CROP YIELD, LABOUR PRODUCTIVITY AND TRACTOR PRODUCTIVITY ON MAIDSTONE MCP ESTATES

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Abstract

Crop yield and resource productivity data for the period 1977/78 to 1989/90 are analysed in order to identify strategically important trends and to derive new management action for the future. The results show that there was not a significant reduction in tons cane produced per hectare under cane, although the average tc/ha/100 mm available water fell from about 6,2 to 5,3. Some of this effect could be ascribed to the rising incidence of eldana borer. Improvements in resource productivity have been achieved over the period in spite of adverse environmental forces. The adaptation of agricultural practices to these environmental factors is also evident. Yield and resource productivity results indicate that there is scope for improvements in the foreseeable future.

Introduction

Maidstone Estates is located around Tongaat on the north coast of Natal. It consists of eight large estates with a total of 12 100 ha under cane. This area has recently been subjected to droughts, floods, eldana borer, labour strikes, wage hikes, local environmental protection issues and other economic factors affecting revenue and expenditure. These pressures have often been accommodated by adaptation of agricultural practices. The management of changes in the environment is reflected in crop yield and resource productivity data for the period 1977/78 to 1989/90. The identification of strategically important trends may form a basis for further planning. The paper is restricted to an assessment of crop yield and labour and tractor productivity. It excludes the management of input materials such as fertilizer, herbicides, nematicides and ripeners.

Materials and Methods

Measurement of crop yield in the sugar industry can be expressed in various ways, with emphasis on tons cane and tons sucrose per hectare, and each of these measures may also be related to time and estimated effective water use. Effective water is defined as all rainfall of less than 50 mm on any one day and 60% of total irrigation water applied. Rainfall was measured at single sites on each of the estates and related to the field yields on the same estate. No provision was made for incomplete canopy, soil type, soil depth or slope. The causes of changes in yield and corresponding changes in agricultural practices may be identified for the period under review.

"Overall" measures of labour and tractor productivity have frequently been used in the sugar industry. For labour productivity, the expression "men per day per 1 000 tons cane produced" includes all labour directly and indirectly used in the production of sugarcane. While this ratio will fluctuate from season to season as the size of the crop varies, it does provide a measure of "overall" labour productivity. Similarly, "overall" tractor productivity has been measured as "hectares under cane per tractor unit".

These measures of yield and "overall" resource productivity are also affected by the substitution of operations over time and by changes in factors such as variety composition, annual area under cane replanted and the composition of soils. Different agricultural practices, because of adverse changes in the environment, serve further to complicate an analysis.

"Direct" measurements of resource productivity in the sugar industry are less familiar than those for crop yield and "overall" labour and tractor productivity. Changes in "direct" measures of productivity do not integrate substitutions between labour-intensive methods and mechanised or chemical methods of operation. The concept of "total productivity" as an all-embracing common measure of agricultural productivity is distinctly absent in the sugar industry.

"Direct" productivity of labour and tractors is measured as the ratio of input: output, or output : input. Labour and tractor productivity can be measured for a farming operation by accumulating the amount of work completed in relation to the number of labour man-days or tractor fuel litres applied, e.g. tons cane per man-day or litres per 100 tons cane. There does not appear to be a standardised convention used in the sugar industry for the expression of "direct" measures of labour and tractor productivity (de Beer *et al.*[2]). The allocation of resources to each operation may vary from farm to farm. The convention used by Maidstone MCP Estates is probably peculiar to this particular situation and it was fairly consistent over the period 1977/78 to 1898/90.

Results and Discussion

Cane and Sucrose Yield

Fig 1 shows the fluctuation of cane yield per hectare under cane with time. Increasing the percentage area harvested reduced average age at harvest, tons cane per hectare harvested and sucrose % cane. Tons cane per hectare under cane tended to vary in accordance with the amount of estimated effective rainfall received by the crop. Variations in the yields of sucrose corresponded closely with variations in cane yield.

