

MANAGEMENT NOTES

GOLIATH—A LONG-BOOM RANGE SPRAYER¹

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Goliath, a long-boom, combine-chassis sprayer, was "born" from corner to corner of the machine shop at the Southern Great Plains Field Station, Woodward, Okla., in May 1962. His chassis, a used \$250 self-propelled grain combine, was made to support a 100-foot spray boom, Figure 1 left and center. He was built of spare and old parts of many origins.

Goliath has proved his ruggedness on over 4,000 acres of field tests on rangeland and cropland. He proved that his structural design was sound—that he could spray both night and day—that he could spray rangeland at 60 acres an hour, an acre a minute, at a normal travel speed of 5 mph—and that he could spray smooth cropland at 100 acres an hour.

Goliath was created for the Great Plains, where the land surface is relatively flat and smooth, where daytime wind velocities are usually high, where pastures and wheat fields are usually large, where low rates and low volumes of spray material are widely used, and where the cost per acre of applying herbicides frequently exceeds the her-

bicide cost.

Goliath has potential use wherever low-cost, rapid spraying of large acreages is desired. With slight modification, the sprayer could be used for insecticides, fungicides, growth stimulants, or liquid fertilizers.

Description and Construction

The chassis—A John Deere Model 55, 12-foot, self-propelled combine was first stripped of its cutting platform and separator unit.² The platform was replaced by a parallel-lifting support mechanism for the spray boom, and the separator by a 340-gallon spray tank, Figure 2, left and center.

In addition, the engine was moved from the top to the back of the combine to lower the center-of-gravity. The rear wheels were widened and equipped with a radius rod to increase stability, Figure 1 left. The front tires and wheels were replaced with aircraft tires and wheels to increase flotation, and the main frame was strengthened with two simple tension rods and stub braces, Figure 1, right.

The boom support—The rear portion of the boom support, or parallel-lifting mechanism, was rigidly mounted to the combine frame. The remainder of the boom support was hinged as a parallelogram so that the front portion could be raised and lowered in a vertical position. The boom support was then fastened to the hydraulic cylinders that formerly controlled the cutting platform.

A folding angle-iron frame was built on the front of the boom support to secure the front guy wires from the boom, Figure 1 left.

The boom—The boom was patterned after an 80-foot boom de-

veloped and used by the Bureau of Reclamation at Socorro, N. Mex.

Each side of the boom was made in two sections, plus a center section, making a total of five sections. The key to its success is flexibility. Materials used in its construction, the guy-wire system, and the hydraulic system on the boom support, all combine to create a rapid damping effect on oscillation and whipping-action of the boom.

The center section, 8 feet, was fastened to the underside of the boom support. Each of the outer boom sections was constructed from two lengths of galvanized, steel, irrigation pipe with a wall thickness of one-eighth inch, Figure 2, right. The inner section was 4 inches in diameter, the outer 3 inches. The booms were fastened to the boom support with a double-action hinge that enables the boom to pivot both up and down and back and forth, Figure 3, left. The hinge at the center of each outer boom was also a central point for the guy-wire support system, Figure 3 center.

Each outer boom can be raised or lowered independently by a hydraulic cylinder in its guy-wire system. It is essential to raise the outer ends of the booms when spraying near small sand dunes, when spraying over fences and small trees, or when crossing small ditches where the end of the boom might hit the ground.

The spray system

The spray tank was made by cutting the rounded sides from a used, 400-gallon gasoline tank. Two baffles and an agitator were then mounted in the tank. A transparent plastic tube was mounted vertically on the front of the tank and calibrated to serve as a fluid gauge.

The agitator was a used, 12-inch propeller from an outboard motor. When turned at 550 rpm inside the 340-gallon tank, it made an excellent emulsion of oil, water, and herbicide. The agitator was controlled with the former grain-elevator clutch.

The pump was a used, belt-driven,

¹Based on cooperative work of Crops Research Division and Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma; and the Missouri Agricultural Experiment Station, University of Missouri.

²Mention of commercial products and companies throughout this article is for identification, and does not imply indorsement or recommendation by the U. S. Department of Agriculture over others of a similar nature not mentioned.

