur heavy expenditure on a 'no too certain' crop.[7] The amounts used at present are generally insufficient and it is necessary that the recommended amounts are used at the proper time of cultivation. In some parts and especially in the eastern districts fertilizers are often not available at the proper time, and if available problems such as credit delays prevent the purchase and timely application.

Plant protection is also given good attention. A variety of agro-chemicals (weedicides, pesticides and fungicides) are sprayed to protect the crop from weeds, pests and diseases. The widespread use of agro-chemicals is a feature that is seen in the dry zone districts. These are obtained from both the cooperatives and private dealers. Sprayers and dusters are hired from the cooperatives.

Increasing extents of the paddy acreage in the dry zone are now prepared with the tractor. It was evident from the field survey that over 90 % of the cultivators in the main paddy cultivating districts are now dependent on tractors — 4– wheel and 2– wheel tractors -- for tilling, threshing and transport operations. It is true that tractors are more expensive than the native buffaloes and bullocks, but the lack of pasture in the dry zone and the difficulty to keep animals in the face of rapid destruction to forests and chenas, have compelled the village cultivators to turn to the tractors. Tilling operations in the dry zone are more

[7] The recommended quantities for the dry zone soils are roughly 2 cwt. sulphate of ammonia or 1 cwt. urea, 1 cwt. phosphate, and ½ cwt. muriate of potash per acre. For the dry zone soils both sulphate of ammonia and urea are recommended as suitable nitrogenous fertilizers. Urea is generally used in the Batticaloa-Amparai districts, while in the other districts sulphate of ammonia is used. The recommended quantities are usually supplied through the cooperatives at an approximate (subsidized) cost of Rs. 78 per acre. The recently suggested 5 cwt. per acre amount will not only be a burden (at current prices) to the cultivatiors but its application will also be difficult in areas without sufficient water supplies. Experience in the field shows that the cultivators are often very reluctant to make use of the available credit facilities for agricultural purposes because of the insecure nature of paddy cultivation. For the recent suggestions, see R. Schickele, 'Strategy for agricultural development', *The Journal of the National Agricultural Society of Ceylon*, Vol. 5, 1968, p. 24. Also, D. V. W. Abeygunawardena (ed.), *Research and production of rice in Ceylon*, p. 249.

easily carried out with the tractor than with the traditional plough. Besides, labour becomes such a scarce factor during peak periods and mechanisation is inevitably the right solution. At present only the lower lying paddy tracts and mud flats which are subject to flooding, are puddled. The 20–40 HP. size rubber-tyred 4-wheel tractor is widely used in most parts of the dry zone, especially in the large paddy growing districts of Amparai, Batticaloa, Anuradhapura, Vavuniya and Jaffna. Paddy holdings in the dry zone are relatively larger and in the colonization schemes they are between 3 and 5 acres. These holdings permit the use of the big size tractors, but the cost of tractor operation is high when they are used on very small plots. For the size of paddy holdings and the dry zone environment the midget 10–20 HP. size 4-wheel tractor is the most suitable one. Though introduced recently, because of its easy manoevourability and high output in relation to its size and price, its use is likely to increase. The 5–10 HP. 2-wheel walking tractor which was introduced recently for the tillage of tiny plots, can be operated economically by the cultivator. This garden tractor, although it is extremely popular in Japan, is not widely used in the dry zone. It has a limited application in muddy and weed covered fields.

Though tractors are used for tillage, threshing and transport operations in the dry zone, they are not easily available. Tractor units set up in a few districts by the government were of little help. Some cooperative unions too set up tractor units but they soon ran into difficulties. At present tractors are usually hired from private owners who are invariably the big land owners and absentee managers of large holdings. Tractors are hired at exorbitant rates since tilling operations have to be carried out within short periods. For instance, in 1967–68 the tractor rates in the Batticaloa-Amparai districts varied from Rs. 45 to Rs. 55 per acre for tilling. These rates were pushed up to as much as Rs. 75 when expenses on tractor maintenance and spares increased under the Foreign Exchange Entitlement Certificate Scheme. The rates are slightly lower in the northern districts. Since mechanisation of agricultural operations has now assumed an important position, it is incumbent on the government to establish more tractor pools in each district

and make available tractor service at reasonable rates.[8] Cooperatives too should set up their tractor units and make available tractors cheaply for their members at the right time of cultivation.[9] Measures such as these would not only help timely tillage and the effective use of early rainfall, but also prevent the impoverished peasant cultivators from being fleeced by the merciless *podiyar* type land owners, especially in the Batticaloa – Amparai rice bowl.

It is no doubt true that despite the various shortcomings in the extension services, peasant cultivators have now understood the importance of the modern production techniques. From field experience it is clear that an increasing number of farmers are using selected seed varieties, fertilizers, agro-chemicals and tractors and other ancillary equipments. With the governments' drive for increased domestic production of paddy and subsidiary food crops further impetus has been added. But to make this a more effective and dynamic process, the shortcomings in the extension services and especially the distressingly poor coordination between the various departments which handle agricultural work, have to be remedied. The problems created by the lack of coordination become worse when a colonization scheme is sited in two adjacent districts. Vavunikulam colonization scheme is a typical example where the cultivators have to communicate with officers attached to the Mannar district and divisional organisations on the one hand and the Jaffna district and divisional organisations on the other.

With a view to intensify the extension services and to generate sufficient momentum in agricultural production the government has now embarked upon a 'special project'

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[8] The years 1967 and 1968 witnessed large imports of tractors for agricultural use. In 1967 1,706 4-wheel tractors were imported. In 1968 901 4-wheel tractors and 1,657 2-wheel tractors were imported.

[9] The cooperative tractor service at the Kantalai colonization scheme was so haphazard. The tractor offered for use often became unusable due to incessant repairs and mishandling. This seems to have caused annoyance and distrust among the cultivators on cooperative tractor service.

or 'package programme'.[10] The intention is to concentrate on a few selected areas by making available through an integrated machinery all the necessary inputs and finance in order to increase the productivity. The areas selected for the intensive programme are the colonization schemes. These areas have the optimum potential for increased production because of secure tenure conditions and assured irrigation water. These are two important factors which inhibit increased productivity. The package programme was first experimentally tried out at the Elahera colonization scheme during *maha* 1967-68, and it was later extended to nine other colonization schemes in the dry zone from *maha* 1968-69. A total number of 12,370 allotments with 37,775 acres of paddyland came under this intensive programme.[11] In view of the low productivity levels in comparison to investment in the colonization

[10] In India an Intensive Agricultural District Programme, popularly known as the 'package programme' was initiated in 1960. The origin of the package plan was a recommendation by the Ford Foundation Team on Agricultural Production that agricultural development programmes should be intensified in selected areas, and in October 1959 the Indian government prepared a draft scheme, the main object of which is to demonstrate over a period of five years the feasibility of increasing agricultural production considerably in areas where optimum potential for agricultural production exists. The programme was initially launched on a limited scale with the agricultural season of 1960-61 in seven districts in the States of Punjab, Bihar, Rajasthan, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, and Tamilnad. The programme was later extended to eight other districts in the other States of Kerala, Mysore Gujarat, Maharashtra, Orissa, West Bengal, and Assam. In these 15 districts the programme was put into effect on a phased basis over five years, and by the end of the Third Plan more than a million farmers and 6.5 million acres in the 15 districts were involved in the programme. The programme was greatly expanded during the Third Plan and the government designated 115 other districts with the potential for materially stepping up their production. These are known as Intensive Agricultural Areas districts. The original 15 districts (2 more have been added in Jammu-Kashmir and Haryana) and 115 IAA districts are now geared for greater production through the package deal.

[11] With the Elahera colonization scheme, the following nine schemes are included in the package programme :

Minneriya	Minipe	Padaviya
Rajangana	Mahavilachchiya	Iranamadu
Hakwatuna	Allai	Gal Oya

schemes, the governments package programme in these areas is most welcome. The approach is to channel trained extension personnel and increased farm supplies into these areas in order to step up the yield of paddy.[12]

It is too early to forecast the results of this integrated agricultural programme since its full impact is expected over a five year period; however occasional field checks by the author in one of the 'special projects' showed that the package deal has not yet produced sufficient increase in productivity to commensurate with the investment in inputs, equipments and personnel. Nevertheless the potential for increased production of paddy lies in the dry zone. About 62 % of the total asweddumized paddy acreage is in the dry zone and over a million acres are sown each year in the two seasons. Besides about 200,000 acres of paddy land have been developed under major colonization schemes. This acreage having assured irrigation water and suitable tenure conditions possesses the potential for increased paddy production. The government's package programme is aimed towards achieving this goal. Such a step is also important in order to transform these high cost colonization schemes into economically viable units.

Inputs and finance

One of the crucial elements in the expansion of agricultural production is the availability of finance and supplies. In Ceylon the peasants had been for a considerable period of time at the mercy of local money lenders, *boutique* keepers and pawn brokers. While these sources had served an important need of peasants and are still significant in the eastern districts, the cooperatives have now taken over the main function of supplying agricultural credit which is given in cash and material inputs (certified seeds, fertilizers, agro-chemicals, etc.) on a per acre basis. The cooperatives in association with rural banking services were reorganised in 1967 with a view to provide a

[12] At the Elahera colonization scheme the target was to increase the yield of paddy to 60 bushels per acre from 48 bushels obtained earlier. The package deal has apparently produced good results. Recent crop cutting surveys reportedly showed that per acre yields of paddy have increased to over 85 bushels per acre *(The Ceylon Daily News, Jan. 21, 1970).*

greater stimulus for the production of paddy and other crops. The new scheme sought to meet the problems of inadequate credit limits and delays in credit reaching the cultivator. The credit limit for paddy cultivation was increased to Rs. 175 per acre up to six acres and Rs. 220 per acre up to ten acres. The per acre limit was further increased to Rs. 262 in 1968. Besides arrangements were made to make available the loans before the commencement of the cultivation season. The new credit scheme also enabled the quick recovery of the loans and substantial amounts have been recovered after the introduction of the new scheme. Field investigations in the various dry zone districts showed that all is not good in regard to credit and supplies. The cooperatives are indeed playing a vital role in the supply of agricultural credit and inputs in the northern districts such as Jaffna, Vavuniya and Mannar, while those in the Amparai, Batticaloa and Trincomalee districts are to a great extent mismanaged. A fair number was reported to have ceased functioning in these areas. The disorganisation in the cooperative network in the east has caused serious problems regarding credit and supplies. Owing to this the peasant farmers are compelled to seek financial assistance from *boutique* keepers and village money lenders. These traditional sources provide loans readily but at a high interest rate. In the eastern districts loans are usually given on the understanding that the repayment should be in paddy at a predetermined price. For instance, cultivators often repay loans with paddy at the rate of Rs. 80 per *avanam* (i.e. 10½ bushels), while an *avanam* of paddy at the government guaranteed price would be Rs. 147. If seed paddy is obtained on loan it has to be repaid at the rate of 1½ times the amount. This is the most prevalent arrangement and it is always to the disadvantage of the peasant cultivator. Under such conditions cultivators are unable to make any useful investment in agriculture. Moreover considerable numbers among the cultivators are sharecroppers or landless agricultural labourers. This explains the relative poverty and backwardness of the peasant farmers, especially in the Amparai–Batticaloa paddy country where the *podiyars* wield supreme power. Effective land reform measures only can remedy the problems of of the peasantry in such areas.

