MECHANIZATION OF HIGH POPULATION SUGARCANE IN LOUISIANA

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ABSTRACT

Cultural practices and production system using commercial varieties of sugarcane and more efficient utilization of sunlight per unit area of the conventional 180 m row have increased the yield of sugar per hectare in Louisiana. Field mechanization from seedbed preparation through harvesting was developed to correspond to the non-conventional production system. A parabolic subsoiler was modified to provide a greater soil fracture area with less power than the conventional straight shank subsoiler. A wide furrow opener was developed to provide a furrow with a profile specified by an agronomist for optimum development to cover wide furrow planted sugarcane. Hydraulic motors connected in series provided power to modified chopper disk gangs. Adjustments were provided to vary the speed of rotation, soil lifting effect and width of cut of the disk. The conventional single bottom cutting blade for a soldier type harvester has an effective cutting width of 60 cm. The single blade was removed and a double blade cutting system was developed. The double blade system was capable of efficiently harvesting cane 120 cm wide.

INTRODUCTION

References are made to high population sugarcane as double drill, multiple drill, narrow row or wide furrow methods of planting. Each type of planting is an effort to increase sugar production per hectare. Louisiana State University and USDA research agronomists have experimented with various combinations of drills and row widths to produce higher yields using commercial varieties. These experiments were designed to utilize more of the sunlight per unit of growing area. Several types of planting using various cultural methods have been studied to increase the yield and positive results were obtained (Ricaud5). However the type of planting or cultural practice must be integrated into a production system. Field mechanization from seedbed preparation through harvesting must be coordinated and adapted into the production system (Cochran1). The development or modifi-
cation of four mechanical implements needed to mechanize the production of high population sugarcane in Louisiana will be discussed in this presentation.

MODIFIED PARABOLIC SUBSOILER

Soil compaction is a serious problem on sandy soils in the Louisiana sugarcane area. This is due mainly to the use of heavy field equipment during wet conditions and to the lack of effective subsoiling. The type of subsoiler used extensively in Louisiana consists of a straight 4 cm shank that opens a narrow furrow approximately 6 cm in width and requires considerable power to pull through the soil (Ricaud). Researches have found that shanks narrower than 5 cm tend to slice through the soil rather than fracture and lift it.

Tupper designed a parabolic shaped subsoiler for use in cotton which lifted and fractured the soil and required less power than straight shank subsoilers. The parabolic subsoiler was designed as a parabolic curve with a gradual increase in slope from $22^\circ$ at the foot to $55^\circ$ at the soil surface when operating at a 40 cm depth. In most cases under similar conditions the parabolic subsoiler can be pulled by a tractor using at least one higher gear than is needed for a conventional subsoiler that does not fracture the soil as well.

Wide furrow and multiple drills are planted over a wider area of the row sur-
face, therefore the width of the soil fracture area during subsoiling should be increased to obtain the maximum effects of the subsoiling operation.

The parabolic subsoiler was modified to provide a greater area of soil fracture. Wings were attached to the parabolic shank as shown in Fig. 1. The wings were constructed from sheet iron 1 cm thick and extended to a height of 61 cm from the bottom of the shank. Each wing was tapered away from the shank to provide a maximum spacing of 33 cm between the top of the wings and a minimum spacing of 15.2 cm at the bottom.

The modified parabolic subsoiler required more power to pull through the soil than the conventional parabolic shank but less than the conventional straight shank. Penetrometer readings showed that the fracture of the soil surface with the modified parabolic measured 1143 mm perpendicular to the direction of travel. The standard parabolic and standard vertical subsoilers measured 762 mm and 406 mm respectively (Haji-Jaafar2).

FURROW OPENER

One of the major problems encountered when planting cane in wide furrows was to keep the seed pieces spread to the outside edges of the furrow. In developing a wide furrow opener the design included a provision to open a furrow shaped with indentations along the outside edges. The wide furrow profile shown in Fig. 2 is desirable to assist in keeping the seed cane distributed across the furrow.
The implement for opening wide furrows was developed by modifying a commercial lister type plow. Parts of the wings on a 35 cm lister plow were removed and larger wings were attached to the plow share shown in Fig. 3 to provide the width of furrow desired. Each wing was positioned at a horizontal angle of 22° with respect to the center line of travel and the wing length was equal to the width of the desired furrow. Experimental results showed that the furrow opener should have a wing spread at the rear of the plow equivalent to 15 cm wider than the width of the furrow to be opened. The additional width was added to allow for soil falling back into the furrow after the opener has passed.

