A SELF-PROPELLED COMBINE HARVESTER FOR EXPERIMENTAL PLOTS

The essential requirements for a combine harvester for experimental plots of grain and seed crops are (1) that large quantities of grain are not retained in elevators, (2) that the machine is capable of thorough cleaning in a short time, (3) that the machine has a high degree of manoeuvrability, and (4) that the machine can harvest most of the important grain and seed crops included in the experimental programme.

Following is a detailed description of a prototype harvester developed to meet the above requirements as closely as possible and based on plot yields of 10-50 lb of grain from individual harvested areas up to 5 ft wide.

Description

General.—The machine is a self-propelled combine harvester of conventional arrangement, i.e. the crop is cut with a sickle bar, conveyed to a threshing drum by means of an auger and elevator, and the grain separated from the straw by means of reciprocating screens.

Fig. 1.—Side view of combine harvester

Sickle Bar and Elevator.—This is a conventional assembly, similar to that in use on several of the standard combine harvesters. The mown material is carried by means of an auger to the base of a centrally placed scraper-type

elevator, which delivers the material to the threshing drum. The movement of the material towards the auger is assisted by a rotating wooden slat reel. Provision is made for adjusting the height and forward position of the reel axis in relation to the sickle bar.

The reel is driven from the sickle bar, auger and elevator drive assembly, so its speed of rotation is related directly to the speed of the threshing mechanism. In certain conditions it is preferable for the reel speed to be related to the ground speed, and if this were required slight modification to the drive arrangements would permit the reel to be driven by one of the front wheels.

The sickle bar is fitted with comb-type fingers 2.4 in. long. Other types of fingers may be fitted if required.

The height of the sickle bar and elevator assembly may be regulated hydraulically, the range of adjustment measured at the sickle bar being from ground level to 3 ft from the ground. Removable panels are provided in the elevator duct and at one end of the auger to facilitate cleaning.

The effective cutting width is 5 ft, but it would be possible to fit a wider sickle bar, if required, and the entire front assembly could if necessary be replaced by a different type of collecting equipment.

Drum and Concave.—The drum is of open construction, 16 in. in diameter and fitted with eight rubber-faced bars, similar to those used in certain of the Allis-Chalmers combine harvesters. Metal rasp bars could be fitted if required. The clearance between the drum and the concave may be regulated between zero and 2 in. by changing the position of the drum shaft bearings. The drum is driven by a roller chain from the main drive countershaft and the sprockets on the countershaft and the drum shaft are readily interchangeable to provide variations in drum speed. Provision is made for adjusting the chain tension to suit different sizes of sprockets.

The concave is fitted with two rubber-faced bars. Provision is made for regulating the clearance between the lower of these bars and the drum. Additional bars, or bars of a different type, could readily be fitted if required.

The drum is provided with a hinged cover. The concave is hinged at the forward end and secured by two bolts at the rearward end so that it may be released and swung downwards away from the drum. Drum and concave are then fully exposed for cleaning.

Separation and Cleaning.—The threshed material is delivered by the drum into a reciprocating "weather-board" straw shaker. The grain falls through large louvred D-shaped perforations in the shaker and is delivered to the forward end of a screen with rectangular louvred perforations. It passes through this screen and through a lower screen with small D-shaped perforations and is collected in a removable tray carried beneath the machine. Two of these trays are provided so that at the end of each plot the full tray may be immediately replaced with an empty one. The trays are suitably shaped for pouring the contents into bags.

Any occasional ears or pods which may be incompletely threshed are collected in a removable tray at the rear of the machine, and they may if required be passed through the machine a second time. This arrangement replaces the conventional "repeat" mechanism of standard threshers, which has not been included in the design because of the extra cleaning involved when the machine is to be used for harvesting pure seed.

An adjustable canvas curtain is hung beneath the cover of the straw shaker to prevent the threshed material from being discharged at the rear of the machine before the grain has been fully separated from the straw. This is particularly important when small plots are being harvested because under these conditions there is little accumulation of straw on the straw shaker.

The straw shaker cover itself is held in position by four spigots and can readily be removed to facilitate cleaning of the shaker and screens. The shaker and the screens may themselves be withdrawn for cleaning.

Fig. 2.—Rear view of combine harvester

Aspiration.—Any light impurities are separated from the grain by means of a conventional centrifugal fan mounted forward of the screens. The volume of air may be regulated by restricting the size of the fan inlets, and the direction of the air flow may be controlled by means of movable baffles in the fan outlets.

Bagging Attachment for Large Plots.—The grain-collecting tray beneath the thresher has a capacity of approximately one bushel, which is more than sufficient for normal trial plots. If the machine is to be regularly used for larger plots or

for harvesting seed-increase areas, the collecting tray may be replaced by an elevator which delivers the grain to a bin with bagging outlets. The elevator is provided with removable panels to facilitate cleaning.