Irrigation water is also an important factor in agricultural production. In the dry zone the rainfall is not only erratic but also highly concentrated in the three northeast monsoon

months. Hence its effectiveness is limited to this short rainy period. When the seasonal rainfall fails it causes serious damage to crops. It is significant that even today much larger extents of paddy lands in the dryzone are cultivated under rainfed conditions and consequently their yields are dependent on the vagaries of monsoon weather. There is supplementary irrigation to the *maha* crop in some parts of the dry zone. But the extent cultivated in the *yala* varies from year to year depending on the available irrigation water. Usually the extent cultivated in the *yala* is about one-third of the *maha* acreage. Sometimes the fields are abandoned in the *yala* season when there was a marked failure of rains in the preceding *maha*. Thus, the shortage of irrigation water is a recurring problem in the dry zone despite the fact that a substantial acreage of paddy land has now been provided with irrigation facilities. An extent of over 200,000 acres of paddy land in the various colonization schemes has been provided with irrigation, and a further extent of 60,000 acres will be developed under the Uda Walawe scheme. Under the Mahaveli river diversion project it is proposed to develop some 900,000 acres under irrigation. This includes 246,000 acres of already aseweddumized paddy land and 654,000 acres of uncultivated land lying in the Mahaveli river basin and in the north central part of Ceylon. Though there has been an expansion in the extent of irrigated land in the dry zone, it is an unpleasant truth that there is much wastage of water owing partly to the importance paid to paddy cultivation and partly to careless management.[13] Crop diversification and stringent water control measures are two important steps that should be adopted in order to make these high cost irrigated lands economically productive. It is reasonable to assume that the productivity in the existing irrigated extents can be doubled if water control and crop diversification measures are adopted. Further to embark upon gigantic river diversion projects involving heavy capital outlay without formulating an effective land utilization programme may be disastrous in the long run.

[13] Irrigation water rates charged by government vary at present to a maximum of Rs. 5 per acre, but the maintenance of irrigation works and operation would cost between Rs. 10 and Rs. 15 per acre. Besides water rates are difficult to collect and they are rarely collected. The irrigation under the Mahaveli project is likely to cost the government over Rs. 40 per acre.

Peasant framework

The transmission of knowledge about the new techniques and the provision of agricultural inputs and finance are themselves not adequate to promote higher productivity trends in the domestic sector. While making available the technology and the necessary farm supplies, it is also important to create the right peasant framework. Such a framework would require suitable land tenure systems, price supports and marketing and transportation facilities.

In Ceylon cultivated land is distributed in a large number of very small holdings. According to the 1946 census 31 % of the asweddumized paddy holdings were less than 0.5 acre in size, while 64 % of the holdings were under 1.0 acre. In all about 85 % of the paddy holdings representing 44 % of the paddy acreage were under 2.0 acres in size, and 96 % of the holdings representing 70 % of the paddy acreage were under 5.0 acres in size. Table 5 illustrates the size variations in paddy holdings at the 1946 census.

TABLE 5. *Size of paddy holdings, 1946*

Size	Number of holdings	% to total number of holdings	Extent covered in acres	% to total extent
Less than 0.5 acre	242,600	31.4	58,005	6.4
0.5 to less than 1.0 acre	253,823	32.9	147,376	16.4
1.0 acre to less than 2.0 acres	162,120	21.0	193,794	21.5
2.0 acres to less than 5.0 acres	85,310	11.1	231,726	25.7
5.0 acres to less than 10.0 acres	19,705	2.6	122,073	13.6
10.0 acres and over	8,260	1.1	146,996	16.3

Source: *Census of Ceylon*, 1946.

The 1946 census also revealed that 60.8 % of the holdings representing 55 % of the paddy land were owner cultivated. The half share *ande* tenancy which is widely prevalent in the Sinhalese districts applied to a quarter of the holdings and land in paddy in 1946. The remaining 13.3 % of the holdings representing 20.8 % of the paddy land were held under various other arrangements such as *tattumaru*, lease, etc. It is probable that there may have been further diminution in the size of holdings since 1946, owing to the increasing pressure of population on land. It is also possible that the number of owner cultivators including those settled on the colonization schemes may have increased; the number of *ande* tenants, lease holders and landless peasants too may have increased.[14]

It is thus clear that in the field of peasant production, the small farm is the most significant. The large majority of the farms are in very small holdings and this is particularly so in regard to paddy and other subsidiary crops. The holdings in the Jaffna peninsula and in the southwestern lowlands are exceedingly small, resulting from the long process of fragmentation and subdivision consequent on increasing population pressure. The holdings in the dry zone are relatively larger; in the colonization schemes the size of paddy holdings is generally between 3 and 5 acres. However on the whole the holdings are small, and on account of the predominance of small farms in the peasant sector the government has been directing its development policy towards the small farmer. There is a view that small farms are economically inefficient units of production and that it is often difficult to effect technical improvements on such small units. Contrary to this view, there are areas in the densely populated monsoon lands in Asia where farms are generally mere 'postage stamps', but they have been observed to turn out greater output per acre. This is largely due to the adoption of highly intensive cultivation practices and the use of new agricultural inputs. Table 6 shows the variations in farm size and productivity levels in nine countries in monsoon Asia.

[14] The extent reported under *ande* tenancy in 1962 was 281, 785 acres and the corresponding extent for 1946 was 212, 151 acres. There was an increase of 69,634 acres in 1962 over that of 1946.

TABLE 6. *Farm size and production*

	Average size of farms (acres)[1]	Production per acre (in U.S. Dollars)[2]	Agricultural production per capita of rural sector (in U. S. Dollars)[3]
Thailand	9.5	42	45
Philippines	8.8	74	72
Burma	7.6	49	79
Cambodia	5.6	48	47
India	5.4	33	39
Pakistan	4.2	55	54
Indonesia	3.3	60	38
Taiwan	3.1	279	114
Japan	2.1	274	102

Source : Lester R. Brown, *An economic Analysis of Far Eastern Agriculture, Foreign Agric. Econ. Report No. 2, U.S.D.A.*, (November 1961). Quoted in Theodore W. Schultz, *Economic Crises in World Agriculture, (Ann Arbor, 1966). p. 12.*

1.— permanently cultivable land excluding wasteland and grazing land.

2.— based on annual production per acre of agricultural land for 1957-59 valued at 1958 world market prices.

3.— based on annual agricultural production for 1957-59, valued at 1958 world market prices, and rural population.

It is clear from Table 6 that the average size of farms in monsoon Asia varied from 9.5 acres in Thailand to 2.1 acres in Japan. These farms are comparatively very small in contrast to farms in the developed countries, but there is considerable variation in the productivity levels of these farms. It is seen that the difference in the size of farms may not be an indication for production efficiency. For instance, farms in India are more than two and a half times as large as they are in Japan (5.4 acres and 2.1 acres respectively) but the per acre production in Japan is about eight times that of India. The main reason for this is that Japanese agriculture is substantially modern while that in India is still largely of the traditional type. In Japan, irrigation facilities are superior, the supply of fertilizer is better and far cheaper relative to the price of rice, and therefore

the farmers apply a hundred times as much fertilizer per acre as do farmers in India.[15] The seeds sown are of the better varieties, and what is more important is that the Japanese farmers have a much higher levels of skills than farmers elsewhere in the region. Thus in Japan an astonishing transformation in agriculture was achieved within the traditional framework of small scale farming.[16] With the motor driven hand tillers and other small equipments, better and cheaper farm supplies, and modern technology the Japanese farmer was able to change the whole character of agriculture. Production efficiency and farm yields are also high in the small family type farms in Taiwan, where complementary changes in land reform have further accelerated the modernization of agriculture. Thus, contrary to prevailing opinion that large farms would be more responsive to technical progress, the small family size farms in Japan and Taiwan in practice have been found to be economically more efficient in terms of output per acre, per worker and per farm. Whereas, on the larger farms employing hired labour, production is carried only so far as it will cover the hiring charges.[17]

As far as farm size is concerned, Ceylon is not different from the other south and southeast Asian countries. Even in Ceylon, the smaller family type farms are reported to be more efficient in production than the relatively larger farms. A recent investigation in central Ceylon revealed that the smaller farms were more efficiently operated and consequently they yielded relatively higher returns per acre.[18] A similar relationship between the size of holding and output per acre was observed in an earlier study of another village in the hill country.[19] A further study carried out in connection with the formulation of a major agricultural development

[15] Theodore W. Schultz, *Economic Crises in World Agriclture*, (Ann Arbor, 1966), p. 49.

[16] In Japan the average farm holding is about 1 hectare (approximately 2. 4 acres), and where 40 % of all farm holdings were below 0.5 hectares in 1961.

[17] Jagdish Bhagwati, *The Economics of Underdeveloped Countries, (London, 1966), pp. 154-56.*

[18] T. Jogaratnam and V. E. A. Wickramanayake, *The survey of Meda-Kalugamuwa village, 1967, (mimeographed).*

[19] N. K. Sarkar and S. J. Tambiah, *The disintegrating village, (Colombo, 1957), p. 46.*

project in Ceylon also showed that the smaller family type farms ranging from 1 to 3 acres had the highest yields per acre in the dry zone.[20] From these surveys it is clear that the smaller farms are generally more efficiently managed than the relatively larger farms, and therefore the maintenance of the family sized farms is economically feasible.[21] The peasant colonization programme in Ceylon has been on the basis of family type farms, and under present conditions it appears to be a realistic and more meaningful approach. Though the small family type farms are generally more productive, substantial numbers of holdings in the southwestern lowlands and the Jaffna peninsula are of uneconomic sizes. Some form of land consolidation measure for the uneconomic holdings would be necessary at this juncture. At the same time it is also necessary to control the never ending process of subdivision and fragmentation of farm holdings.[22] A comprehensive land reform programme is urgently required, and such a programme should seek to remedy the problems of ownership and tenure on the one hand, and to prevent the family type farms from dwindling into uneconomic sizes. Under the prevailing tenancy arrangements the benefits that could accure to tenants are very meagre and this in turn discourages the adoption of improved techniques of production. A high incidence of tenancy (as much as 45 % of all paddy holdings under *ande*, lease nd others), insecurity to tenure and exorbitant land rents generally characterize paddy cultivation. Landlords often change their tenants to bid up rents, and also appropriate 50 % of the total yield of tenant cultivators. They also charge exorbitant rates of interest

[20] K. V. Sri Ram, *Mahaveli Ganga irrigation and hydropower survey, Vol. III (A), (Colombo, 1968).*

[21] S. E. Johnson and R. P. Christensen, Efficient use of labour, land and capital for agricultural development of densely populated areas, *Vol. III, Agriculture, U. S. Papers prepared for the benefit of the less developed areas,* (Washington, 1963), pp. 42-43. '...large scale organization of farming frequently is not the most effective way to increase land productivity in densely populated areas. In fact, much available evidence indicates that small family farms generally have higher yields per acre.' Quoted by V. Kanapathy in *United Malayan Banking Corporation Review*, Vol. II, No. 1, 1966, p. 11.

