A DESCRIPTION AND THE RESULTS OF PROGRAMMED WEED CONTROL ON A LARGE SUGARCANE ESTATE

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Abstract

A system of weed control with programmed operations and the control of herbicide usage is described. Ready mixed herbicides are supplied to the estates in 20 litre plastic containers from a centralised mixing plant. Use efficiencies are calculated according to the amount of diluted chemical used and the area of the sprayed field. This provides a check on the accuracy of the spraying equipment. The establishment of an operator task according to the type of applicator is discussed.

The programming of the new sequence of weed control operations for plant and ratoon cane has reduced the total labour used on weed control by 125 849 man days over six seasons. The weeding efficiency has improved accordingly from 15,2 man days/hectare to 7,8 man days/hectare over the same period. Since the implementation of this system an overall saving of R11 069 per annum on total weed control expenditure at current costs has been effected.

Introduction

The fact that weeds affect sugar cane growth has been reported by numerous workers. Almond and King[1] showed in a comprehensive trial that the difference in favour of weeded cane was 78,2 tons cane per hectare and an increase of 1,34 units in the sucrose percent cane. Pearson[4] reported that when weeds were eradicated before the formation of secondary cane shoots, an increase of 22 to 44 tons cane per hectare resulted. These findings emphasise the fact that the sugar cane plant is most vulnerable to weed competition during its early stages of growth. The value of chemical weed control was illustrated by Thompson[6] in an experiment at Illovo where he suggested that an expenditure up to the value of 22 tons cane or 3,08 tons sucrose per hectare to maintain weed control was very likely to be an economic investment.

On a large estate effective weed control is highly dependent on the timely execution of weeding operations. Furthermore, effective weed control is impaired by the increasing labour shortage and the build-up of other labour intensive operations during the peak weed growth period, usually after the spring rains. The use of a planned system of chemical weed control together with the judicious use of tractor cultivation has reduced the total labour requirements. Although a considerable monetary saving may be effected by the integrated use of herbicides and mechanical cultivators, even greater savings can be made by the efficient control of the mixing and application of herbicides.

The procedure at The Natal Estates Limited is to provide ready mixed chemicals to each estate from a centralised mixing plant where the mixing and rates of herbicides used are carefully controlled. The planning of both hand weeding and herbicide operations is done in consultation with each Estate Manager and follows a prescribed programme. This programme is flexible and may be altered if necessary.

An accurate control of herbicide usage on each estate is effected by this system. Any irregularities in herbicide usage in a field due either to faulty applicators or to the incompetence of the operator, is immediately recorded and corrective measures are taken.

The weed control system described in this paper does not preclude the use of hand weeding. Hand weeding is essential to remove localised patches of perennial grass although this is seldom labour intensive.

The programmed system of integrated weed control

(*a*) *Plant cane*

Planting operations commence in August and continue through to March. The sequence of operations for the control of weeds in plant cane is shown in Table 1.

Fertilizer is generally top-dressed eight weeks after planting when the effects of the pre-emergent herbicides have faded. Subsequent inter-row mechanical cultivation, in addition to covering the fertilizer, suppresses weed growth when the crop is at the root-transition stage and is consequently most vulnerable to herbicide damage (Rochecouste[5]). To control the in-row weeds and those emerging some two weeks after cultivation a post-emergent herbidice spray is applied. This controls most weed species until approximately sixteen weeks after planting. Mechanical cultivation and a spot weeding, either by hand or by a directed scorch type herbicide, may be warranted sixteen weeks after planting generally when weed re-infestation occurs. Directed sprays may be necessary to control persistent weed species until canopy formation. In certain instances, however, a further post-emergent herbicide spray may be required particularly if cane canopy formation is delayed. Experience shows that a light hand weeding using not more than 5 man days/hectare after the leaf canopy has formed is necessary to eradicate seeded *Sorghum* and *Panicum* species and prevent re-seeding of the field.