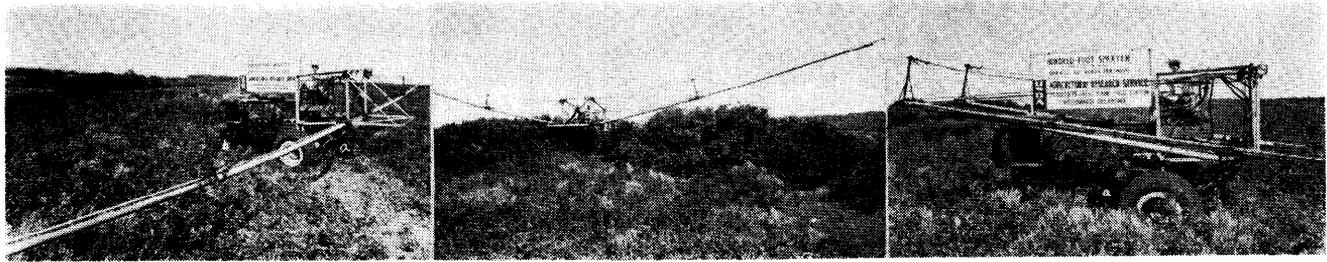


FIGURE 1. *Left*—Boom in near-horizontal spraying position. Note front guy wires on boom (a). Rear guy wires (hidden by other wires) fasten to sprayer frame. A radius rod was added to the widened rear wheels (b). *Center*—Boom and boom support in raised position in 10-foot shinnery oak. Slack wires on boom are for safety. *Right*—Sprayer in traveling position—overall width, 10 feet. Folded boom is chained to a cradle mounted in front of motor. Note tension rod and stub braces under sprayer frame (a).

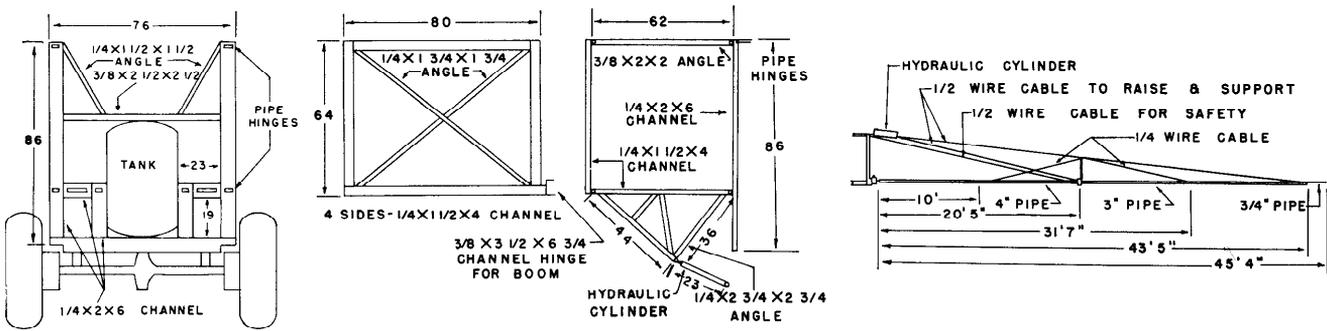


FIGURE 2. *Left*—Sketch of center-mounted, 340-gallon tank and channel-iron support for parallel-lifting mechanism. *Center*—Parallel-lifting mechanism for the spray boom; front view on left, side-view on right. *Right*—Sketch of left boom.

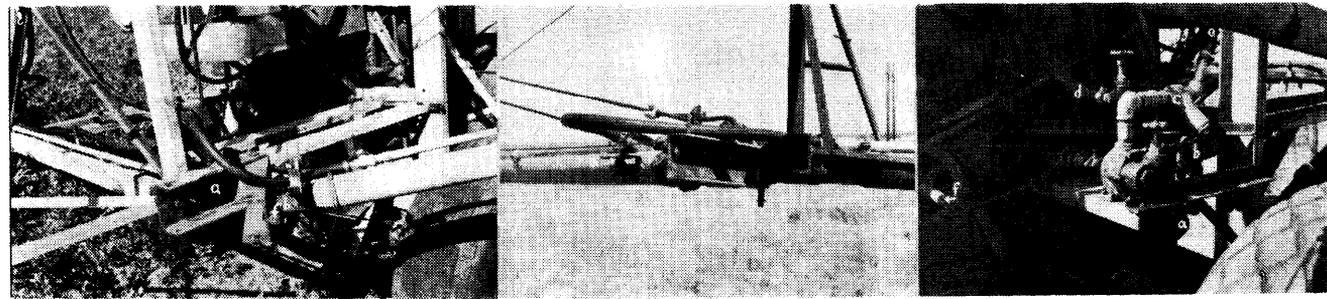


FIGURE 3. *Left*—Double action channel hinge (partially opened) (a), and pipe hinge (b) for inner end of boom. *Center*—Hinge at center of left boom. Also a central point for the guy-wire support system. Note mounting of nozzle and fluid-line bracket on web-belt material to prevent vibration leakage (a). *Right*—Pump unit showing end of shop-made cloth strainer (a), 50-mesh strainer (b), 100-mesh strainer (c), tank line for filling tank with sprayer pump (d), boom line (e), and drive shaft for propeller-agitator (f).

gear pump with a pressure range of 10 to 65 pounds and an output rate of about 50 gallons per minute at 1500 rpm. The pump was driven from a pulley on the agitator shaft and was controlled by the grain-elevator clutch, Figure 3, right.

Effective line strainers are the key to spraying success with low-volume sprayers. The first of 3 strainers was made from a used, 4-quart, oil filter by replacing the filter unit with a 4-inch, thin-wall pipe with numerous 1/4 inch holes, Figure 3, right, a.