[22] S. Selvanayagam, 'Intensive farming and agricultural trends in the Jaffna region of Ceylon', *The Journal of the National Agricultural Society of Ceylon, Vol. 3, 1966, pp. 21-35.*

on cultivation loans and for the hire of agricultural implements. If the domestic sector were to yield good returns, it is important that there should be drastic changes in tenancy arrangements. With this end in view the Paddy Lands Act was passed in 1958 to ensure the tenant security of tenure and controlled rent. The Act also provided for the setting up of Cultivation Committees for the efficient management of agricultural holdings, maintenance of village irrigation works, consolidation of uneconomic holdings, etc. In implementing the Act it was realised that the Act was incapable of bringing about the desired result in agrarian structure. In order to make good the legal shortcomings the Act was amended subsequently several times, and in 1964 fairly comprehensive amendments were introduced. In spite of all these, the legislation in practice has had only a negligible impact on the tenancy situation. Land reform measures are not only vital but they have to be adjusted differently to different areas. For instance, paddy holdings in the Hambantota district are large; the *nindagam* holdings in the Ratnapura district too are of like sizes. These holdings which account for about 20 % of the total paddy holdings in Ceylon, are generally owned by absentee landlords. The logical land reform measure that should be adopted in these areas is to transfer the ownership to the tenant cultivators. The transfer of proprietary rights to the peasant operators would give the necessary incentive for increased production. In the Batticaloa–Amparai country too the paddy holdings are large; in certain parts holdings exceeding hundred acres are also noticed. These paddy holdings are owned by *podiyars* (big land owners), but they are cultivated on commercial lines by employing agricultural labour. These large holdings in the east coast account for about 10 % of the total paddy holdings, and they are reasonably well managed from the point of view of production efficiency. However the existence of capitalist land owners having possession of the large majority of the holdings together with a class of impoverished landless agricultural labourers has created serious social problems. Land reform measures should seek to remedy this inequality in the region. 25 % of the paddy extent in Ceylon is in holdings of between 2 and 5 acres. These belong to small owners but are often cultivated by tenants. In this case, the tenants who cultivate these holdings should be provided with the necessary safeguards such as security of tenure and restrictions on rents, and land reform measures should be directed towards

achieving such ends. The remaining 45 % of the paddy lands are in holdings of less than 2 acres. These are the typical family sized peasant holdings, which are predominantly operated by owner-cultivators. There will be little scope for basic land reform changes in these areas but effective organizational changes prescribed under the Cultivation Committees can push forward productivity trends. In the densely populated parts in the southwestern lowlands and in the Jaffna peninsula, land reform measures may have to be in the form of land consolidation. Thus it would appear that effective agrarian reforms in Ceylon have to be carried out under the existing Paddy Lands Act in varying ways. While basic agrarian changes are necessary in about 30 % of the paddy acreage including the commercialized areas in the east coast, secure tenurial arrangements and organizational reforms are called for in the remaining parts. The Paddy Lands Act has been in force over ten years, but it must be stated that due to various shortcomings very little effective reforms have been carried out.[23] Without basic agrarian reforms it would be difficult to ensure the ready adoption of modern production techniques for increasing the productivity levels in the domestic sector.

In transforming the traditional agricultural sector, marketing and transport facilities and price supports are as important as land reform measures, agricultural knowledge and farm supplies. Price support for local agricultural produce has remained as an accepted policy of the government from the 1930's. The pioneer attempts made at colonization in the dry zone, the lack of transportation facilities and the low prices paid for peasants' produce necessitated some kind of protection, and in consequence the government initiated various schemes in order to render some assistance to the peasant cultivators. But effective steps in this direction were taken only after the independence with the introduction of the Guaranteed Price Scheme. Paddy and a number of subsidiary food crops are presently covered under this scheme, and these commodities are purchased direct from the producers through the multipurpose cooperative societies. It has now been realised that the price support has been one of the main inducements for the increased

[23] D. V. W. Abeygunawardena (ed.), *Research and production of rice in Ceylon, (Colombo, 1966), p. 259.*

production of food crops, especially paddy. The increased production of subsidiary food crops in the Jaffna peninsula is partly due to the stable prices offered for these crops under the price support programme. However, problems of insufficient storage facilities, delays in making payments to cultivators, the lack of transportation especially in the new peasant colonization schemes and disorganisation in the cooperative network continue to hamper the satisfactory functioning of the price support programme. Owing to these difficulties, the peasant cultivators in certain parts and particularly in the eastern districts are compelled to dispose of their produce to middlemen at substantially lower prices. The difficulty in obtaining the necessary agricultural finance and inputs too compels some cultivators to enter into prior agreements with middlemen and local *boutique* keepers to sell their produce at predetermined prices. The government price support has no doubt played a very vital part in offering stable prices to most peasant crops, which in some cases are much higher than the world market prices, but the drawbacks in the purchasing machinery, the supply of agricultural credit and finance, the cooperative network and the difficulty of transportation have prevented the full benefits that cauld accrue to peasant cultivators under this scheme. The transportation facilities presently available in the dry zone are thoroughly inadequate. Though the main towns and administrative centres are connected with trunk roads and railways, the peasant colonization schemes and the Batticaloa–Amparai paddy country are not effectively linked by rural feeder roads. In most colonization schemes the roads are mere cart tracks and these are scarcely served with motor transport. This applies to even some parts of one of the major and oldest colonization schemes, Galoya. It is necessary that transportation facilities in the dry zone should be improved, and such a measure would help to minimise the problems of farm supplies and marketing of agricultural produce.

Finally, for a sustained development of domestic agriculture, it is important to adopt a comprehensive land use plan for the dry zone. Though the dry zone is recognized as one large region occupying about 70 % of the total land area, there are distinct variations in topography, drainage, soil types, water resources, etc. It is possible to demarcate well defined land classes on the basis of these differences, and each will have its own quality and

potentiality.[24] Thus, the utilization of each land class will have to be planned carefully, but generally a diversified crop husbandry in association with animal husbandry would be desirable for the dry zone. It has been seen that the rainfed lands are often subject to crop failures. The rainfall in the *maha* season is both irregular and insufficient, and therefore it is impossible to adopt intensive crop husbandry on such rainfed lands. Farmers operating small family type holdings of 3 to 5 acres on a purely rainfed system of farming experience great hardship, and if these farmers were to earn economic returns from these holdings they have to be provided with irrigation. The rainfed lands (*maha* season) are generally suited for the extensive cultivation of maize, sorghum, kurakkan and some paddy. The irrigated lands (*yala* season) are suited for the intensive cultivation of short duration crops such as onions, chillies, vegetables, groudnuts and short term paddy. The present tendency to grow paddy in both seasons results in the most uneconomic use of water and land resources, and therefore a diversified system of farming would give better economic returns. A comprehensive agricultural system for the dry zone should comprise the following: (1) The development of small farms with irrigation for the intensive cultivation of onions, chillies, groundnuts, vegetables, tobacco and high yielding paddy. The problems of population pressure, unemployment and underemployment would warrant the creation of many such farms, and it would be necessary to settle as many people as possible on such irrigated small holdings. But at the same time every effort should be made to obtain the maximum possible economic returns from these irrigated holdings. The available farm management data show that paddy when cultivated in both seasons in the Amparai, Batticaloa, Anuradhapura and Polonnaruwa districts at present gives on the basis of prices offered under the guaranteed price scheme an average net income of Rs. 864 per acre per annum. But under highly improved practices the net income is likely to increase to Rs. 1,224. When paddy is cultivated with tobacco in a system of rotation the net income under present practices and prices would be Rs. 1,015, and it is likely to increase to Rs. 2,195

[24] By employing similar criteria, the author has demarcated land quality classes for the Jaffna region; See S. Selvanayagam, *Land Use in the Jaffna Country, Ceylon, M.A. Thesis, University of London, 1963, (unpublished).*

under highly improved practices. In the Jaffna peninsula, the cultivation of high value crops in a system of rotation presently gives a net income of between Rs. 3,261 and Rs. 5,190. The cultivation of crops in the Jaffna peninsula is characterised by highly intensive labour and inputs of fertilizer, agro-chemicals and improved seeds, combined with a completely controlled irrigation.[25] Under further intensified practices the net incomes in Jaffna peninsula are likely to increase to between Rs. 3,952 and Rs. 6,415.[26] It is thus seen that a diversified system of intensive farming would give the maximum economic advantage. (ii) The development of large holdings for rainfed cultivation of low value crops. Since the cultivation is confined to the *maha* season it has to be on an extensive basis, and a system of mixed farming with low value grains, paddy and animal husbandry should be developed. But the appropriate mixed farming systems for the irrigated and rainfed areas should be so devised to conform to regional variations and land classes in the dry zone.

The highland allotments in the colonization schemes which were developed at a high cost, remain virtually unutilized.[27] Since there are no irrigation facilities these highland allotments cannot be utilized at present. The utilization of highland allotments has for long remained as one of the most elusive problems; however in some colonization schemes in the Jaffna and Vavuniya districts, limited

[25] S. Selvanayagam, 'Market Gardening in the Jaffna Region: A Study of the Inuvil-Thavady Villages', *The Ceylon Journal of Historical and Social Studies, Vol. 9, No. 2, 1966,* pp. 172-176.

[26] *Report of the Irrigation Program Review — Ceylon,* FAO/IBRID Cooperative Program, (Ceylon, January, 1968). Also, T. Jogaratnam, 'Farm Planning in Ceylon: An application of the Linear Programming Technique', *The Journal of the National Agricultural Society of Ceylon, Vol. 5, 1968,* pp. 30-40.

[27] '... An examination of land utilization also indicated that some 40 % of the farm area, usually lying a little above the irrigation canal, is not exploited. At present the farmer has neither equipment nor knowhow to utilize this area intensively, and hence it constitutes a useless appendage to his farm, despite the fact that in many cases it is of better quality, and its exploitation possibilities more varied than those of the lowlying section which is devoted solely to paddy.' Yehoshua Arbel, *Report on a survey of the arid zone of Ceylon,* (Jerusalem, 1964), p. 4. (mimeographed).

extents are presently used for the cultivation of subsidiary crops such as onions, chillies, groundnuts, vegetables and tobacco. Wherever possible water is tapped from underground sources. It would be worthwhile if attempts are made to explore the possibilities of tapping underground water resources elsewhere in the dry zone. Also it might be possible to pump water from the irrigation canals to highland plots. At present some efforts are being taken to expand the area under lift irrigation. The sprinkler system of irrigation, though somewhat costly to instal, would be advantageous for the cultivation of subsidiary food crops. A comprehensive land use plan embracing the irrigated lowlands, rainfed lowlands and highlands with the correct combination of crop rotations and animal husbandry is essential for the development of the dry zone of Ceylon.

