ESTIMATING SLED AND STONEBOAT DRAFT

by
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Measurements of sled and stoneboat draft were made while hauling a 1,000 lb load over ground conditions ranging from a gravel road to a newly planted oat field. There was little difference in draft between the sled and stoneboat on hard ground, but the stoneboat provided lower draft on soft and tilled soils. This information can help the teamster plan fieldwork, match a sled or stoneboat load with the power available and establish realistic guidelines for animal performance.

Introduction

Most teamsters have a sled or stoneboat. They are easily built, inexpensive, and great tools for hauling stones, firewood, feed and most everything else around the farmstead. And, since they are small, maneuverable and capable of carrying both light and heavy loads, they are excellent implements for use in training and conditioning draft animals. But how large a load should a sled or stoneboat carry for efficient training and conditioning? How much of the load does the team feel as tension in the towing chain? And how do ground conditions affect draft?

This article reports on research done at Tillers' training center to compare sled and stoneboat draft over a range of surfaces. Specific objectives were to measure an average draft and develop rules-of-thumb for estimating draft of sleds and stoneboats on: 1) a gravel road, 2) an alfalfa-grass sod, 3) a firm soil, and 4) a tilled, settled soil.

Our Need to Know . . .

In writing a series of articles on implement draft, we at ***Tillers International*** are seeking to improve the relationship of people with their working animals. We are committed to easing the burden of animals as they help meet the energy needs of small farms.

If we lack an understanding of what we ask of our animals, we have limited means of knowing why they may act up in particular ways. If a teamster mistakenly thinks a load is light, he or she may become overly demanding. Underestimating a load may lead to a heavy whip and frustrate the animals into becoming nervous and unpredictable. Repeatedly overloading a team will discourage them and reduce their willingness to pull. Our goal is to enhance the teamsters ability to match the power of the team with the demand of the load.

Estimating a load will take a little practice and attention. But you will be rewarded with a more productive relationship with your animals. They trust us to attend to such details and their trust grows as we demonstrate our trustworthiness to them. Those who have not worked oxen or draft horses may think this overestimates their perceptiveness and memory; nonetheless, experience clearly teaches the perceptive teamster that oxen and horses develop differing levels of trust and respect for variations among drivers. There are real benefits to be gained by understanding the loads you are asking your animals to move. ***Tillers*** hopes this article will help

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all teamsters empathize with the tasks they are presenting to their animals.

Draft Measurements

Draft is the force (pounds-force, lbf) needed to move an object in the direction of travel. A convenient rule-of-thumb for estimating the pulling ability of oxen is that a well-conditioned team can provide an effort measured as tension (lbf) in the draft chain equal to 10-12% of their body weight throughout the day and greater loads for short periods of time. This level of loading allows a reserve of power to overcome normal variations in draft and provides for a sustained effort within environmental constraints.

Tillers' draft measurements were made using a simple hydraulic pull meter--a closed-circuit fluid system that consisted of a hydraulic cylinder and a pressure gauge. The pull meter was placed in the towing chain and the reaction force was measured by the pressure gauge on the discharge side of the cylinder. This device allowed instantaneous measurements of draft (lbf), and when combined with time and distance, power output (hp).

Measurements of draft were made with both a sled and a stoneboat over a range of ground conditions. The gravel road was firm and compact with little exposed aggregate. The alfalfa-grass sod was firm but moist. The firm soil was a loamy soil covered with soybean stubble from the previous cropping season. The tilled, settled soil was a loam soil recently spring plowed, fit and seeded to oats.

Stoneboats are typically about three-feet wide and six- to eight-feet long. Their low profile makes them ideal for loading heavy stones by rolling them onboard rather than having to lift them off the ground. Their large contact area minimizes ground pressure which improves flotation in soft and tilled soil.

A sled consists of an elevated platform on two parallel skids or runners. Carrying the load on narrow skids increases the ground pressure at the skid/soil interface. This allows the skids to grip the soil and helps prevent side-slip when moving across a slope. But concentrating the load on skids can also increase sinkage, motion resistance and draft in soft and tilled soils.