Cane yield per hectare under cane did not appear to decline significantly with the advent of eldana and consequent changes in agricultural practices. The average age of cane at harvest from 1977-1982 inclusive was about 18 months. From 1983-89 inclusive it was about 14½ months. Tons cane per hectare under cane was about 52 and 49 for the two periods respectively, but the average number of eldana per 100 stalks in consignments delivered to the mill increased from 2,4 to 6,4. Reducing crop age to control eldana borer adversely affected cane yield per hectare harvested and sucrose % cane. The lower cane yield at harvest adversely affected labour and tractor productivity and the lower sucrose content depressed cane quality. Productivity in terms of tons cane per hectare per 100 mm water fell from an average of about 6,2 during 1977-82 to about 5,3 during 1983-89. This may have been due at least in part to the increased incidence of eldana mentioned above. The measurement of tons cane per hectare per 100 mm estimated effective water is subject to error in both the numerator and the denominator. However, the consistent decline in water

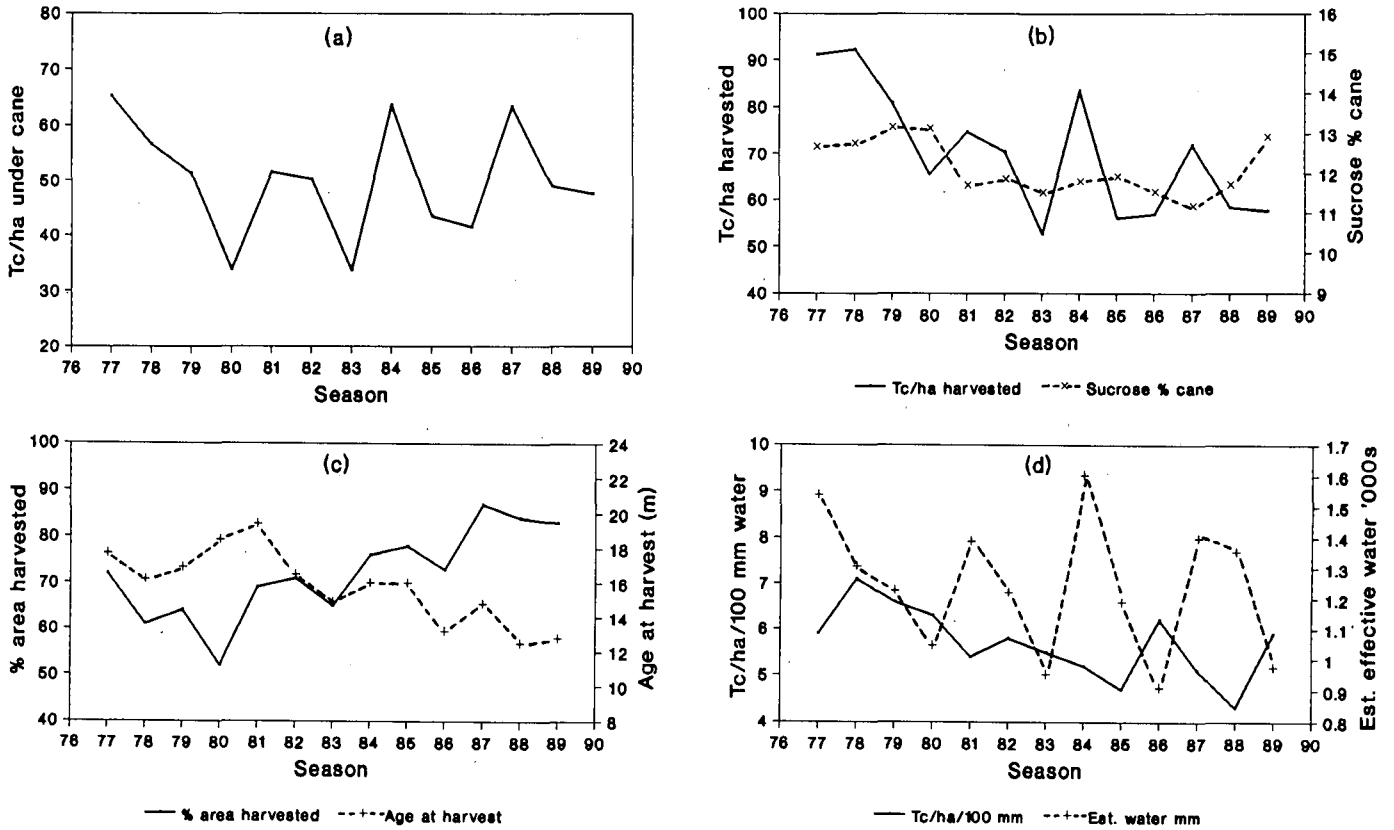

FIGURE 1 Analysis of yield data.

use efficiency may well represent real adverse effects on crop yield.

