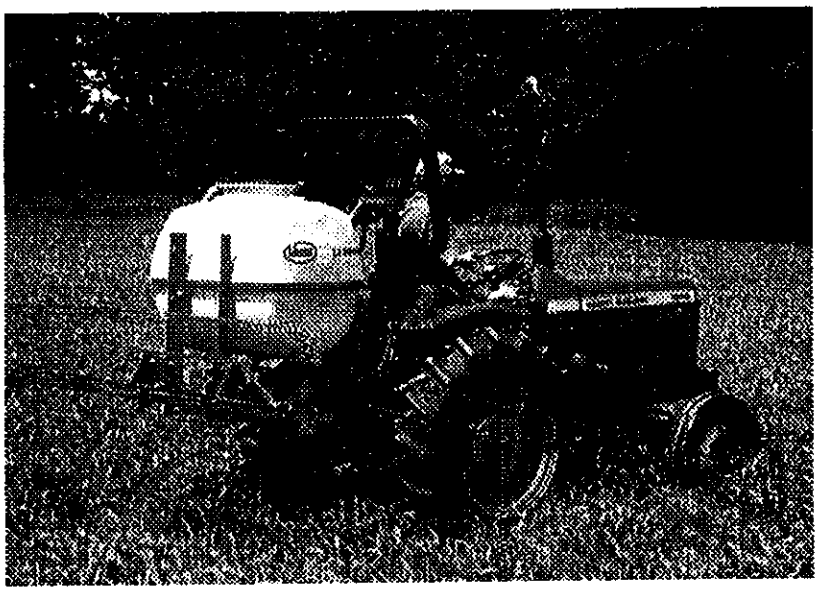
Project Number 54
September 1988

# Small Agricultural Tractors For Wildfire Use



*Roscommon Equipment Center*

Northeast Forest Fire Supervisors
*in Cooperation with*
Michigan's Forest Fire Experiment Station

Updated, September 1989

DNR

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**Acknowledgments**

The project was suggested by the Vermont Forests, Parks and Recreation Agency. Primary research was done by Jerry Kasik, an Agricultural Engineering student at Michigan State University, as part of a cooperative education program at Michigan's Forest Fire Experiment Station.


**Disclaimer**

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# INTRODUCTION

The use of foam and wet water for wildfire control and prescribed burns has been used by many agencies.

Tankers (engines) have been used to apply foam, but are large and may not be maneuverable enough to use efficiently in some areas in the northeast.

This project resulted from a request by the Vermont Forests, Parks and Recreation Agency to develop a tank with a power take off (PTO) driven pump which could be mounted to a 3-point hitch on a 4 wheel drive agricultural type tractor. This unit could increase productivity on prescribed fire by allowing more rapid firing during an already narrow burn "window". Expected cost benefit for a prescribed fire may be as high as $5 to $10 reduction per acre for areas of limited access.

The initial parameters for the tank requested by Vermont consisted of a 60-80 gallon tank with an auxiliary tank for foam concentrate, 50 to 75 feet of hose on a take-up reel, foam nozzle (aerated type), a fluid level indicator and drafting capabilities for refilling the tank. These parameters were expanded during the evaluation to include the following: side stability (minimum 15 degrees/26 percent), rear stability (minimum of 26 degrees/50 percent), tank capacity (minimum 50 gallons), tank construction (corrosion resistance & minimize weight), pump flow (5-10 gpm), and tractor size (15-25 hp).

This report is intended to provide guidelines for a user to analyze a variety of different tractor/tank systems.

# EVALUATION PROCEDURE

The evaluation of the equipment in this report was theoretical. No equipment was tested by the Forest Fire Experiment Station. Some values were approximated because they were not available from the manufacturers.

## TRACTOR:

In Table 1, manufacturers, model numbers, horsepower and drive type are listed for each tractor considered in this report. Tractor stability was calculated to use as a base for comparison with the tractor/tank system.