AN EVALUATION OF CREDIT AND INSURANCE SCHEMES FOR PADDY

NIMAL SANDERATNE

INTRODUCTION

GIVEN the technical possibility of increased rice production, the communication of these techniques to the farmer, and the availability of the necessary physical inputs, the success of a rice production programme depends on the incentives provided to farmers. The provision of incentive conditions require a wide range of policies including *inter alia* the reform of tenure conditions, the stabilisation of producer prices at remunerative levels, the establishment of adequate marketing organisation, the availability of adequate credit at reasonable rates to finance the necessary high yielding inputs and the reduction of risks of crop loss due to unfavourable natural conditions.

Agricultural policy is most effective where a comprehensive programme is designed to improve the total situation rather than one which attempts to solve particular facts of the agrarian problems. Rice production policies in Ceylon have for more than a decade, accepted the position that the problems endemic in peasant agriculture require comprehensive reforms. These reforms have included changes in tenure conditions, government purchase of paddy at guaranteed minimum prices, the expansion of institutional credit sources, and a limited crop insurance programme.

The present article examines recent experiences in credit schemes and in particular the New Agricultural Credit Scheme and the limited Crop Insurance Scheme.

CREDIT SCHEMES

Policy Background — Earlier Credit Schemes

The process of transforming traditional agriculture requires the use of increased material and capital inputs. While

these inputs yield a return several times their cost the difficulties of obtaining finances at reasonable cost could be a serious setback to the adoption of improved technology. Hence the need to provide institutional credit.

The provision of institutional credit at reasonable cost has, however, been ridden with the problem of a high rate of default. On the one hand, the poverty of the peasants and their lack of suitable collateral security render it almost impossible to resort to legal means of recovery. Further, the criterion of security is relevant only in case of default and is not a measure of the need for, and justifiability of, credit. On the other hand, their very lack of resources urge strongly the need to provide adequate credit.

One solution is to pin responsibility on the village level organisation disbursing funds. A low level of repayments of 60 % of short-term credit disbursed by the Department of Agrarian Services between 1947/48 to 1952/53 suggested the adoption of the principle of corporate responsibility between 1953/54 to 1962/63. This implied that borrowing by co-operative societies for their members, was dependent on the repayment of loans already taken. Where members had defaulted and the co-operative unable to make good these funds the society was debarred from subsequent borrowing for its members. During the decade 1953/54 to 1962/63 around 96 % of funds disbursed was repaid. This is indeed an impressive level of recovery for a scheme of credit to the peasant sector.

However, the insistence on the principle of corporate responsibility had its inherent defects. Over the years an increasing number of co-operatives defaulted and their members whether defaulters or non-defaulters were debarred from borrowing. Many farmers who had rapid loans were deprived of obtaining further credit under the scheme owing to the uncredit-worthiness of their societies. It is also likely that some borrowers in defaulting societies who knew of their inability to to borrow subsequently may have refrained from paying back their loans.

These factors resulted in a decrease in lending under this scheme. In the first three years credit increased from Rs. 11.7 million in 1953/54 to Rs. 21.9 million in 1956/57 and then displayed a declining trend reaching its nadir in 1962/63 with a borrowing of only Rs. 10.7 million.[1]

In 1963 a new credit scheme was introduced. "The fundamental objective of the scheme was to ensure an immediate increase in paddy production by making available to farmers the maximum credit they required to adopt improved cultivation practices."[2] To achieve this objective the credit limit per farmer fixed at five times his share capital was done away with, as in practice, most farmers owned only a single share and as such their maximum credit entitlement was only Rs. 250/-, irrespective of the extent cultivated. Under the new scheme credit limits were fixed at the rate of Rs. 175/- per acre to a maximum of Rs. 500/- for three acres to a member with a single share and a maximum of Rs. 1000/- for five acres for share. holders of two or more shares. The loan was given according to a breakdown by purpose for different cultivation operations (Table I). In addition farmers cultivating a second season were entitled to a further 50 % of the credit they were entitled to in the first season. All non-defaulting members were entitled to credit irrespective of the society's repayment record.[3]

To ensure recovery of loans it was proposed to stipulate the conditions that debtors sell paddy equivalent in value to the loan, to the co-operative. Further, the failure to repay a loan obtained from a co-operative society was to be made an offence punishable with a fine or term of imprisonment. Neither of these provisions were, however, implemented.

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[1] These figures relate to total credit given and not to credit for paddy cultivation alone. The breakdown for paddy is not readily available for these years. An estimate of approximate amounts given for paddy for these years are as follows :— 1953/54 — Rs. 3.6 million; 1956/57 Rs. 3 8 million and 1962/63 Rs. 8.2 million.
Administration Reports Director of Food Production 1953/54 —56/57 and *Commissioner of Agrarian Services 1957—1962/63.*

[2] *The Administration Report of the Commissioner of Agrarian Services* 1962– 63. p.kk 54.

[3] *Ibid Loc.cit*

TABLE I.

Paddy Loans — Breakdown by Purpose of Utilization

PURPOSE	Maximum Credit Allowed Per Acre of Cultivation (Rs.)		
	1963/64—1966/67	1967/68	1968/69
	(1)	(2)	(3)
Seed Paddy (2 bushels)	24	32	32
Ploughing	40	55	60
Fertilizer (4½ cwts.)	36	58	95
Transplanting and Row-Seeding	25	25	25
Weeding and Weedicides	25	25	50
Harvesting	25	25	—
Total	175	220	262

Sources: *(1) Administration Reports, Commissioner of Agrarian Services.*

(2) Cooperatives and Rural Credit Department, People's Bank.

TABLE II.

Loans and Repayments of Agricultural Credit Schemes, 1947-1967.

Period	Amount Loaned	Amount Recovered	Percentage Recovery
1947/48 — 1952/53	45.56	27.23	59.8
1953/54 — 1962/63	147.53	141.01	95.6
1963/64 — 1966/67	122.59	68.87	56.2
1947 — 1967	315.68	237.11	75.1

Source :- *Administration Reports of the Commissioner of Agrarian Services.*

The short-fall in paddy production in Maha 1964/65 and the increase in the open market price consequent on the rice ration cut in 1966 made it difficult to implement the provison of insisting on the sale of paddy to co-operatives. In fact the fear of not obtaining adequate domestic supplies of rice for distribution under the rice ration scheme lead to even relaxing the requirement to purchase paddy from bona fide farmers according to the registered crop list.[3]

During this phase, 1963/64 to 1966/67, the liberalisation of credit limits and procedures, resulted in an increase in the amount lent. The level of recovery, however, again fell to a low of 56 %, owing to the abandonment of the principle of corporate responsibility and the inability to purchase paddy on a crop list basis under the Guaranteed Price Scheme. There was also evidence of misuse of funds given for these purposes. Co-operatives which had recovered loans from members had instead of repaying these to the Department of Agrarian Services used these funds for other purposes.[4]

The credit experience categorised by the phases discussed above is shown in Table II.

To sum up, the experience of government agricultural credit schemes since independence was that of Rs. 315.7 million lent – only Rs. 237.1 million had been recovered.[5] The two methods of ensuring recovery considered earlier, that of insisting on corporate responsibility and of procuring sales under the Guaranteed Price Scheme was not practicable. The first due to its defect of debarring non-defaulting members of defaulting societies and the second as open market prices were high so as render the guaranteed price not particularly attractive. Further, there appeared to be a general impression that funds disbursed by a government department was in the nature of a grant rather than a commercial transaction.

On the other hand to increase rice production it was essential to provide adequate credit to meet the additional cost of

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[3] *The Administration Report of the Commissioner of Agrarian Services 1964/65* p. kk 53.

[4] *Ibid loc cit*

[5] These figures once again relate to total credit and not credit for paddy alone.

the necessary capital inputs and labour expenditure and to make available such credit in time for the cultivation operation.

To meet these problems and needs the new Agricultural Credit Scheme was introduced in September 1967. Under the scheme credit was channelled through the People's Bank and a new form of security was found in the pledge of the rice ration coupons of the farmer's household. Credit limits were increased and procedures streamlined to ensure that farmer's credit needs were met in time.

FEATURES OF THE NEW AGRICULTURAL CREDIT SCHEME

Procedure

Under the New Agricultural Credit Scheme an individual farmer applies for a loan to his co-operative society. This application is considered on the basis of the farmer's credit needs for cultivation and the maximum credit limit permissible under the scheme. The Co-operative Inspector test checks 10% of these applications.

Once the committee of the co-operative society determines the aggregate credit requirements of its members a decision is taken regarding the maximum credit limit of the society. The composite loan application with the necessary endorsement by the Co-operative Inspector that the amount is within the amount approved by the Assistant Commissioner of Co-operative Development is expected to reach the People's Bank about 1½ months prior to the commencement of the cultivation season.

The purpose of this first application is to gauge the maximum extent of credit required under optimum cultivation conditions. A revised application form is prepared 2 weeks prior to the commencement of cultivation taking into account rainfall and other prevailing cultivation conditions. As the earlier application for the higher amount of credit has been approved in principle, the revised application is acceptable with the minimum of delay.

The Co-operative Societies pledge a usance note for the funds to the People's Bank and in turn have as security from farmers the right to withhold the rice ration coupon

of the farmer, his dependents and any others pledged to repay the fund. Where a farmer has not rapid the loan, his ration coupons are withheld and the value of the weekly measure of free rice he is entitled to credited to the Co-operatives by the Government at the rate of Re. 1/- per measure.

Due to the overlapping of the Maha and Yala seasons, a farmer is not deprived of the first stage of a loan for the subsequent season if the reason for non-repayment of the loan is that he has not disposed of his crop at the time of loan application. Until a farmer repays a loan, either in cash or its value in rice ration coupons, he is not entitled to a loan in a subsequent season. In cases where a farmer has been unable to repay his loan due to crop failure caused by reasons beyond his control the period for repayment is extended over three subsequent seasons.

Credit Limits

The maximum credit limit for paddy cultivation for an individual farmer in Maha 1967/68 and Yala 1968 was Rs. 220/- per acre to a maximum of 10 acres. The breakdown of this sum by purpose is given in Table I.

Within the maximum limit of Rs. 220/- per acre for paddy cultivation certain variations are permissible. For instance, the Rs. 50/- allotted for transplanting or row seeding and manual or mechanical weeding may be used for the purchase of chemical weedicides. Loans may also be given for the purchase of approved insecticides and fungicides. Also the amount given as seed paddy varies according to whether it is broadcast, transplanted or row seeded and the current price of seed paddy. Similarly the amount released for fertilizer varies with the kind used and the subsidised prices of fertilizers.