Fig 2 shows the extent to which replanting programmes were increased due to more frequent harvesting of crops. This is further illustrated in Fig 2 in that the sum of the areas under plant cane to fifth ratoon crops, expressed as a percentage of total area under cane, declined rapidly from 1980 onwards as age at harvest was reduced to control eldana. The disposition of cane varieties shown in Fig 2 indicates that NCo376 was the dominant variety throughout the period, but that from 1986 onwards the advent of N12 began to modify the disposition of varieties.

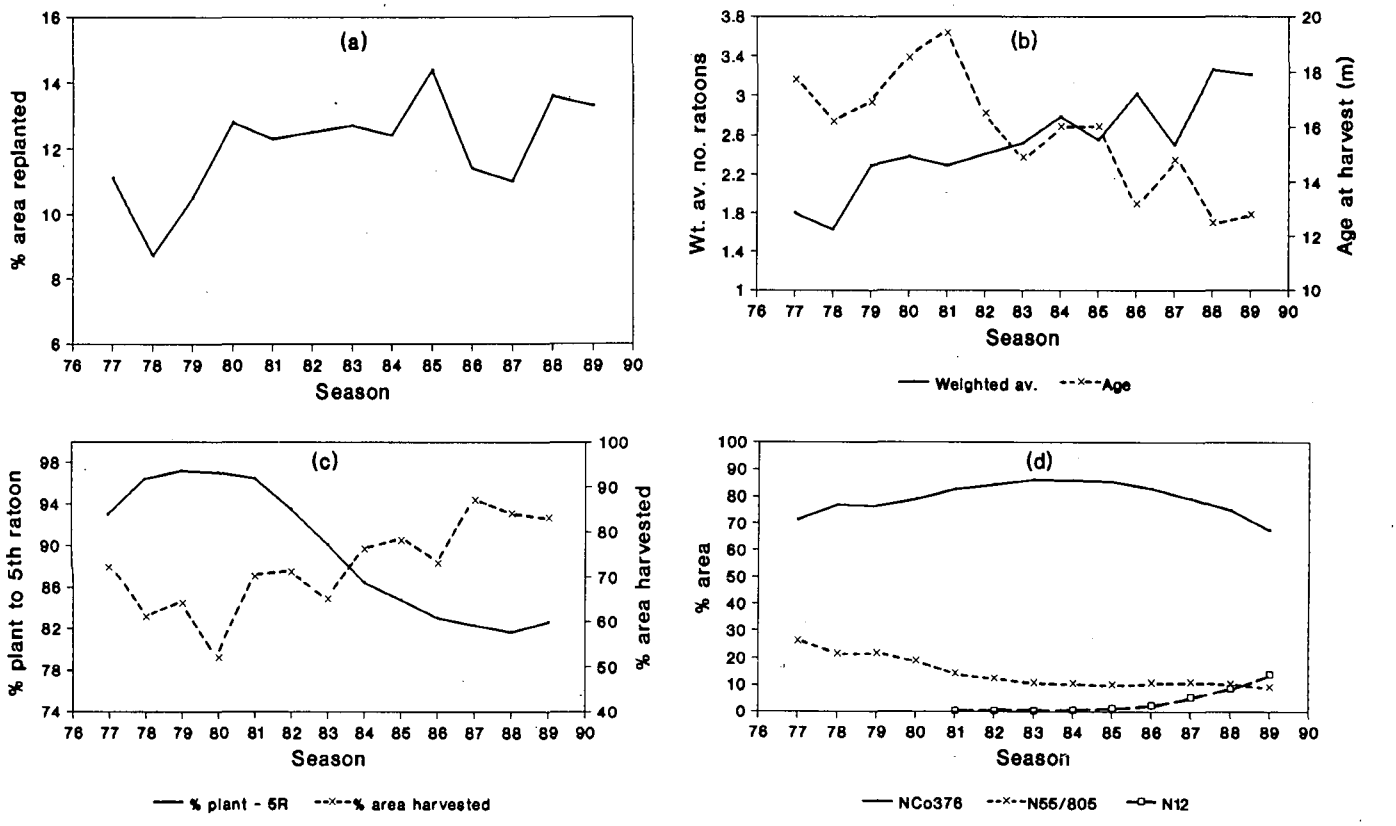

FIGURE 2 Effects of replant programs.