Side stability was calculated in two situations (see Figure 1). The first (#1) was side stability about a line through the center of the front axle and the center of the rear tire (left or right), (Line "A" Figure 1). This is the angle at which the tractor will tip until the front axle oscillation reaches its limit. Front axle oscillation is a value in degrees at which the front axle of the tractor can pivot side to side from its center point. The second (#2) is the side stability calculated about a line through the center of the front tire and the center of the rear tire (Line "B" Figure 1). Stability #2 occurs after the oscillation stop has been reached. The latter is more critical because the tractor will roll over if this value is exceeded. Rear stability was also calculated to provide a comparison with the rear stability after the tank is added.

Due to the weight of the tank assembly the maximum lift capacity of the 3-point hitch at 24 inches from the lift point is an important factor. Lift capacity at 24 inches is a standard set by the American Society of

## TANK:

Factors considered in determining the weight of the tank system were 75 feet of 5/8" hose, hose reel, auxiliary tank, drafting equipment, tank with pump only, water and foam concentrate. See Table 2 for commercial tanks considered in this evaluation. The tank assembly (see Table 2) involves commercial tanks that include hose, hose-reel, drafting capability (referred to as Rapid Refill by agricultural manufacturers), and auxiliary tank, unless stated otherwise.

A minimum of 53, and a maximum of 105, U. S. gallons were the tank sizes commercially available.

The number of refills of the main tank per auxiliary tank in Table 4 was calculated by using one unit of foam concentrate per 100 units of water (1% mix ratio).

## PUMP:

The type of aspirating foam nozzle used is a deciding factor in purchasing the pump. A required flow between 5 gpm and 10 gpm has narrowed the choice to a positive displacement pump. Diaphragm and roller pumps are the types that are available with commercial tanks in this report. The major advantage of roller pumps is their low cost and low maintenance. Diaphragm pumps have better efficiency and more consistent overall performance. Through the performance data given in the graphs, a particular pump may be chosen to fulfill the required needs.

## FOAM & FOAM EQUIPMENT:

The U. S. Forest Service maintains a list of approved fire chemicals that have undergone tests for effectiveness and safety. At the time of this report four wildfire foams have met interim approval requirements. It is suggested that the USFS approval list be checked prior to foam purchase.There are aerated type nozzles available commercially that fall in the 5 gpm to 10 gpm range. Nozzle development is changing. The distributor of the wildfire foam concentrate normally can help you locate a nozzle suitable for use. Nozzles vary from expensive aluminum machined models to inexpensive PVC pipe types. Formal evaluations of forestry foam nozzles have not been made to date. A metering system for mixing the foam solution at the pump or nozzle could be beneficial, but at this time these are in the developmental stage. Some are available for purchase, but again cost and designs are changing rapidly.

## OVERALL TRACTOR/TANK SYSTEM:

In determining the tank size for each tractor, the weight of the tank system was one of the deciding factors. Many of the smaller tractors were eliminated because they could not lift the smallest acceptable tank.

**Table 2. Typical commercial agricultural spray tanks**

| TANK | MODEL | TANK GAL. | DRAFTING | AUXILIARY TANK CAP. | REFILLS PER AUX. TANK | HOSE REEL | WEIGHT /WATER |
|---|---|---|---|---|---|---|---|
| HARDI | BL53 | 53 | YES | 3.5 | 7 | YES | 739 |
| HARDI | BL80 | 80 | YES | 3.5 | 4 | YES | 1013 |
| HARDI | NK105 | 105 | YES | 3.5 | 3 | YES | 1266 |
| AgTec | 604 | 60 | N/A | 6.9 | 12 | N/A | 810* |
| AgTec | 1004 | 105 | N/A | 6.9 | 7 | N/A | 1215* |
| VICON | LS 200M | 53 | YES | 5.3 | 10 | HOSE STORAGE | 857 |
| VICON | LS 300M | 80 | YES | 5.3 | 7 | HOSE STORAGE | 1110 |
| VICON | LS 400M | 106 | YES | 5.3 | 5 | HOSE STORAGE | 1397 |