(*b*) *Ratoon cane*

Despite the many advantages of a good trash blanket (Wilson[7]) it is becoming increasingly difficult, in view of the

TABLE 1

The sequence of operations for the control of weeds in plant cane

Pre-emergent Herbicide	Fertilizer Top-dressing and cultivate	Post-emergent Herbicide	Inter-row Cultivate	Spot weed	Post-emergent Herbicide	Spot weed
Immediately after planting	± 8 weeks after planting; mechanically	± 10 weeks after planting and first flush of weeds	± 16 weeks after planting; mechanically	± 18 weeks after planting; by hand or chemically	± 20 weeks after planting usually for autumn plants only	Final hand or chemical weeding prior to canopy formation

TABLE 2

The sequence of operations for the control of weeds in burnt or lined ratoon cane

Line trash	Fertilizer top-dressing and cultivate	Pre-emergent herbicide	Inter-row cultivate and spot weed	Post-emergent herbicide	Spot weed
	As soon as possible after cutting (within 3 weeks)		± 10 weeks after cutting	± 14 weeks after cutting and first flush of weeds	± 22 weeks after cutting

TABLE 3

The sequence of operations for the control of weeds in trashed ratoon cane

Spread trash and spot weed	Fertilizer top-dressing	Post-emergent herbicide	Spot spray	Post-emergent herbicide	Spot spray
Within 3 weeks after cutting	± 6 weeks after cutting	± 10 weeks after cutting	± 18 weeks after cutting to control established grasses	± 24 weeks after cutting	As a directed spray prior to canopy

TABLE 4

The task area covered and number of men per herbicide operation

Applicator	Operation	No. 20 litre containers	Area covered hectares	Men required
Tractor mounted	Infield	125	6,6	1 driver + 1 assistant
Sprayer	Verges and breaks	75	4,0	1 driver + 2 operators
Knapsack	Infield	25	1,3	1 operator + ½ assistant

growing labour shortage, to maintain a suitable trash blanket. The resulting trash blanket is inadequate to suppress weed growth and chemical weed control is invariably necessary. Where possible the trash is lined mechanically over each alternate interrow which provides an adequate mulch on half of the land and bare soil on the remainder. In general, all fields harvested during the peak weed growth months (December, January) are left under a full trash blanket. Where ratoons are burnt prior to harvest, weed control follows a pattern similar to that described for plant cane. (Table 2.)

The faster growth of ratoon cane, particularly in summer, necessitates fewer herbicide operations. Consequently a cheaper short term pre-emergent herbicide, i.e. 2,4-D, is used. In ratoon cane all fertilizer operations are completed as soon as possible after cutting. Because the use of pre-emergent herbicides is not possible in trashed cane, the sequence of weed control operations is somewhat different and is shown in Table 3.

Weed growth in the cane row prior to canopy development may be effectively controlled by a quick-acting short-term herbicide directed onto the weed growth. This operation is neither labour demanding nor time consuming. Where there is an adequate trash blanket several spot sprayings are usually sufficient to control weed growth. The duration of weed control provided by the respective operations is highly dependent on climatic conditions. Lower weed populations and slower weed growth in winter require fewer weed control operations.

(c) *Field verges and breaks*

Both seed propagated and rhizomatous perennial grasses occur in abundance along the edges of cane fields, in the breaks and more specifically along national and provincial road reserves. These perennial weeds, if not checked in their early stages, will keep re-infesting adjacent fields and perpetuate the weed problem. Weed control on an estate, therefore, is directed at weed growth on both the verges and breaks and in the fields. Field verges are generally graded or bulldozed to enable weeds to be slashed back mechanically rather than controlled chemically. Where such operations are impossible chemical control by means of a tractor mounted spray system, using extension hand lances, is resorted to. A non-selective long residual herbicide combination is preferred for this purpose.

The control of weeds on the field verges and in the breaks is programmed for the days when the tractor mounted sprayer is released from infield operations.

Centralisation and control of herbicide mixing

Each estate manager is responsible for the control of weeds on his section. The sequence of weed control operations and the herbicides used are pre-determined in a monthly plan compiled by the estate manager. The programme is, however, flexible and is reviewed bi-monthly. The programming of operations is aimed at obviating the congestion of spraying operations during the peak weed growth period.