The cultivation loan for Maha 1967/68 and Yala 1968 was released in three stages. In the first stage the aggregate sum required for ploughing seed paddy (where loan is required in cash) transplanting or row seeding and weeding at a maximum of Rs. 137/- per acre was advanced. In the second stage of loan payment the Assistant Commissioner of Agrarian Services is paid direct for supplies of fertilizer, seed paddy and agro-chemicals. The funds released at the third stage are for harvesting purposes. The loan period for a farmer was 240 days or for a co-operative 270 days.

From Maha 1968/69, due to the rise in the cost of fertilizer and ploughing rates, the amount given was increased from Rs. 220/- per acre to Rs. 262/- per acre as indicated in Table I. The loan for harvesting was done away with and the loan for weeding and weedicides increased to Rs. 50/-. This loan was also released in three stages. In the first stage the loan for seed paddy, ploughing or weedicides was released in cash at the commencement of the cultivation season. The instalment for fertilizer was remitted direct to the Department of Agrarian Services and the third instalment for handweeding and transplanting or row seeding was paid in cash.

Funds, Refinance and Interest Rates

The funds lent by the People's Bank under this scheme are refinanced to the full extent by the Central Bank.

The Central Bank lends funds at 1½ % per annum to the People's Bank which in turn lends to co-operative societies at the rate of 5 % per annum. The co-operative societies may lend to their members up to a maximum rate of interest of 9 % per annum. An additional 3 % per annum is charged on loans not repaid by the stipulated period.

The Central Bank guarantees loans to the extent of meeting 75 % of the amount in default and charges a fee of one half of 1 % for this guarantee.

Under this scheme, the People's Bank also lends to the six Co-operative Banks at 3½ % per annum and these in turn lend to co-operative societies. In the case of funds lent through Co-operative Banks the guarantee premium of ½ % is borne equally by the Co-operative Bank and the People's Bank.

Credit Disbursed

The introduction of the scheme in Maha 1967/68 was marked by a substantial increase in credit given for paddy cultivation. While the highest amount loaned in any year for paddy for both seasons was Rs. 32.5 million in 1963/64,[6] the

[6] The total amount of credit given in 1963/64 was also the highest at Rs. 34.6 million. Rs. 32.5 million is estimated as given on the basis of data on breakdown of loans by purpose. *The Administration Report of the Commissioner of Agrarian Services*, 1957—1967/68.

amount loaned for paddy for the Maha season alone was Rs. 61 million. The amount loaned for both seasons was Rs. 72.7 million and is over two fold the highest annual amount of credit previously given for paddy. (Table III)

The increase in the amount lent in Maha 1967/68 was due to both the increase in the credit limit from Rs. 175/- per acre to Rs. 220/- per acre and an increased coverage. The introduction of the new credit sc eme was accompanied by an enthusiasm to increase credit utilisation and officials are known to have persuaded reluctant farmers to borrow. The short fall of Rs. 17 million in the amount utilised from the amount approved for Maha 1967/68 is also perhaps indicative of the drive to increase credit utilization. Further, defaulters under the earlier schemes were again entitled to borrow.

In Yala 1968, however, the amount lent declined significantly. While the acreage cultivated in Yala 1968 was somewhat over half the cultivated area in Maha 1967/68, the credit approved and utilised was less than a fifth of the amount of the previous Maha. This decrease may be accounted for to some extent by the fact that credit needs in the Yala season are generally lower than for Maha, due to the commencement of the Yala season at the period of greatest liquidity. This general phenomenon would have been particularly valid in Yala 1968 as the Maha 1967/68 crop was favourable in most parts of the country.

Further, several defaulters in Maha 1967/68 would not have been eligible to borrow while others may have been disuaded from borrowing due to the withholding of rice ration coupons. It is possible that many farmers did not expect rice ration coupons to be withheld from defaulters of Maha 1967/68 loans.

In Maha 1968/69, the credit approved and utilised was comparatively smaller – only Rs. 45.6 million or 74 per cent of credit given in the previous Maha. This decline in the aggregate sum lent is particularly significant as the per acre limit was increased from Rs. 220/- to Rs. 262/- per acre. Since data on the area serviced by loans are not available, we may estimate the area serviced in the latter season as a proportion of loans in the former, on the assumption that the amount of funds used per acre is the same in both seasons. The

TABLE III *New Agricultural Credit Scheme — Paddy Loans*
(Position as at end December 1969)

Season / Operations	Amount in Rupees Million				As Percentage of Amount utilised			
	Maha 1967/68	Yala 1968	Maha 1968/69	Yala 1969	Maha 1967/68	Yala 1968	Maha 1968/69	Yala 1969
Amount Approved	78.2	15.7	58.2	14.1	127.4	138.9	127.6	146.9
Loans Granted	61.4	11.3	45.6	9.6	100.0	100.0	100.0	100.0
Total Repayments of which:	51.9	9.4	24.3	5.0	84.5	83.2	53.3	52.1
Voluntary	42.9	8.9	23.2	5.0	69.9	78.8	50.9	52.1
Rice Ration Coupon	9.0	0.5	1.1	0.0	14.6	4.4	2.4	0.0
Crop Failure Extensions	0.5	0.2	2.6	0.1	0.8	1.8	5.0	1.0
Dues not in Default	0.0	0.0	0.5	4.1	0.0	0.0	1.1	42.7
Defaults	9.0	1.7	18.6	0.4	14.7	15.0	40.6	4.2

Source: *Rural Credit Department, People's Bank.*

area serviced by loans in Maha 68/69 may be estimated to be about 60 per cent of the area serviced in the previous Maha.[11]

This decline may be partly accounted for by the fact that the amount disbursed in Maha 1967/68 was above the actual needs for reasons mentioned earlier. Further, since defaulters were debarred from obtaining credit until loans obtained earlier were repaid either in cash or with rice ration coupons, several farmers would not have been eligible for loans. District-wise analysis of loans given in Maha 1968/69 disclose in several districts a positive correlation between the level of voluntary recovery in Maha 1967/68 and amount utilised in Maha 68/69 (Table 4).

TABLE IV *Comparison of Voluntary Recoveries and Subsequent Credit Utilization.*

	Rate of Voluntary Recovery in Maha 1967/68 Per cent	Maha 68/69 utilization as per cent of Maha 67/68 utilization
Nuwara Eliya	95.4	85.4
Kandy	93.1	76.3
Polonnaruwa	91.2	96.5
Badulla	86.3	82.0
Kegalle	85.5	21.9
Jaffna	84.5	88.2
Mannar	81.8	130.3
Ratnapura	80.0	61.6
Moneragala	79.7	99.4
Vavuniya	78.2	95.3
Matale	77.6	96.3
Colombo & Kalutara	75.8	23.1
Hambantota	75.3	78.2
Batticaloa	74.8	80.0
Matara	74.6	46.1
Kurunegala	59.0	37.8
Anuradhapura	56.5	81.0
Amparai	55.0	66.8
Trincomalee	54.9	63.2
Puttalam	50.9	64.3
Galle	47.2	16.1

Source: *Rural Credit Department, People's Bank.*

The extent to which reported increased productivity enabled farmers to self-finance their agricultural operations is not known but reported increases in incomes[7] and savings in the rural sector[8] support such a view.

Recoveries

Voluntary repayments were 69 per cent in Maha 1967/68, 78 per cent in Yala 1969 and only 51 per cent in Maha 1968/69 (Table 3). These levels of recovery are much lower than during the period when corporate responsibility was insisted on.

Several reasons accounted for the inability to achieve a higher level of repayments but the basic weakness was that while the People's Bank had replaced the Department of Agrarian Services and some of the mechanics of the scheme were changed, the most crucial link between the farmer and the credit agency – the co-operatives – remained unaltered. The introduction of the new agricultural credit scheme was not accompanied by any reform of co-operatives or an attempt to strengthen their management. Co-operatives had generally displayed weaknesses in management, the lack of supervision of lent funds and an inadequate vigilance to recover loans. In several instances co-operatives had misused funds. Co-operatives had no particular incentive to recover loans as the amount unrecovered may not be charged against them.[9]

A higher level of recoveries was expected on two grounds. First, because a commercial bank rather than a government department was disbursing credit it was assumed that there would be a greater degree of responsibility and fear of non-repayment. This does not appear to have operated in several instances. Farmers have once considered loans more in the nature of a grant rather than a loan. This attitude was fostered by these loans being disbursed again by the same village organisations – the co-operatives – and

[7] *Central Bank of Ceylon Annual Report 1968* page 29.

[8] For instance savings in rural banks increased from Rs 1.4 million to Rs. 3.3 million in 1968, and to Rs. 6.2 million at the end of 1969, Rural Credit Department, People's Bank.

[9] Information collected by Central Bank of Ceylon in a survey of default under New Agricultural Credit Scheme.

due to the introduction of the scheme being preceded by an amnesty on all loans taken prior to 1958.[10]

The withholding of rice ration coupons was expected to be a deterrent against non-repayment. In practice while it may have been a deterrent against default in the case of some farmers, others have shown a preference for repayment through rice ration coupons.[11] This is so as it may be more advantageous for a farmer to forego his ration rice rather than pay from income derived from the sale of paddy. A rice ration coupon valued at one Rupee is the equivalent of Rs. 15.64 per bushel of paddy while the guaranteed price paid to a producer is Rs. 14/- per bushel of paddy. Apart from the price advantage, payment with rice ration coupons is spread over a long period of time. The only disadvantage of this form of repayment is that the farmer is not eligible to a fresh loan till the entire loan is recovered and rice ration coupons are available for hypothecation.

Basic weaknesses in the institutional structure of paddy holdings had a significant bearing on the ability of farmers to repay. Small-sized holdings and the system of tenure were the most crucial of these. In the case of small-sized holdings the amount borrowed under the scheme may have been higher than required for cultivation and funds were expended on consumption. In such circumstances while a farmer's liability increased there being no commensurate increase in production he had no capacity for repayment.

In paddy lands cultivated under the Ande system of tenure and where for one reason or another, the provisions of the Paddy Lands Act of 1958 is not effective, the use of credit may have actually worsened a farmer's economic condition. This is so as the additional cost of inputs would have been fully borne by the farmer and facilitated by the credit scheme, while the proportion of the increased output

[10] *Administration Report of the Commissioner of Agrarian Services 1966—67*, p. kk 43.

[11] Survey of Default under New Agricultural Credit Scheme.

paid to the landlord as share rent, could be such as to leave the farmer with a net loss on the investment.[12]

Indebtedness to other sources was also a factor reducing the capacity for recoveries of these loans.[13] The greater vigilance of the private lender and his ability to bring pressure to bear on defaulters have resulted in their having a prior claim on farmers' incomes. Often private creditors ensure the recovery of their loans by collecting dues on the threshing floor.