* Does not include hose, hose reel, and drafting equipment

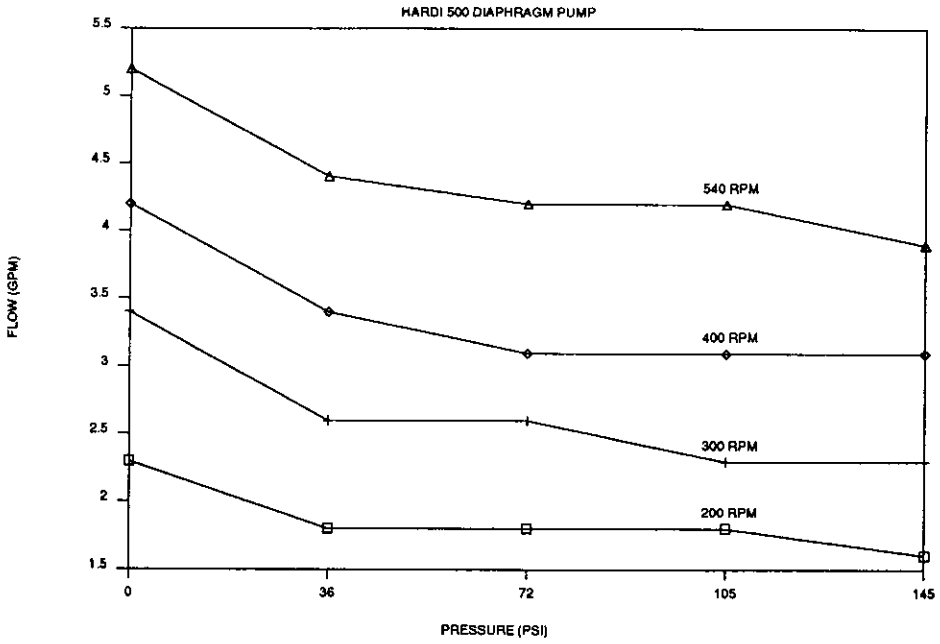
## Table 3. Tractor/tank systems

| TRACTOR | TANK | TOTAL WEIGHT | COUNTER-WEIGHT | #COUNTER-WEIGHTS[1] | NUMBER ALLOWED | LBS/COUNTER-WEIGHT | STABILITY #1 SIDE | STABILITY #2 SIDE | STABILITY REAR | FRONT AXLE WEIGHT/RATING | REAR AXLE WEIGHT/RATING |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CASE IH 245 | VICON LS200M | 2917 | 392 | 8 | 3 | 49 | 23 | 27 | 27 | 861 / 3500 | 2448 / 3850 |
| CASE IH 245 | AgTec 604 | 2870 | 294 | 6 | 3 | 49 | 26 | 30 | 27 | 736 / 3500 | 2428 / 3850 |
| CASE IH 245 | HARDI BL53 | 2799 | 245 | 5 | 3 | 49 | 26 | 30 | 27 | 715 / 3500 | 2329 / 3850 |
| CASE IH 255 | VICON LS200M | 2952 | 392 | 8 | 3 | 49 | 23 | 27 | 27 | 876 / 3500 | 2468 / 3850 |
| CASE IH 255 | AgTec 604 | 2905 | 294 | 6 | 3 | 49 | 26 | 30 | 27 | 751 / 3500 | 2448 / 3850 |
| CASE IH 255 | HARDI BL53 | 2834 | 245 | 5 | 3 | 49 | 26 | 30 | 27 | 731 / 3500 | 2348 / 3850 |
| FORD 1220 | VICON LS200M | 2286 | 455 | 13[2] | 5 | 35 | 19 | 23 | 27 | 829 / (3) | 1912 / (3) |
| FORD 1220 | AgTec 604 | 2239 | 420 | 12[2] | 5 | 35 | 23 | 27 | 27 | 699 / (3) | 1960 / (3) |
| FORD 1220 | HARDI BL53 | 2168 | 385 | 11[2] | 5 | 35 | 23 | 27 | 27 | 672 / (3) | 1881 / (3) |
| FORD 1320 | AgTec 604 | 3039 | 280 | 8 | 5 | 35 | 31 | 36 | 26 | 735 / (3) | 2584 / (3) |
| FORD 1320 | HARDI BL53 | 2968 | 210 | 6 | 5 | 35 | 31 | 37 | 27 | 724 / (3) | 2454 / (3) |
| FORD 1320 | VICON LS200M | 3086 | 350 | 10[2] | 5 | 35 | 27 | 33 | 27 | 878 / (3) | 2558 / (3) |
| FORD 1520 | HARDI BL53 | 3017 | 140 | 4 | 5 | 35 | 28 | 33 | 27 | 730 / (3) | 2427 / (3) |
| FORD 1520 | VICON LS200M | 3135 | 280 | 8 | 5 | 35 | 24 | 29 | 27 | 912 / (3) | 2503 / (3) |
| FORD 1520 | AgTec 604 | 3088 | 210 | 6 | 5 | 35 | 27 | 33 | 26 | 769 / (3) | 2529 / (3) |
| FORD 1720 | HARDI NK105 | 3956 | 595 | 17[2] | 5 | 35 | 28 | 33 | 27 | 1098 / (3) | 3453 / (3) |
| FORD 1720 | VICON LS300M | 3800 | 455 | 13[2] | 5 | 35 | 26 | 31 | 27 | 1093 / (3) | 3162 / (3) |