While the effects of reducing age at harvest on crop yield cannot be accurately quantified, the adverse effects on the overall crop composition are obvious. The required replanting programme will depend partly on the percentage area harvested because of the adverse effects of increasing ratoon number on crop yield. Crop yield will tend to decline more rapidly with succeeding ratoons due to increased frequency of harvesting but not necessarily in direct proportion. The observations and judgement of the estate manager will determine which fields are replanted. The inevitable effects of increasing the number of ratoons on crop yield will ultimately have to be compensated by adjusting the size of the annual replanting programme.

"Overall" labour productivity

"Overall" labour productivity for all operations, in terms of men per day per 1 000 tons cane produced each year, tended to improve, as shown in Fig 3. This occurred despite the adverse effects of larger replanting programmes, increased areas to be harvested annually, and the resultant increase in areas to be cultivated. Similarly, harvesting and infield transport productivity were adversely affected by lower yield per hectare harvested.

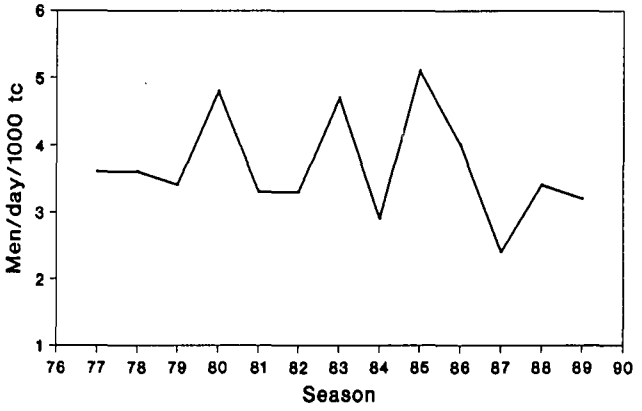

FIGURE 3 Overall labour productivity.

"Direct" labour productivity

Fig 4 shows how "direct" labour productivity of each operation changed over the period 1977/78 to 1989/90, and that it resulted in modified productivity standards. These standards are used for zero-base budgeting and for budget control.