The desired furrow profile was obtained by making the rear of the wing a minimum of 7.5 cm lower than the bottom of the plow share. This dimension provided a deeper furrow on the outer edges to assist in keeping seed pieces on the outside extremities of the furrow during planting and covering.

![Furrow shape](image)

**FIGURE 2.** Profile of wide furrow for high population sugarcane.

Each wing had a curved shape to roll the furrowed soil away from the plow. There was no curvature where the wing was attached to the original lister plow. The portion of the wing that was curved increased from zero to a maximum of ½ the wing height at the rear. Lateral braces 20 mm in diameter were connected to the plow shank and the wings to stabilize the vertical movement of the plow during operation. Cross braces were used to support lateral forces on the wings.

**POWDERED COVERING DISK**

Proper covering of wide furrow planted cane is important. Seed cane must remain distributed across the entire width for wide furrow planting to be effective. Furrows up to 45 cm wide can be effectively covered using standard chopper disks. To cover cane planted in furrows greater than 45 cm, including 90 cm and 120 cm width, a powered disk implement was developed. The powered disks, shown in Fig. 4, lifted and moved the covering soil over the seed cane without forcing the seed pieces together.
Development of the powered disks began with two commercial chopper disk gangs with 3-60 cm blades. The outside disk on each gang was removed. A hydraulic motor was mounted and attached to the shaft positioned through the remaining two disk blades. Hydraulic motors were selected to rotate the two disks at a speed of 175 rpm. The two hydraulic motors were connected in series as shown in Fig. 5 to maintain a constant speed of rotation for each disk gang. A minimum flow rate of 40 liters per minute through the circuit with an operating pressure of 2200 psi available is recommended to power the disks. The hydraulic circuit may be attached directly to the tractor remote hydraulic system provided the tractor...
hydraulics can supply an adequate flow rate and pressure to operate the implement continuously. An independent hydraulic system was designed and mounted on the implement tool bar. A positive displacement piston pump was driven by the tractor power take off. Pressure relief and pressure compensated flow control valves were included in the circuit to protect the pump and regulate the disk rotating speed.

The chopper disk frame had adjustments so the vertical angle of the disk could be changed to vary the lifting effect of the disks. Adjustments in the horizontal angle could be made to change the width of the soil slice of the disk. Forward tractor speed also affected the amount and position of the soil moved by the disk. Combinations of the adjustment built into the implement provided adequate covering soil for cane planted in furrow widths up to 180 cm.

MODIFIED SOLDIER TYPE HARVESTER

Producing sugarcane from wide furrows requires cultural practices that maintain a flat row surface profile so maximum harvesting efficiency can be obtained. Producing high yields of sugarcane is not significant unless the crop can be harvested and delivered to the mill efficiently and economically. Louisiana has an efficient harvesting operation for cane produced on conventional drills and a large capital investment would be required to change from the soldier type harvesting system.

Research was directed toward modifying the conventional soldier type
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Pressure
Relief

Motor
Motor

A. Independent hydraulic circuit

Tank

Motor
Motor

B. Tractor connected hydraulic circuit

FIGURE 5. Hydraulic circuits for powered disk implement

harvester to harvest cane produced on wide beds. Results have shown that a single, 80 cm diameter bottom blade for a soldier harvester has an effective cutting width up to 60 cm. Harvesting cane wider than 60 cm with a single bottom blade leaves cane in the field and reduces harvesting efficiency. A double blade system for a soldier type harvester was developed by Cane Machinery Engineering Company and the LSU Agricultural Engineering Department to harvest cane wider than 60 cm including the maximum width that can be effectively produced on a 180 cm row. The double blades shown in Fig. 5 were 75 cm in diameter and positioned with one blade forward of the second blade to provide a 7.5 cm overlap of the inner cutting edges. The blades were powered hydraulically and connected in a series circuit. Additional hydraulic power was used to provide each blade with approximately the same power as a single bottom blade system.
FIGURE 6. Soldier type harvester modified with double bottom blades for harvesting sugarcane produced on wide beds.
The double blade operated simultaneously and could be raised or lowered to the same level without contacting each other. The cutting blades rotated in opposite directions inward which caused a sweeping action to move and orient the stalks toward the center of the harvester in line with the sticker carrier chain. Single blade soldier harvester can be modified with double bottom cutting blades but this modification should be done by experienced manufacturers.

REFERENCES


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RESUMEN

Los modos culturales y el sistema de producción usando variedades comerciales de la caña de azúcar y mas eficiente utilización de la luz del sol cada unidad de area de la línea convencional 180 m han aumentado el rendimiento del azúcar por hectarea en Louisiana. Mecanización del campo desde la preparación de la semilla por medio de cosechar fue desarrollado para corresponder al sistema no convencional de la producción.