The misuse of funds by co-operatives also accounts for a record of lower recovery. Loans not used by members or those recovered from them have been used by co-operatives for other purposes. Either due to the illiquidity of these funds or due to the unprofitability of their use, co-operatives have not returned these funds to the Bank.[14] This implies that repayment of loans from farmers was higher than repayment from societies to the People's Bank.

The extent of default, apart from its financial cost, raises the basic issue of reducing over time the number of credit worthy borrowers. Agricultural credit policies have shown this perennial weakness which renders it difficult to implement a programme of enhanced credit to meet increased cost of capital inputs necessary for higher productivity.

In Table IV, the district-wise voluntary levels of recovery of Maha 67/68 loans are compared to the levels of credit utilisation in the subsequent Maha 68/69. This discloses in several districts a positive correlation between the levels of voluntary recovery and subsequent utilisation of funds. Galle is the most striking instance of the district with the lowest recovery level and the lowest subsequent utilisation of funds. Other districts where low levels of voluntary recovery are matched with low levels of credit utilisation are Kurunegala, Amparai, Trincomalee and Puttalam. In Anuradhapura, however, where the level of voluntary recovery was low, the level of subsequent credit utilisation was relatively high. This may be accounted for by new farmers coming into the scheme.

Districts with high levels of voluntary recovery, Nuwara Eliya, Polonnaruwa, Badulla, Jaffna and Mannar also had high levels of subsequent credit utilisation. However, Kandy and Kegalle which had one of the highest levels of voluntary recovery utilised only 76 per cent and 22 per cent respectively of the previous Maha loans. Matara which had a moderate level of voluntary recovery displayed a sharp drop in credit utilised.

The lack of data on the number of new borrowers and the extent to which farmers have self-financed their cultivation, limits the conclusions which can be drawn from the above analysis. Yet, in general, the low level of repayments appear to have an important bearing on the continued expansion of the credit scheme.

Conclusion

The decline in the number of creditworthy borrowers may seriously jeopardise the long-term programme to achieve increased agricultural productivity by increased use of capital and material inputs. This points to the need to fashion an institution at village level capable of determining the credit worthiness of borrowers and the supervision of lent funds.

Changes in agricultural policy have so far not addressed itself to this fundamental requirement but been content to alter the procedure and amounts lent. Once this fundamental institutional change is effected it would be possible to follow a more flexibile credit policy permitting the credit disbursing agency to determine the precise magnitudes according to local needs. Such needed flexibility could include more varied credit limits corresponding to cultivation practices[15] and size of units.

[12] Several co-operatives have reported this to be a cause in the wet zone areas. They have expressed the sophisticated economic deficiency of a share croping system in interesting ways as for example one co-operative says "Loans could not be repaid as cultivation is carried on by farmers (sic) and not landlords". *Ibid.*

[13] *Ibid.*

[14] *Central Bank of Ceylon, Annual Report 1968*, p. 153.

[15] For a discussion of varied credit needs in different parts of the country see J. M. Gunadasa, 'Credit Schemes and Paddy Cultivation in Ceylon', in *The Journal of the National Agricultural Society of Ceylon*, Vol. 5, June 1968.

The development of a responsible credit institution at village level would also enable production credit to be determined on the basis of its impact on production rather than on the consideration of security and to supplement production credit with consumption credit which would in turn exert a beneficial impact on production capacity.

CROP INSURANCE FOR PADDY.[16]

A pilot crop insurance scheme inaugurated in the Maha season 1958/59, covered approximately 26,000 acres in five of the twenty two revenue districts.[17] This scheme operated on an administrative basis till 1961 when the Crop Insurance Act was legislated.[18]

The area covered by insurance was extended to around 65,000 acres in eleven districts in Maha 1962/63 and to its present extent of 200,000 acres in sixteen revenue districts in Maha 1963/64.[19] The area insured in the Maha season is also covered by insurance when cultivated in the Yala season and the total extent presently covered by insurance in both seasons is approximately 15 per cent of the total paddy area.

Main Features of Scheme.

Crop Insurance is compulsory in the areas covered by the scheme. It is an 'all risk' rather than a 'specific risk' insurance scheme in that damage caused to crops by a multiplicty of causes such as drought, lack of water, excessive water, floods, plant disease, insect infestations, wild boar and wild elephant destruction and loss of crops due to the introduction of approved methods of farming are indemnified.[20]

[16] The author has discussed this subject in greater detail in two earlier articles "Crop Insurance — An Assessment and New Directions" in *Central Bank of Ceylon Bulletin*, October 1968 and "Ceylon's Crop Insurance Experience 1958-1968. "*The Indian Journal of Agricultural Economics* Vol. XXIV No. 2 April - June 1969.

[17] *Administration Report of the Commissioner of Agrarian Services for 1959* p. kk 59.

(18) *Crop Insurance Act. No. 13 of 1961.*

(19) *Administration Report of the Commissioner of Agrarian Services for 1962/63* p. kk 64.

(20) *Ibid* p. kk 65.

The scheme was envisaged as a partially subsidised venture rather than an actuarially based self-financing self-liquidating one. Although on an actuarial basis, some areas require a higher and others a lower premium charge, the scheme operates on an uniform premium rate of Rs. 6/- per acre. With this uniform charge of Rs. 6/- per acre the aggregate dues are less than the actuarilly computed aggregate premium dues. This deficit - the premium subisidy - as well as the costs of administration were expected to be borne by the government.[21]

It is not compulsory for the premium to be paid prior to the commencement of cultivation. To make premium payment less burdensome there are provisions for the premium to be paid after harvesting, if desired and in kind when produce is sold to multi-purpose co-operative societies.[22]

The indemnity coverage varies from a minimum of Rs. 100/- per acre in both seasons to a maximum of Rs. 180/- per acre in the Maha season and Rs. 160/- per acre in the Yala season. The variation in coverage is dependent on both risk probability and productivity levels. Lower risk probability areas and higher productivity areas have higher indemnity coverages. However, in keeping with the insurance principle of limiting indemnity payment to only a proportion of normal income the maximum indemnity coverage is limited to 50 per cent of the average yield in an area. The yield is valued at the guaranteed price for paddy.[23]

As an incentive for the adoption of improved techniques of cultivation there is a higher indemnity coverage of 10 per cent, without an extra premium charge, for the adoption of improved techniques. These improved techniques are row-sowing, transplanting or row-transplanting of pureline seed, use of weedicides or weeding or harrowing and the use of approved fertilizer.[24]

[21] *Administration Report of the Commissioner of Agrarian Services for 1959*, p. kk 60.

[22] *Crop Insurance Act No. 13 of 1961*, Sections 7 (1), 11 (1) and 15 (4)

[23] *Ibid* Section 25.

[24] *Administration Report of the Commissioner of Agrarian Services for 1961—62*, p. kk 53.

Indemnity is payable proportional to both the stage of production at which crop loss occurs as well as the extent of loss. When loss occurs at a stage when re-sowing or replanting is still possible only 15 per cent of indemnity is payable. This covers only costs of initial sowing. When crop loss is after this stage but before flowering 70 per cent of indemnity is payable. Full indemnity is payable when loss is after flowering.

Indemnity is payable only if the extent of damage exceeds 30 per cent of average yields of the insurance unit.[25] Which is defined as the entire farm area cultivated by the farmer and not each individual plot. Notice of damage has to be given within 21 days.

Insurance Experience

In the eleven years of the scheme's operation actuarially computed premium dues exceeded indemnities paid by Rs. 0.44 million, the indemnities paid being 95.6 per cent of premium dues. Therefore, although the uniform premium rate of Rs. 6/- per acre was considered inadequate to meet indemnity payments, the ten years experience implies that the computed premia was higher than necessary.

The inability to collect premium dues has been the most serious setback to the scheme. Premium collection was only 37.9 per cent of premium dues. The short-fall in premium collection of 62.1 per cent has resulted in a deficit of nearly Rs. 6.16 million. Premium collection has accounted for only 39.7 per cent of indemnity payment.

Table VI indicates the sources of collection between 1965/66 to 1968/69. Most colleetions have been through recoveries made from indemnity payments. Recoveries from purchases under the Guaranteed Price Scheme varies with the attractiveness of the guaranteed price as against the open market price. The lower extent of recoveries in 1967/68 and 1968/69 were due to lower purchases under the GPS for paddy consequent on a higher open market price.

[25] *Administration Report of the Commissioner of Agrarian Services 1964/65* p. kk 53.

TABLE V *Paddy Crop Insurance — Financial Experience 1958/59 — 1968/69*

	Premium Due	Premium Collected	Indemnity Paid (including commission)	Short Fall (—) or Surplus (+) Between		
				Premium collected and Premium Due	Premium due and Indemnity paid	Premium collected and Indemnity paid
Rs. Mn	9.92	3.76	9.48	— 6.16	+ 0.44	— 5.72
Per cent of Premium Dues	100.0	37.9	95.6	62.1	4.4	—

Source : *Crop Insurance Division Dept. of Agrarian Services.*

TABLE VI *Methods of Premium Collection 1965/66 — 1968/69*

Methods of Collection	1965/66		1966/67		1967/68		1968/69		Total 1965/66 — 1968/69	
	Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%
Cultivation Committee	2,791	0.3	3,266	0.5	4,599	0.8	6,471	1.6	17,127	0.7
Guaranteed PriceScheme	265,426	32.0	151,438	23.9	17,782	2.9	12,274	2.4	446,920	17.3
Indemnity Payment	561,926	67.7	479,075	75.6	585,441	96.0	488,264	96.0	2,114,706	82.0
Total	830,143	100.0	633,779	100.0	607,822	100.0	507,009	100.0	2,578,753	100.0

Source : *Crop Insurance Division Dept. of Agrarian Services.*

The compulsory nature of the scheme and the concession afforded to farmers to pay the premium at harvest time entitles a farmer to claim indemnity coverage at time of crop failure without necessarily making a prior premium payment. When indemnities are paid all past premium dues could be deducted.

The recovery of premium dues from indemnities defeats a fundamental purpose of insurance of providtng the farmer with adequate funds at times of crop failure to tide-over till the next harvest. When several premiums are deducted from a single indemnity payment a large proportion of the indemnity may not be paid to the farmer at crop failure.

The inability to collect premium dues has been attributed to a lack of appreciation of benefits of crop insurance and the expectation of such benefits without an obligation to make payment. In low crop – loss probability areas the lack of response could also be attributed to the relatively high premium rates consequent on the averaging of premium rates.[26]

The averaging of premium rates raises the basic issue of equity in premium rates. A crop insurance programme attempts to spread losses over many persons exposed to the same risks; to spread losses over many areas and over many years. Merely balancing aggregate premium dues and indemnity payments over a period of years is inadequate.

Premium rates must ensure that persons of discernably different risk probability are not categorised in the same actuarial unit. Under the present scheme farmers in low-risk probability areas are in effect subsidising those in high-risk probability areas. The crop-loss probability in the sixteen areas covered vary from .010 to .122 in the Maha season and from .013 to 0.930 in the Yala season.[27] In terms of premium rates a farmer in a very low risk area who should pay an actuarially computed premium of Re. 1/- per acre does in fact pay Rs. 6/- per acre.