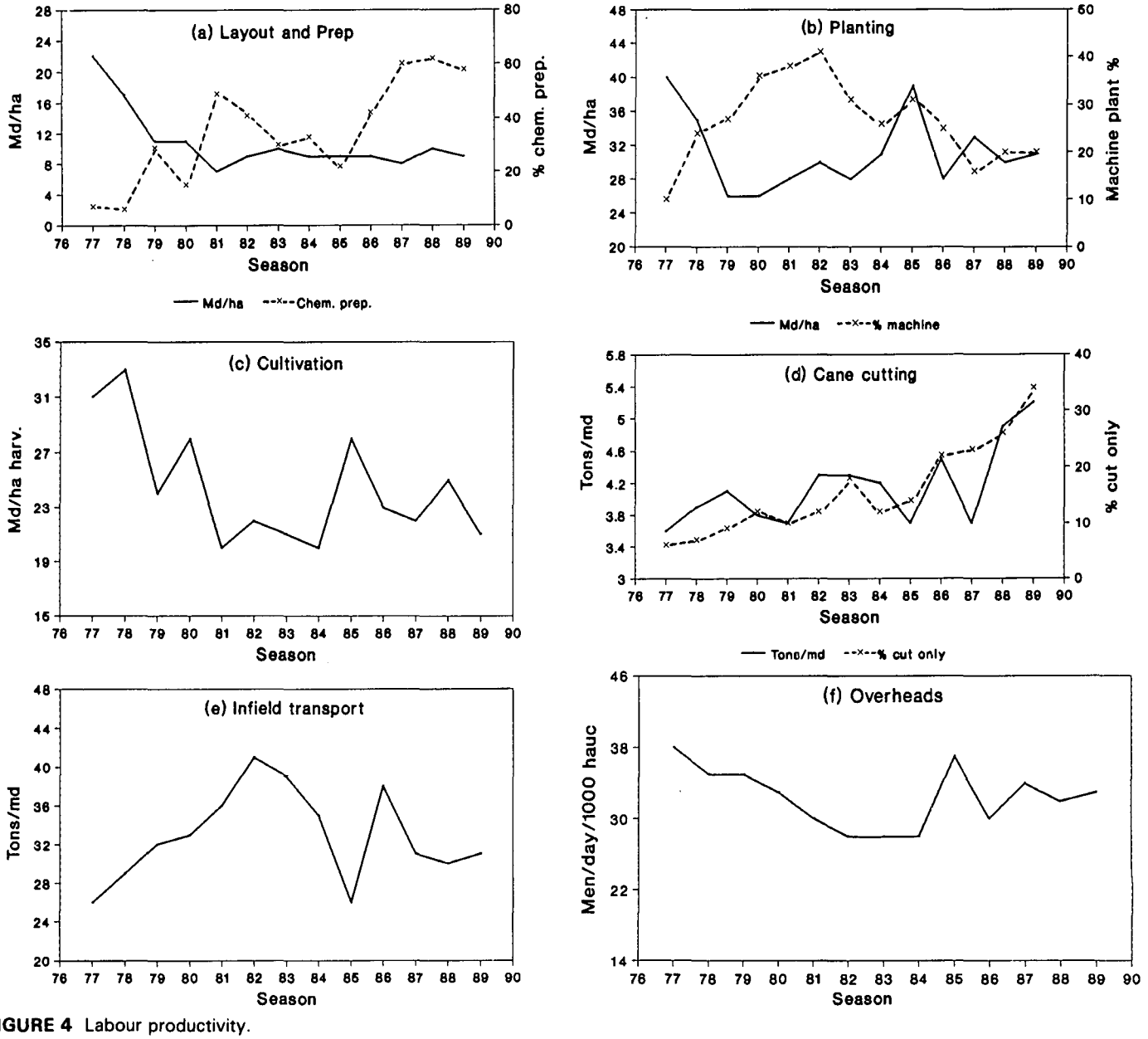

FIGURE 4 Labour productivity.

Field layout and land preparation labour productivity improved from 22 to about 8 man-days/ha as underground drainage and field layout operations for chopper harvesters were phased out. The increasing percentage of chemical preparation, using Roundup to kill the old crop, did not influence labour productivity, even when 60% of the programme was completed in this way.

Planting labour productivity improved from 40 to 26 man-days/ha because the area planted with filtercake was reduced. Machine planting reached a peak in 1982/83 and then labour productivity deteriorated as the area planted by machine decreased from 40% to about 20%. This decline followed poor germination in machine-planted fields. There is potential to improve productivity from 26 to less than 10 man-days/ha by planting transplants, which also provides a basis for higher yield per hectare under cane by reducing the length of time before full canopy is achieved (Boyce[1]).

Cultivation labour productivity improved from 32 man-days/ha harvested, and then fluctuated between 20 and 25 man-days/ha harvested. The effective use of herbicides contributed to the reduction of labour used for cultivation. The percentage of the harvested area that was burnt or trashed may also have influenced labour use on cultivation.

Cane cutting labour productivity improved consistently from 3,5 to 5,0 tons/man-day due to the introduction of the "cut-only" method, combined with grab loaders on relatively flat-land (0 - 12° slope). Mechanisation of infield loading was economically justified under these conditions. As the proportion of "cut-only" tons increased to 35%, labour productivity measured as tons/man-day improved, but this was largely due to the mechanisation of hand loading rather than to better performance of labourers. Mechanical cutting on flat-land will soon become economically viable, and the possible effects of AIDS on future labour availability cannot be ignored. Sub-contracting by cane cutters and complete contracting out of harvesting, could well enhance labour productivity and labour relations in the future.

Infield transport labour productivity improved from 26 to 40 tons/man-day, and then steadily declined to about 30 tons/man-day. This decline was caused by the reduction in payload associated with reduced yield of cane per hectare harvested. The major fall in 1985/86 was caused by the mid-season mill stoppage for one month. Further improvements in productivity will become possible through constant-grade roads, "horizontal" farming with strip cropping, double-bundle trailers and consequent direct delivery of cane to the mill.