| FORD 1720 | AgTec 1004 | 3905 | 525 | 15[2] | 5 | 35 | 26 | 32 | 27 | 1151 / (3) | 3279 / (3) |
| FORD 1720 | HARDI BL80 | 3703 | 350 | 10[2] | 5 | 35 | 28 | 34 | 26 | 946 / (3) | 3107 / (3) |
| FORD 1720 | VICON LS400M | 4087 | 700 | 20[2] | 5 | 35 | 25 | 31 | 27 | 1278 / (3) | 3509 / (3) |
| FORD 1720 | AgTec 604 | 3500 | 175 | 5 | 5 | 35 | 30 | 35 | 27 | 840 / (3) | 2835 / (3) |
| JOHN DEERE 750 | HARDI BL53 | 2739 | 270 | 6 | 5 | 45 | 23 | 27 | 27 | 767 / (3) | 2242 / (3) |
| JOHN DEERE 850 | HARDI BL80 | 3708 | 315 | 7 | 5 | 45 | 30 | 36 | 26 | 920 / (3) | 3103 / (3) |
| JOHN DEERE 850 | VICON LS200M | 3552 | 225 | 5 | 5 | 45 | 27 | 32 | 28 | 1006 / (3) | 2771 / (3) |
| JOHN DEERE 850 | AgTec 604 | 3505 | 135 | 3 | 5 | 45 | 30 | 35 | 26 | 840 / (3) | 2800 / (3) |
| KUBOTA 8200 | VICON LS200M | 2422 | 495 | 9 | 3 | 55 | 20 | 24 | 26 | 836 / 1800 | 2081 / 3200 |
| KUBOTA 8200 | AgTec 604 | 2375 | 440 | 8 | 3 | 55 | 23 | 27 | 27 | 749 / 1800 | 2066 / 3200 |
| KUBOTA 8200 | HARDI BL53 | 2304 | 440 | 8 | 3 | 55 | 23 | 28 | 29 | 773 / 1800 | 1971 / 3200 |
| KUBOTA 8200HST | HARDI BL53 | 2437 | 385 | 7 | 3 | 55 | 25 | 29 | 26 | 727 / 1850 | 2095 / 3250 |
| KUBOTA 8200HST | AgTec 604 | 2508 | 440 | 8 | 3 | 55 | 24 | 29 | 28 | 803 / 1850 | 2145 / 3250 |
| KUBOTA 8200HST | VICON LS200M | 2555 | 495 | 9 | 3 | 55 | 22 | 26 | 27 | 889 / 1850 | 2161 / 3250 |
| KUBOTA 9200 | VICON LS200M | 2561 | 495 | 9 | 3 | 55 | 16 | 19 | 27 | 1034 / 1900 | 2022 / 3200 |
| KUBOTA 9200 | HARDI BL53 | 2443 | 385 | 7 | 3 | 55 | 18 | 21 | 27 | 873 / 1900 | 1955 / 3200 |
| KUBOTA 9200 | AgTec 604 | 2514 | 440 | 8 | 3 | 55 | 18 | 21 | 28 | 944 / 1900 | 2010 / 3200 |
| KUBOTA 9200HST | AgTec 604 | 2530 | 440 | 8 | 3 | 55 | 20 | 24 | 28 | 951 / 1925 | 2019 / 3200 |
| KUBOTA 9200HST | HARDI BL53 | 2459 | 385 | 5 | 3 | 55 | 20 | 24 | 27 | 870 / 1925 | 1974 / 3200 |
| KUBOTA 9200HST | VICON LS200M | 2577 | 495 | 9 | 3 | 55 | 18 | 22 | 28 | 1041 / 1925 | 2031 / 3200 |