Herbicides are drawn from a centralised mixing plant by the estates' personnel each afternoon in preparation for spraying early the following morning. A requisition for each field stating the name of the estate, the field, the area of the field and the required herbicide, according to the monthly plan, is submitted to the mixing plant by the estate manager. Only sufficient herbicide for use during a single day is prepared. Mixing of the herbicide is carried out in one of four 2 000 litre mixing tanks. Mechanical agitators ensure thorough mixing of the herbicides in the tanks prior to decanting into 20 litre plastic containers. The herbicide is then ready for use in the field.

(*a*) *The daily work load or task*

The number of plastic containers used in a field during a single day is a function of the type of applicator used and the number of applicators available. A work load or task is established for each applicator (Table 4). For ease of handling the 20 litre plastic container is filled to the level of a moulding ridge on the container. The total volume of diluted chemical per container is then 16 litres.

The number of labourers required to carry containers and to fill the applicators remains fixed. A tractor sprayer requires one attendant whilst one attendant serves two knapsacks. (Table 4.)

(*b*) *Use efficiency*

According to the size of the field, the quantity of herbicide actually applied is compared with the amount that should have been applied.

Example:

Area of field . . . . . = 10,0 hectares
Number of containers used . = 170
Total diluted chemical applied = (170 × 16) = 2 720 litres
Tractor boom calibrated to apply 300 litre/hectare
Theoretical amount applied
(300 litre × 10,0 ha) . . = 3 000 litres
Use efficiency

$$\frac{2\ 720}{3\ 000} \times 100 \quad . \quad . \quad . \quad . = 90\%$$

A 20% variation in use efficiency is the maximum tolerated. Unacceptable use efficiencies result in the immediate re-calibration of the applicator.

No efficiencies are calculable for spot sprays or the spraying of field verges and breaks.

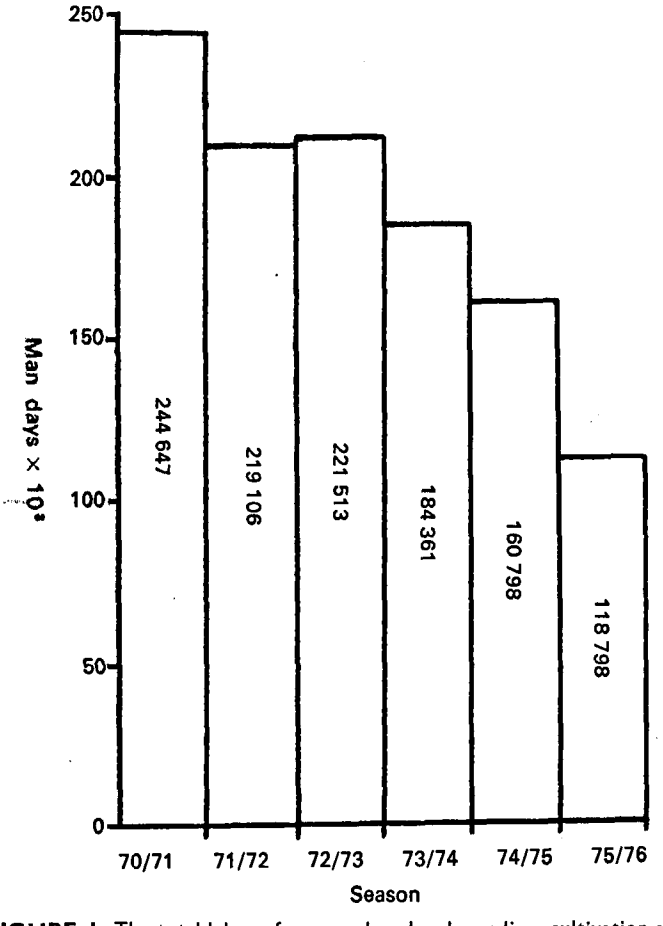

FIGURE 1 The total labour force used on hand weeding, cultivation and herbicide operations, in man days, for a 310 day season on 12 000 hectares over a period of six seasons.

(*c*) *Advantages of the system*

(i) An accurate control of herbicide expenditure and the consequent adherence to the overall herbicide budget is facilitated.

(ii) Faulty applicators are immediately discovered and re-calibrated before excessive damage or repeated inefficiency occurs.