A heavy-duty cotton sock was placed over the 4-inch pipe to serve as a coarse strainer. It proved highly efficient.

The second strainer was a commercial gasoline strainer with a 50-mesh screen, Figure 3, right, b. The third strainer (Spraying Systems Co., Bellwood, Illinois, line strainer, Model 1/4 ATWAL) contained a 100-mesh screen, Figure 3, right, c.

In addition to the 3 line strainers, each of the 50 nozzles on the boom was equipped with a 100-mesh

screen. The importance of using clean water or oil in the spray tank and of having numerous, efficient strainers cannot be over-emphasized. The cost of nozzle-cleaning comes high—an acre a minute!

The fluid line was made from 10-foot lengths of 3/4 inch, inside-diameter, heavy-wall, aluminum pipe fastened end-to-end with rubber heater hose and hose clamps. Holes were drilled in the fluid line every 24 inches, and Split-eyelet, Teejet, flat-spray nozzles (Spraying System

Co.) were installed.

Nozzle No. 7421 was alternated along the boom with nozzle No. 7421-TD which was used to fasten the fluid line at 48-inch intervals to the boom—using a flexible mounting, Figure 3, center, a. When tested, there was no measurable loss of pressure in the fluid system when volume output was 3 to 10 gallons per acre.

Orifice tips can be interchanged easily to vary output of spray material per acre. When orifice-tip size 650067 was used with a 24-inch nozzle spacing, a boom pressure of 25 pounds, and a sprayer speed slightly under 5 miles per hour, a total of 3 gallons of spray material was applied per acre.

The spray material in each section of the fluid line can be drained into the main tank by opening individual valves when the boom is in its top position. This saves about 3 gallons of spray material and eliminates prolonged boom dripping that could be a hazard to susceptible crops.

Pressure control was obtained with a 3-unit Directo valve, a pressure-relief valve, and a pressure gauge (Spraying Systems Co.) mounted in front of the operator. Each section of the boom was controlled independently to save spray material when spraying narrow strips as a field is completed and to permit the up-wind boom to be shut off when the sprayer is turned. This action helps keep spray material off the operator.

Other specifications—Overall length 25 feet; road height on trailer 12 feet; weight, empty, 7,770 pounds; boom height at center 5 to 7 feet;

boom height at outer ends 6 to 18 feet; speed .5 to 10 mph; spray output 1.5 to 40 gallons per acre.

Field Tests

The long-boom sprayer was used to spray sand sagebrush (*Artemisia filifolia Torr.*), shinnery oak (*Quercus havardi Rydb.*), and weedy cropland during three summers. Its performance was excellent. The machine had power and traction to spare. It climbed dunes easily, was stable on moderate slopes, and was generally less tiresome to ride than a large farm tractor. The variable-speed belt-drive mechanism proved invaluable to slow or gain speed rapidly without causing the boom to whip.

No major breakdown occurred. A break-away system was first installed on the boom so it could swing back if it struck an obstacle. This caused excessive fore-and-aft movement of the boom. The excessive movement was stopped by using fore-and-aft guy wires on the boom and by using steel pins in the boom hinges.

Most new machines have their faults, and Goliath was no exception. The sprayer had less-than-desirable braking power and steering leverage. Also, it was necessary to slow down when crossing deep cattle trails or small gullies to prevent excessive boom whip. Rapid stops also caused considerable whipping of the boom, and excessive spray drifted onto the operator under some conditions of wind and rough terrain. These limitations were partially compensated for as the operator gained experience. Some tire damage was experi-

enced on shinnery oak rangeland where numerous, short, sharp-pointed, fire-hardened stems are a hazard to all rubber-tired vehicles.

Estimated Costs

Accurate costs for construction, maintenance, and operation are not available. Estimated construction cost of a similar long-boom sprayer is \$1,000 for materials and \$500 for welding labor. Estimated operating cost for spraying is 10 cents per acre for gas, oil, repair, depreciation, and interest on investment—if it is assumed 10,000 acres are sprayed per year. Estimated labor cost for spraying is 18 cents per acre—if a 4-man crew and a work-day spraying rate of 30 acres per hour are assumed. Estimated out-of-pocket spraying costs are absurdly low—2 cents an acre for gas, oil, and grease, and 4 cents an acre for repair.

Custom Spraying

The long-boom sprayer has potential for day and night application of herbicides and other spray materials to relatively smooth rangeland and to many crops grown in large fields. It also has potential as a valuable adjunct to aerial spraying (1) for small acreages, (2) for windy and high-thermal periods, and (3) for spraying near susceptible crops. For instance, Schmitt Brothers Aerial Sprayers, Park, Kansas, built a long-boom combine-chassis sprayer in April 1963. The machine was patterned after Goliath, and during its first month, it successfully sprayed over 3,000 acres infested with army worms as well as several hundred acres of weeds in fallow wheat.

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