Fig. 3.—Harvesting an experimental plot of dwarf grain sorghum

Air-blast Cleaning Equipment.—A high-volume, low-pressure air supply is provided by a rotary vacuum pump operated in the reverse direction. The pump is mounted on the framework of the machine and driven from the main engine drive, which may be engaged as required by means of a jockey pulley tensioner applied to the drive belt. A suitable length of rubber hose, fitted with a tubular steel nozzle, is attached with a standard hose coupling to the pump outlet.

Power Unit.—A Ford 4-cylinder watercooled petrol engine is mounted above the straw shaker cover. This engine is designed to develop approximately 15 b.h.p. (12 hr rating) at a speed of 2000 r.p.m. The engine speed is regulated by a governor.

Drives to Threshing Mechanism.—The fan and the air pump are driven directly from the crankshaft extension by means of conventional V-belt drives. The remainder of the threshing mechanism is driven from a countershaft which is itself driven from the crankshaft extension by means of a double V-belt drive. This drive may be engaged as required by means of a movable jockey pulley which tensions the belts.

The chain drive from the countershaft to the drum shaft has been described. The sickle bar and elevator assembly, the straw shaker and screen eccentric shafts and the hydraulic pump for operating the sickle bar and elevator assembly lift are all driven by V-belt drives from the countershaft.

Chassis and Ground Drive.—The machine is built on a welded steel chassis and is carried on four pneumatic-tyred wheels, the sizes of which are quoted below in the list of dimensions. The drive is transmitted to the front wheels and the machine is steered by the rear wheels.

The machine is fitted with a "Dunstan" hydraulic transmission unit. The hydraulic pump forming part of this unit is driven from the main countershaft and activates a hydraulic motor mounted beneath the machine in the region of the front axle.

The pump and the motor are linked by flexible hydraulic pressure hose. The rotation of the motor is transmitted to the front wheels through two differentials. The drive is transmitted between the differentials by means of a roller chain. This type of transmission provides an infinite variation of ground speed between zero and 4 m.p.h. in forward and reverse direction and eliminates the clutch and gearbox of conventional drive trains. The maximum ground speed may be changed by fitting different sprockets in the drive to the second differential.

In the neutral position the transmission acts as a brake. A conventional hydraulic brake system is fitted to the front wheels for use in emergency should the transmission fail.

Controls.—The machine is controlled from a platform mounted on the off side above the front wheel. In the sitting position the operator's head is about 8 ft from the ground, giving him a clear view of the cutting mechanism. The machine is steered with a conventional steering wheel and linkage to the rear wheels. Forward speed is controlled by means of a lever and quadrant, the required speed being selected by engaging the lever in the appropriate notch in the quadrant.

The engine speed is regulated at the governor itself, but a hand control is provided within the reach of the operator to reduce the speed to a slow idle. The engine is started by means of a self-starter controlled from the operator's position. There is a foot pedal to operate the hydraulic brakes on the front wheels.

The drive from the engine to the countershaft is engaged by a lever at the side of the operator's position. The hydraulic jack operating the adjustment of the sickle bar and elevator assembly is also controlled from the operator's position.

Dimensions.—General dimensions are as follows:

Overall length	15 ft
Overall width	6 ft
Overall height	7 ft 6 in.
Wheelbase	7 ft 9 in.
Track	4 ft
Ground clearance	8 in.
Turning circle	29 ft
Weight	3,486 lb
Ground speed	0–4 m.p.h.
Tyre sizes—	
Front (driving wheels)	7·00 in. x 20 in.
Rear (steering wheels)	6·00 in. x 16 in.
Cutting width	5 ft
Cutting height	Ground level to 3 ft
Drum width	29 in.
Drum diameter	16 in.

Performance

The harvester has successfully harvested field experiments with soybeans and grain sorghums. It has also been used for threshing maize and *Dolichos biflorus,* the latter being a fine vining legume with seed somewhat similar to lentils.

The machine has been used to harvest soybean varietal trials in which it was necessary to harvest pure seed. It was found that two men could efficiently clean the harvester in approximately 10 min.

Credits

The specifications upon which the design of this machine was based were decided at a joint discussion held at Kingaroy between officers of Agriculture Branch, Department of Agriculture and Stock; Commonwealth Department of Primary Industry; and the principals of Kingaroy Engineering Works. Throughout the manufacture of the machine the authors assisted the manufacturers in a consultative capacity. The detailed design of the machine and its construction were undertaken by Kingaroy Engineering Works, Kingaroy.

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