(iii) The rates and components of herbicide mixes can be carefully regulated by trained and experienced staff.

(iv) Herbicide assistance to growers is simplified since growers may draw ready mixed herbicide from the mixing plant.

(v) Mixed herbicides do not stand for lengthy periods of time in the mixing plant. Settling out of chemical is minimised.

Results of the system

The total productive labour force used on hand weeding, cultivation and herbicide operations is presented in Fig. 1. The corresponding labour efficiencies in terms of units per hectare for the total labour force and the labour force used on hand weeding only is presented in Fig. 2. For ease of comparison the combined area controlled by the above operations has been standardized to 12 000 hectares and the seasons have been adjusted to 310 days.

From the 1970/71 season to the 1975/76 season a 51% reduction in the labour force used on hand weeding, cultivation

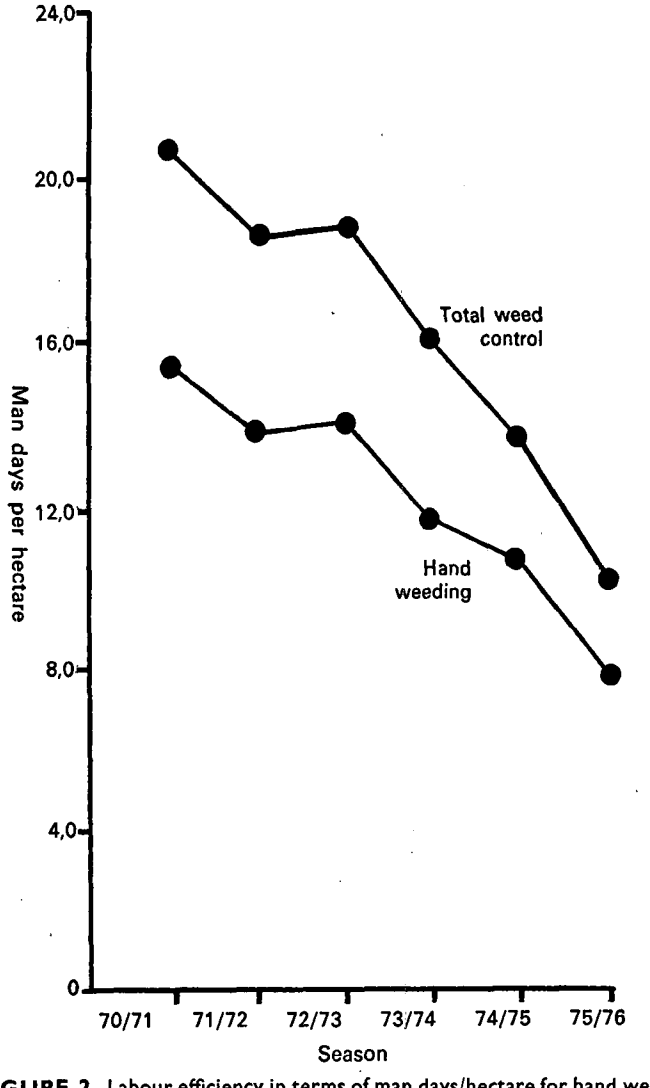

FIGURE 2 Labour efficiency in terms of man days/hectare for hand weeding and total weed control (hand weeding, cultivation and herbicice operations) over six seasons.

and herbicide operations has been achieved. This amounts to 125 849 man days or 406 men per day with a commensurate value of R251 698 per annum at current costs.

Although the total labour force has been reduced, the hand weeding efficiency has improved from 15,2 units/hectare in 1970/71 to 7,8 units/hectare in 1975/76. Since the introduction of resource planning in 1973/74 a visible improvement in the efficiency of all weed control operations is evident.

The total expenditure on weed control operations and the overall cost saving since the introduction of programmed chemical weed control is presented in Fig. 3.