Overhead operations include estate administration, machine maintenance, building maintenance and maintenance of roads and breaks. The moderate improvement of overhead labour productivity was due to rationalisation of estates to increase estate size. Chemical treatment rather than mowing of grassed roads, breaks and waterways will lead to improved labour productivity in the future.

"Overall" tractor productivity

The "overall" tractor productivity for all operations is expressed in Fig 5 as hectares under cane (HAUC) per tractor for each year. This is not a measure of the actual amount of work completed on the farm, nor does it indicate the direct use of tractor capacity per unit of work completed. Hectares under cane per tractor initially improved rapidly, as hectares under cane increased and the number of tractors required was rationalised. From 1982 onwards, changes in tractor units tended to follow changes in hectares under cane and stabilised at about 75 hectares under cane per tractor.

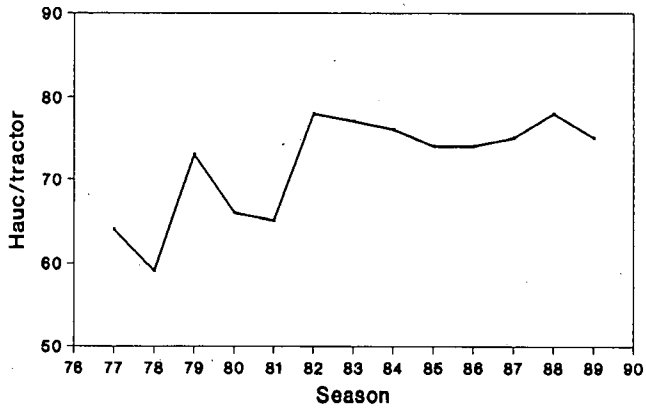

FIGURE 5 Overall tractor productivity.

"Direct" tractor productivity

Fig 6 shows how "direct" tractor productivity changed over the period 1977/78 to 1989/90 and resulted in modified tractor productivity standards, which are used for zero-base budgeting and for budget control.

Field layout and land preparation tractor productivity were improved when underground drainage and field layout operations for chopper harvesters were phased out, which resulted in a change from 180 to about 100 l/ha. The increasing proportion of the programme completed by chemical treatment then resulted in further improvement to about 60 l/ha. The proportion of the programme completed by chemical treatment will increase in the future (providing that the price of glyphosate does not rise steeply) and this change will improve tractor productivity.

Tractor productivity for planting tended to be stable at about 38 l/ha and then deteriorated to 50 l/ha, as the percentage of machine planting declined due to poor germination of plant cane. The introduction of transplants will reduce seedcane transport and furrowing, and could improve productivity to less than 20 l/ha.

Cultivation tractor productivity improved rapidly at first from about 22 l/ha harvested to less than 10 l/ha, and then remained stable. The initial improvement was associated with replacing mechanical weed control based on Australian practices with herbicides and eliminating the raking of trash and tops for the control of eldana. The continued use of effective chemical treatments for weed control, nematode control, crop nutrition and ripening of cane will probably not permit further improvement in tractor productivity on cultivation operations.

Infield transport tractor productivity improved rapidly from 52 to 36 l/100 tons cane hauled in 1984/85. The subsequent deterioration from 36 to 45 l/100 tons was caused by lower bundle weights due to the reduced yield per hectare harvested. Expected changes in infield transport in response to lower yield/ha, as described earlier, will lead to major improvements in tractor productivity.

Tractor productivity on overhead operations consistently improved from 50 to about 25 l/day/1000 ha under cane. This improvement of tractor productivity was again due to rationalisation of estates to increase estate size. The use of chemical treatment of grassed roads to control the rate of grass growth will lead to reduced mowing of roads and breaks and to a reduction of l/day/1 000 ha under cane.

Conclusions

Strategically important trends in crop yield and resource productivity have been identified. The adaptation of agri-

cultural practices to adverse environmental factors in the past was evident. Management action on the basis of these trends was generated in terms of possibilities for further immediate improvements in yield and resource productivity.

The potential for a further decline in yield/ha/100 mm of estimated effective water, due to eldana, is a major threat. Adaptation of current agricultural practices involves increasing replanting programmes as required, and monitoring of the decline of yield with succeeding ratoons. However, eldana resistant varieties such as N12 and biological control, could lead to a decrease in eldana numbers. There could then be opportunities to increase harvest age in order to retrieve some previous competitive advantages.