[26] Ministry of Planning and Economic Affairs, *Agricultural Development proposals* 1966—70, p. 141.

[27] *Ibid* p. 147.

The justification advanced for the rather extreme averaging of risks is that indemnity coverrates in low-risk areas are higher than in the higher-risk areas.[28] However, to a farmer in a low-risk probability area a higher indemnity coverage is no inducement as his expectation of obtaining indemnity benefits is low. It is more logical to offer insurance at lower cost to farmers with a lower risk probability and permit indemnity coverages to reflect production costs and productivity levels.[29]

Premium rates determined on an actuarial basis may be considered too high in certain areas. Instead of following the present practice of averaging premium rates, a subsidy could be given to meet the cost above a rate considered too high for payment by farmers. This subsidy as well as the administrative costs of the scheme could be borne by the government.

Areas where the crop loss probability is extremely high, such as lands around the Nilwala Ganga in the Matara district, should be kept out of the scheme, as their inclusion would be tantamount to an outright grant rather than the spread of risk over years of success and failure.

The linking of the Crop Insurance Scheme with the new Agricultural Credit Scheme could render both schemes more effective by increasing premium collection and loan repayment. In such a dovetailing of the schemes, the revised variable premium rates, reflecting more fully crop loss probabilities, could be added as a cost and the credit limit increased by this amount. The insurance premia would be paid direct to the insurance scheme, in the same manner as the fertilizer costs are paid at present direct to the Commissioner of Agrarian Services. The payment of insurance premia could be a condition of granting credit.

When crop loss occurs, a proportion of the indemnity could be paid direct to the credit agency and the outstanding amount spread, as at present, over three subsequent seasons. The proportions paid to the credit agency and to the farmer would depend on an assessment of the income needs of the

[28] *Ibid* p. 147

[29] *Ibid Loc cit*

farmer to tide-over till the next harvest. The production credit required by the farmer would be met by the subsequent loan.

The principle enunciated may be explained by an example. A farmer borrows Rs. 275 for an acre he cultivates. When crop loss occurs if he is eligible to Rs. 290 per acre and if it is assessed that the farmer requires Rs. 150/- to tide-over till the next harvest, Rs. 140/- is set-off against his loan. The outstanding sum of Rs. 135/- would be paid back at the rate of Rs. 45/- per season in the three subsequent seasons.

Apart from ensuring the repayment of credit, the easing of the farmers' economic difficulties at times of crop failure would be of general benefit. It would reduce their commitment to non-institutional high interest lenders which could have detrimental effects on production by decreasing their capacity for, and profitability of, investment.

In an attempt to keep premium rates within the paying capacity of the farmer, indemnity coverages have been kept commensurately low. Present coverages from Rs. 100/- to Rs. 180/- per acre, are around a seventh to a fourth of the value of the average national yield per acre and do not in many cases cover even costs of farm inputs obtained from outside. Evidence recently obtained suggest a total national average cost of paddy production of Rs. 373/- per acre. Total costs vary from a high of Rs. 650/- to a low of Rs. 280/- per acre. The cost of farm inputs purchased from outside average Rs. 321/- and vary from Rs. 221/- to Rs. 534/- per acre.[30]

Inadequate indemnity coverage fails to ensure that a natural hazard does not wipe away money and labour expended by a farmer in cultivation or enable him to continue his cultivation in the subsequent period without interruption. With inadequate indemnity coverage, despite crop insurance, a farmer may be driven into the hands of high interest money lenders or merchants and be again enmeshed in a

[30] Central Bank of Ceylon, "*Survey on Cost of Production of Paddy*" Colombo 1969. Appendix Table 4.

'vicious circle' reducing both his capacity for, and profitability of, investment. The upward revision of coverages and premium rates is justifiable in a context where the cost of inputs, average yields and price of paddy have risen.

The inadequacy of personnel to handle the scheme particularly at field level, has resulted in delays in indemnity payments taking between three to six months. These delays could defeat the objective of providing adequate relief at times of crop failure so essential in a peasant agricultural context of both inadequate personal savings and institutional credit.

At present it is possible to notify crop damage within as long a period as 21 days. This deprives field inspection and verification of claims thereby increasing the possibility of making fraudulent claims. This deficiency suggests a greater degree of decentralisation of the scheme particularly with the extension of the scheme to new areas.

Conclusion

Since 1963/64, the acreage covered by crop insurance has remained static at around 200,000 acres. The inability to expand the scheme has been mainly due to the high level of subsidy required consequent on the inability to collect premium dues. The implementation of this scheme on such a limited scale and that too as a subsidy measure and without fulfilling several of the objectives of an insurance programme, can hardly be justified. The crop insurance scheme needs to be revamped on the lines suggested with a view to increasing farmer participation in the scheme, to make the credit scheme more effective and to reduce the amount of government subsidisation of both the credit and insurance schemes.

BREEDING FOR MILK AND MEAT IN THE MID AND HILL COUNTRY REGION OF CEYLON.

V. BUVANENDRAN

THE lands under uneconomic tea and rubber in the mid and hill country areas which might be considered for crop diversification will not only extend over a range of altitudes but will also show a wide variation in other characteristics such as gradient, accessibility etc. The animal husbandry enterprise for the different areas and for any particular holding will, in addition to these factors be determined by the extent of the holding. For example, accessibility is not an important consideration for a farmer wishing to raise cattle for meat. However, the extent of the land is important, as these animals have to be kept on grazing if the enterprise is to be economical. Further, while even steep lands will be suitable for raising sheep, such lands may be unsuitable for dairying. In contrast to beef production, dairying can be undertaken even on small extents of 5 – 10 acres as animals can be kept intensively under a zero grazing system of management.

Though different types of livestock enterprises are possible depending on the type of land and the climatic zone, a factor common in all operations is that the land has to be brought under pasture. This involves a considerable outlay of capital both for uprooting existing tea and rubber plantations and for the establishment of pasture. If the returns are to be commensurate with the capital expended, it is essential that a high return should be obtained and hence the nature of the operation should be intensive with a high production of milk or meat per acre. Since the indigenous cattle of Ceylon are very low producers averaging only about 1000 lbs. of milk per lactation and a carcass weight of 135 lbs, it is evident that livestock enterprises on these areas have to be based either on exotic superior breeds or improved local stock. Improving indigenous animals by genetic methods is a long term programme and therefore cannot provide

an immediate solution to meeting the need for superior stock. Therefore exotic breeds suited to local conditions will initially have to be imported with simultaneous schemes to upgrade indigenous stock.

MILK

The considerable degree of success that has been achieved with the use of European breeds of cattle during the past three decades is ample evidence that dairy programmes based on exotic stock would yield excellent results if scientific practices of disease control are adopted together with the necessary degree of stockmanship. Though various temperate breeds of cattle were initially tried in the hill country government farms, the choice has finally fallen on three breeds—the Friesian, Ayrshire and the Jersey.

As regards the suitability of these breeds for the different climatic zones in the region considered, the Jersey because of its adaptability to heat would be more suitable for the relatively hotter regions in the mid-country though under a zero grazing system, it should be possible to keep even the Friesian and Ayrshire in the hot areas. All three breeds are however suited for the hill country zone.

Some of the vital statistics relating to production characteristics of the three major breeds are given in Table 1.

TABLE 1. *Production statistics of some temperate breeds of cattle**

Breed	Milk yield	Fat %	S.N.F. %	Total solids %	Total solids/ lactation (lbs.)
Friesian	7100	3.5	8.5	12.0	852
Ayrshire	6200	3.9	8.7	12.6	781
Jersey	5100	5.0	9.6	14.6	745

* *Milk yield data relate to production of these breeds in Government farms. Composition data were obtained from Blanchard* et al *(1966).*

The breeds differ considerably in their production characteristics which are particularly striking between the Friesian and the Jersey. While the Friesian has a higher

milk potential, the Jersey produces a richer milk with a higher fat and S.N.F. content. If the total yield of solids per lactation is considered, the Freisian still emerges as the superior breed because its higher milk more than compensates for its low total solids percent in milk.

The price structure for milk by the Milk Board is based on a floor price of -/35 cts. for milk of 3.5 percent fat increasing on a sliding scale of one cent increase for every 0.1 percent increase in fat. On this price scale, if one calculates the ruturns from milk on the basis of figures given in Table 1, it will be seen that the Friesian gives the highest return even though its milk fetches only the lowest price of -/35 cts. This is because the Jersey, though having a fat level of 5 percent receives only -/45 cts. whereas in actual fact, its milk is worth -/50 cts. It would therefore seem that the present price structure for milk where the maximum limit is placed at 4.5 percent fat, while suitable for a liquid milk market may not be realistic if the milk is to be used for conversion to spray dried milk powder. The item of importance in milk used for the latter purpose is the percent of total solids and therefore the price scale of milk used for this purpose should be based on the total solids with no ceiling on the maximum limit.

However, until price scales are revised, it will be beneficial for the farmer to have a mixed herd of approximately half Friesian and half Jersey so that he can enjoy the benefits of the higher milk yield of the Friesian and the superior fat concentration of the Jersey.

The discussions so far have considered only the merits of the various exotic breeds in a dairy enterprise. Though imports of animals are necessary in the first instance to provide the nucleus herds necessary to commence on a dairy diversification programme, it is essential that the resources of indigenous stock in these areas also should be harnessed to provide superior stock by the application of proper genetic methods.

Data from cross-breeding experiments which have been carried out in government farms between the Sinhala on the one hand and Jersey and Friesian cattle on the other, indicate that the productivity characteristics of the Sinhala

TABLE 2. *Lactation yields of Sinhala and their crosses with temperate breeds.*

Breed	Milk yield (lbs.)
Sinhala	1000
Jersey × Sinhala	2620
Friesian × Sinhala	3360

are vastly improved by the first introduction of exotic temperate blood (Table 2). It has now become clear that this superiority of the first cross is due to the existence of marked hybrid vigour probably because of the divergent background of the two breeds used in crossing. The presence of hybrid vigour in the first generation would imply that a further increase of temperate blood by backcrossing to the same pure breed would not result in an additional increment of hybrid vigour and therefore the increase in yield by further upgrading would if at all, be small. Therefore a rotational breeding programme involving two or more exotic breeds would provide a reasonable chance of achieving a greater degree of success than upgrading to one particular breed as the former exploits the maximum hybrid vigour resulting from a combination of two or more breeds. This method would also be advantageous from the aspect of milk composition since it would be possible to obtain animals giving optimal milk yield and composition by a proper choice of parental breeds. A suggested scheme of rotational breeding in the mid and hill country region is the use of Friesian, Ayrshire and Shorthorn/Jersey breeds cyclically, one breed being used in each generation (Table 3).