(1)This value may exceed the maximum number recommended by the manufacturer, contact the manufacturer for further information
(2)This system will need a substitute counterweight bracket, contact the manufacturer for further information
(3)This value should be approved by the manufacturer

# APPENDIX

FLOW vs PRESSURE

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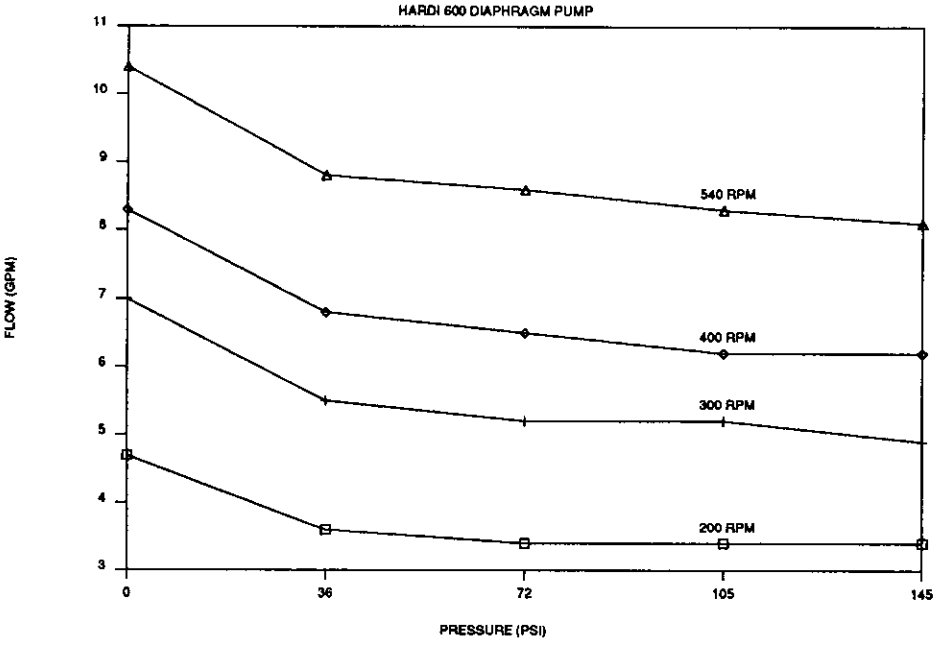