On each operation there are important opportunities for further immediate improvement in labour and tractor productivity. Detailed observation and analysis of each operation will lead to new approaches indicated by past performances. Special attention should be given to the concept of "total productivity" in order to optimise the combination of all agricultural inputs.

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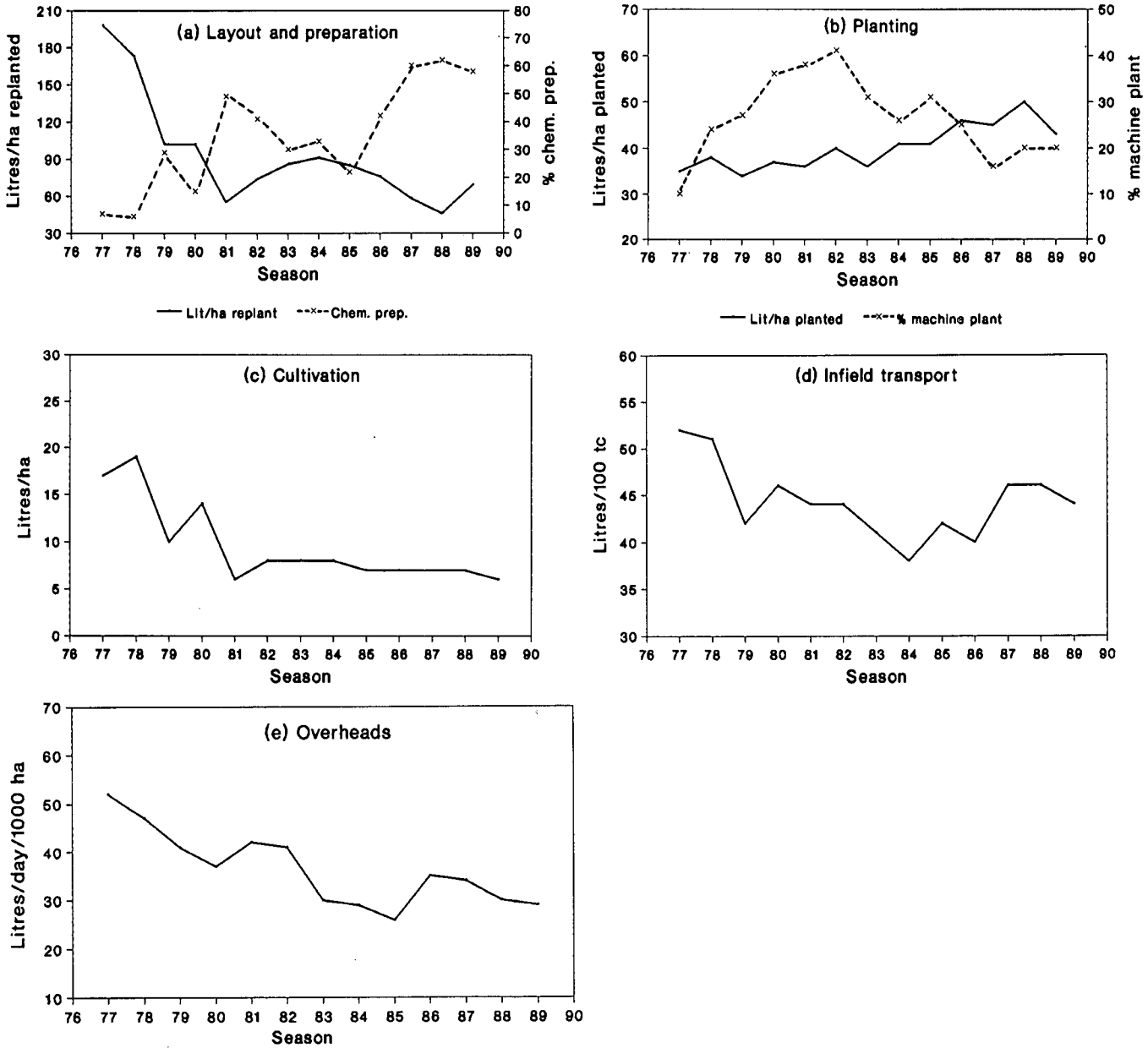

FIGURE 6 Tractor productivity.