TABLE 3. *Scheme of suggested rotational breeding programme using Sinhala foundation stock.*

Generation	Sires	Dams	Progeny
0	—	Sinhala (S)	—
1	Friesian (F)	S	FS
2	Ayrshire (A)	FS	AFS
3	Jersey (J)	AFS	JAFS
4	F	JAFS	FJAFS

The cycle is now repeated.

BEEF

There is no doubt that a great potential for beef production exists in Ceylon both in relation to resources and demand. However, the restrictive price policy on beef that is being followed does not permit this enterprise to be developed as a viable industry since rearing of cattle for beef is uneconomical at the current prices.

The prospects for development of a beef industry on scientific methods in the mid and hill country regions seem promising if proper price incentives are available. Breeding of specialised beef breeds exclusively for beef is considered uneconomical even in most countries of the West and breeding policies based on such breeds are bound to meet with even greater failure in Ceylon because specialised markets for quality beef do not exist in this country.

Development of the dairy industry based either on pure breeding of exotic breeds or upgrading of indigenous stock would result in a spill-off of a large number of male calves as a by -product. Since one half of the calves born each year to dairy cows would be males and only a small number would be required for breeding, the majority would be available for beef production after a period of rearing.

Considering first the pure exotic dairy breeds, a comparision of growth rates of these animals with pure beef breeds reveals interesting information (Table 4). The Friesian is superior to most beef breeds in live weight gain/day and is exceeded only by the Charollais in this character, The Friesian therefore is an ideal animal both from the point of

TABLE 4. *Comparison of live weight gains of dairy & beef breeds. (Adapted from Barton* et al, *1968 and Hodges* et al, *1960).*

Breed	Live Weight Gain/Day (lbs.)
Charollais	2.45
Friesian	2.31
Ayrshire	2.00
Hereford	2.14
Aberdeen Angus	1.93
Jersey	1.62

view of dairying and beef. Even the Ayrshire has a comparable growth rate to that of traditional beef breeds and only the Jersey among dairy animals is inferior to beef breeds. Even with the Jersey, there remains the possibility of crossing this animal with other superior breeds to obtain progeny with high growth potentials. In fact, such a cross breeding policy is adopted by most Western dairy farmers using the culled cows and heifers. In this context, the Friesian and Jersey crosses are particularly valuable since these animals are not only good meat producers but are also superior dairy stock (Table 5).

TABLE 5. *Milk and beef qualities of the Friesian, Jersey and their hybrids (Robertson, 1949 and Barton* et al, *1968.)*

Character	Friesian	Jersey	Friesian × Jersey
Milk yield (lbs.)	7600	5200	7200
Fat (%)	3.12	5.65	5.05
Live weight % (comparative)	142.4	100.0	133.4
Growth rate (lbs/day)	1.49	1.13	1.39

Similarly cross bred bull calves sired by exotic bulls on indigenous cows in a rotational breeding programme as outlined earlier will have a much higher growth potential than indigenous stock and will thus be suitable for raising as beef animals.

It would thus seem that a vast potential for the development of a beef industry is offered by the surplus bull calves from dairy undertakings.

However, as the calf is fed on milk till weaning, the high cost of raising a calf to weaning age represents a prohibitive overhead charge on the calf and makes beef production costly. Therefore alternative subsititutes for milk such as artificial milk replacers have to be found which could be fed to the young calf after an early period on maternal milk. Such artificial milk substitutes are routinely used in calf feeding in advanced dairying countries and development of such calf feeds from indigenous ingredients will be an important requirement even in this country. The composition

of a typical early weaning calf feed (as a substitute for milk from the fifth week) used in Great Britain is shown in Table 6.

TABLE 6. *Composition of a typical early weaning calf diet used in Great Britain (Ministry of Agriculture & Food, 1965).*

Flaked maize	8 cwt.
Rolled oats	6 cwt.
Molassine meal	3 cwt.
Fish meal	2 cwt.
Soya bean meal	1 cwt.
Vitamins & Minerals	30 lbs.

SHEEP

In most countries with well developed livestock industries, sheep are normally raised on land unsuitable for dairying or beef. This is partly because beef and milk command premium prices compared to lamb. In Ceylon however, mutton prices are considerably higher than beef and it is therefore not necessary to relegate sheep raising to only the poorer lands, though sheep can be raised with profit even an such areas.

The milder climatic conditions of the regions considered in the present context offer the possibility of basing sheep husbandry on superior temperate breeds such as the Dorset, Border Leicester and South Down instead of poorer tropical breeds. Experimental data on the performance of these breeds are very limited but the results that have been obtained with a small flock of Dorset sheep at the Turbert Government Livestock Farm indicate that the prospects for sheep farming are promising. An annual prolificacy rate of 84 lambs born per 100 ewes joined and a growth rate of 0.3 lbs. per day with weights averaging 105 lbs. at one year have been obtained chiefly on grazing, though supplementary concentrate feeding was given to pregnant ewes. Other breeds such as the Border Leicester and South Down have not been adequately tested in Ceylon but judging by the experience of sheep breeders in other countries it would seem that a breeding policy based on crossing two or three breeds to combine the necessary characters of prolificacy, growth rate and carcass quality will have to be followed even in this country if optimum returns are to be obtained.

CONCLUSIONS

A good potential for grassland farming with productive species of pasture exists in the mid and hill country regions of Ceylon. In order to utilise this to the fullest advantage, animal husbandry programmes for milk, beef or mutton should be based on animals with superior genetic potentials. The milder climate conditions of these areas offer unique possibilities of raising productive temperate animals in such enterprises.

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TYRE MAINTENANCE IN AGRICULTURE

L. E. DE ZOYSA

IT is, indeed, a remarkable fact that with the cost of tyres invariably being the item of highest expenditure in the cost of vehicle maintenance, here in Ceylon, so little time and attention is paid to proper tyre maintenance. Once new tyres have been fitted to a vehicle here, it is a matter of running them to death. Very often, to a totally unnecessary and premature death. And if this is so, as it is, in the case of road vehicles, it is far more so in off-the-road vehicles, particularly tractors, trailers and earth-moving equipment.

Quite apart from the total absence of proper maintenance of tyres, some "on the spot" repairs done to damaged tyres are not only unbelievably crude, but cause such damage to the tyres that in next to no time they are competely ruined and unserviceable. The "bolt and nut" patch so common on local Agricultural and Industrial Tractor tyres is indeed as bad as plunging a dagger into a stab-wound in a man. There are several other repairs, like loose gaiters, shabby vulcanising, which far from arresting the immediate trouble, only aggravate it and render what could easily be a servicable tyre into something fit only for the junk heap.

In a broad sense, a tyre is made up of the tread, the casing, and the beads. The tread is that part of the tyre which touches the ground. The casing is made of several plies of cord and maintains the inflation pressure of the tyre required for supporting the load. The beads are the encased steel wire rings which fix the tyre to the rim. The tread is the most vulnerable part of the tyre, not only because it is subject to cuts and abrasion but being made of rubber which is constantly in contact with the ground, must wear out sooner or later. To offset this, manufacturers of tyres have so designed and constructed the casings as to make them suitable for rebuilding. In this way, a tyre can have several lives. Needless to say beads hardly over fail. It stands to reason therefore that proper tyre

care would not only ensure maximum service, but make it possible for a worn tyre to be reconditioned more than once.

The proper maintenance of tyres is neither expensive nor time consuming. A few routine precautions, and a tyre, though unlike the proverbial cat with nine lives, *can certainly have more than one.* Tyre maintenance can broadly be classified into the **Dont's** and **Do's.**

DONT:

1. *Don't overload.* Tyres are scientifically constructed to carry specific loads. The quick turnover from carrying 4 tons where a load of three has been specified can be offset soon enough by irreparable damage to tyres. A 20% overload will reduce the life of a tyre from 100% to 70%. A 40% overload reduces life to 51%.

2. *Don't under inflate.* Particularly in agricultural tractors, when they cannot get across soggy ground, the tyres are deflated a little to allow for better traction. The immediate objective of getting across heavy mud may be achieved but severe damage is done to the cord fabric and sidewalls by making the casing flex more than it is intended to. Under-inflation will cause, among other things, uneven tread wear, sidewall radial cracks, ply separation and loose or broken ply cords.

3. *Don't over inflate.* Very often when vehicles including trailers are overloaded, the tyres are over-inflated under the misconception that this nullifies the overload. Over inflation causes a high degree of stress and reduces the cords resistance against road surface shocks and abraisions, to say nothing of the pressure to be borne by the beads which could, under such stress, burst.

4. *Don't bleed tyres.* In operation, particularly in long hauls on hot roads, there is a heat build up inside a tyre. This would cause the air inside to expand, but the casing prevents such expansion. This results in increased pressure. If the tyre is allowed to cool, the pressure will return to normal, so that bleeding i.e. deflating when a tyre is hot, in unnecessary. Tyre pressures must always be checked when tyres are cool, preferably first thing in the morning, before vehicles set out on daily work.

CAUTION:

5. Do not drop the pressure guage on the ground.
6. Do not plug the guage on a value stem hole which is fouled by soil or sand.

DO'S:

A great deal of a tyre's success depends on the drivers knowledge of and attention to a tyre's functions.

1. Always operate under fixed conditions.
2. Always follow the recommended tyre pressure, load and speed specified by the manufacturer.
3. Pay close attention to road obstacles and hardness of road surfaces.
4. Check vehicles regularly. Misalignment of wheels and broken springs, uneven braking, will shorten tread life.
5. Check for oil leaks on to tyres. Oil is rubber's primary enemy. Oil on tread and sidewall will shorten the life of a tyre.
6. Check rims and valves carefully.
7. Check tyres regularly for cuts and abrasions. Early repairs to minor damage are much more economical. Repairs at a later stage, when deterioration has developed, requires more costly and more difficult repairs.
8. Above all, don't run a tyre to extinction, but do remove it while the casing is still strong and send it in for re-moulding. A considerable saving can be effected by this.

MINIMUM REQUIREMENTS FOR RE-MOULDING

1. In general, the suitable time to re-cap or re-mould tyres is when the tread has worn out to 80% of the original tread depth.
2. Even if the tyre is worn to the casing, it can be re-moulded provided the wear has not gone beyond the second layer of carcass chord (canvass).
3. This length of the cut on the inside of a tyre should be less than one half of the tyre section width. e.g. If the section of a 11.00 × 28 is 11", therefore the cut inside must be less than 5½".

4. Any two such cuts must not be less than 20" apart.
5. When there are several small cuts, their total length must be less than 1/2 the tyre section width.
6. The end of the cut inside the casing must not be nearer to the bead than 1/4 of the tyre section, e.g. if tyre section from shoulder to bead is 6", end of cut should be more than 1½" from bead.
7. Bead wire should not be broken or bent.
8. There should be no circumferential damage at the shoulder or side inside the tyre.

Tyres fulfilling these conditions can be successfully re-moulded to give them new life.

These simple rules if zealously observed will give owners of vehicles not only maximum life from new tyres, but at least one additional life for worn out tyres.

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