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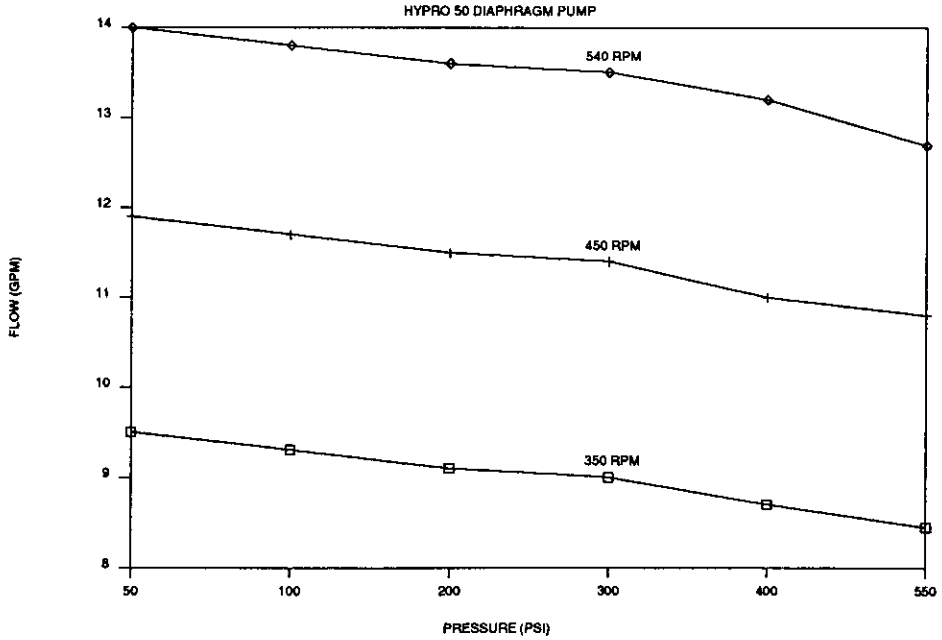


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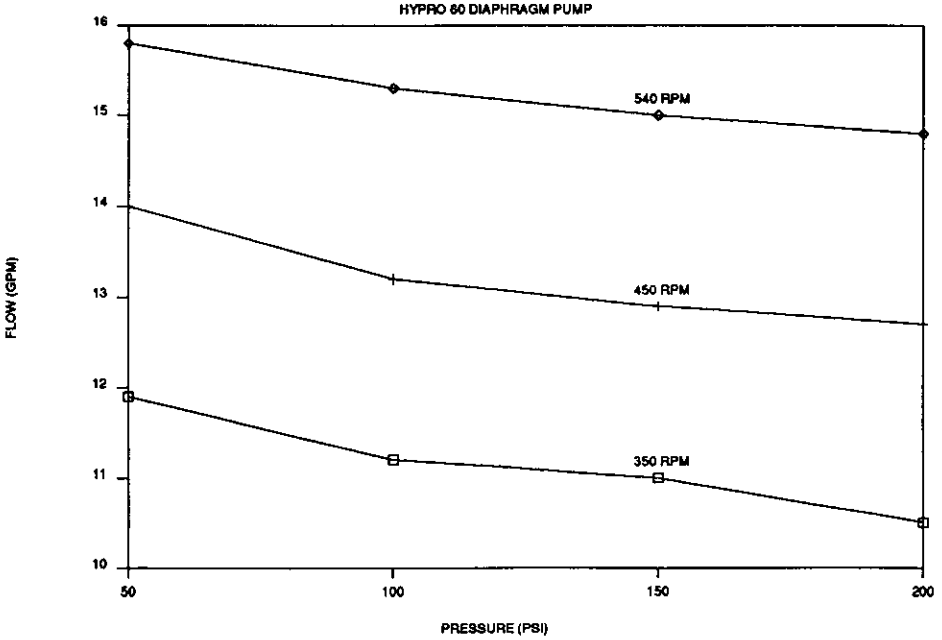

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