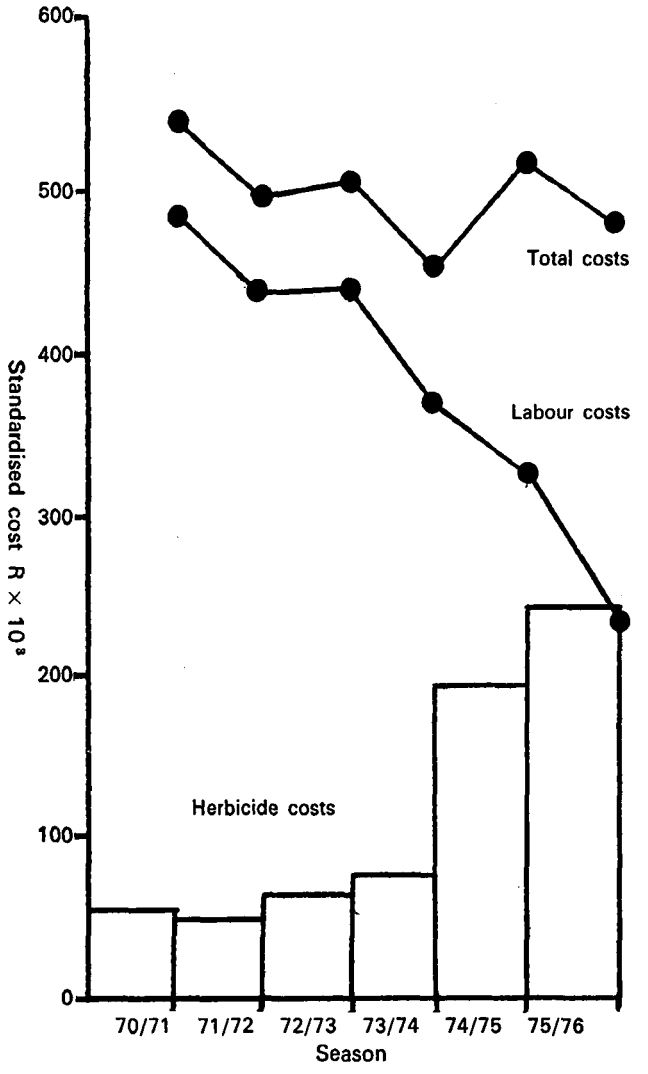

FIGURE 3 The influence of programmed chemical weed control on total weed control costs.

Expenditure on herbicides and labour has been calculated over the six seasons at current costs and is consequently an under-estimation of the actual saving achieved. The total money saved over six seasons is R66 416 or R11 069 per annum. Clearly the expense incurred in establishing the centralised herbicide mixing plant and the purchase of the necessary herbicide equipment is well justified.

The appreciable reduction in total weeding cost during the 1973/74 season was due to the severe labour shortage experienced during that period. This instigated the adoption of resource planning incorporating chemical weed control.

Discussion

The control of herbicide usage, labour and equipment resources on a large estate during the period of rapid weed growth is seldom accomplished without the appearance of weedy fields towards the end of the season. The demand on the labour force during this period is such that weeding operations usually assume a position of low priority. The implementation of programmed chemical weed control described in this paper has considerably lessened the abnormal demand curve described by Hill.[2] A reduction of 125 849 man days per annum over six seasons, as a result of this system, has largely contributed to an average labour productivity of 4,0 men/1 000 tons of cane. This is well below the industrial average presented by Hudson[3] in 1973 of 6,5 men/1 000 tons.

At its inception the aim of the herbicide programme was merely to substitute available resources (herbicide and equipment) for unavailable resources (labour). The monetary saving thus effected is evidence of the success of the system. The improved labour productivity in terms of men per 1 000 tons of cane and the easing of the labour demand during the cutting period is such that the necessary conversion to mechanised harvesting may be forestalled until more suitable harvesters are available for the local topography.

There are further aspects of weed control which warrant attention. The application of herbicides by semi-skilled labourers often results in poor herbicide performance or conversely severe crop damage. It is hoped that a recently introduced programme of audio-visual instruction to potential operators may overcome the problem of poor application. New and improved application equipment is continually being assessed with a view to improving both operator output and application efficiency.

Effective herbicide usage and control cannot be achieved without the programming of labour resources and operations. Similarly, the results achieved cannot be attributed to either operation alone but rather to the combination of the two.

Acknowledgements

Thanks are due to the management who were instrumental in developing the final system and in producing the results.

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