In our draft trials the combined weight of the sled or stoneboat plus the load was 1,000 lb. The sled had skids measuring nine-feet long by four-inches wide. This contact area provided for an average ground pressure of 1.2 lb/in^2. The stoneboat measured thirty-five inches wide by eight-feet long for an average ground pressure of 0.3 lb/in^2.

There was little difference in draft between the sled and stoneboat when hauling the load over a gravel road. An average draft was 382 lbf for the stoneboat and 379 lbf for the sled (Table 1). On this hard surface about 38% of the total load was transferred to the team as tension in the towing chain.

On the alfalfa-grass sod an average stoneboat draft was 460 lbf while an average sled draft was 419 lbf. The hay field was firm enough so that neither implement formed ruts or noticeable depressions in the soil. On this firm surface the motion resistance of the concentrated load on the sled runners was less than the resistance offered by the low/pressure, large contact area of the stoneboat. The emerging hay crop likely reduced skid friction compared to a soil surface. In the

hay field, 42% of the sled load and 46% of the stoneboat load was transferred to the team as tension in the towing chain.

Differences in draft between the implements increased as we moved to softer surfaces. On the firm soybean ground the sled runners cut in a small amount but the stoneboat caused little disturbance. In moving and compressing soil the sinkage of the skids increased motion resistance and sled draft to 576 lbf compared to 459 lbf for the stoneboat. An average draft was about 46% of the load for the stoneboat and about 58% for the sled.

The greatest difference in draft between the sled and stoneboat was on the tilled, settled soil of a freshly seeded oat field. The sled skids cut in about an inch while the stoneboat was able to float on the soil surface with little disturbance. The average stoneboat draft was 485 lbf. Draft was about 30% higher (635 lbf) when using the sled.

Concentrating the load on sled runners increased sinkage and motion resistance on soft and tilled soils. The team experienced a 68% increase in draft between the gravel road and the oat field, and a 37% increase in going from the hay field to the firm soybean stubble. The greater flotation of the stoneboat lead to only a 27% increase in draft as the team moved from the gravel road to the tilled soil.

Power Measurements

Draft power is often described in units of horsepower (hp). The horsepower unit was first described by James Watt in England in the late eighteenth century. Watt found that an average horse could lift 366 lb of coal out of a mine at the rate of one foot per second (366 ft-lb/sec). In seeking to rate his steam engines in terms of the competition of the day--the horse--but not wanting to overstate the ability of his engines, Watt arbitrarily inflated the power delivered by a horse to 550 ft-lb/sec. The ability to move 550 lb with a velocity of one foot per second has been used ever since as the unit of horsepower.

Power delivery is a measure of the work accomplished. It is not always a suitable measure of a team's effort. In equation form:

Hp = (force, lb. X distance, ft) / time, sec

Power delivery is increased by increasing force (draft, lbf), or speed (ft/sec). In pulling competitions victory means power delivery. But a team may struggle mightily to move a heavy load and if the load does not move, no power is delivered. For most teamsters, draft alone is more descriptive and meaningful than power delivery in managing and training draft animals. Draft measured as tension in the towing chain is independent of time and distance.

Table 1. Draft and power output for a 3,850 lb ox team drawing a 1,000 lb load.

	Draft			
	Lbf	% Load	% Body Wt	MPH	HP
Sled					
Gravel Road	379	38	10	2.3	2.3
Hay Field	419	42	11	1.8	2.1
Firm Soil	576	58	15	2.2	3.4
Tilled, Settled	635	64	16	2.0	3.4

Stoneboat					
Gravel Road	382	38	10	2.2	2.2
Hay Field	460	46	12	2.1	2.6
Firm Soil	459	46	12	2.0	2.4
Tilled, Settled	485	49	13	2.0	2.6

A comparison of horsepower delivered in Tillers' sled and stoneboat trial is provided in Table 1. The oxen generally traveled at about 2 mph. Power delivery was greater when pulling the sled on soft soils because of the higher draft requirements. Power delivery ranged from 2.2 to 2.6 hp with the stoneboat and 2.1 to 3.4 hp with the sled. Draft measured as a percent of the teams' body weight ranged from 10 to 13% with the stoneboat and 10 to 16% with the sled.

Machinery Selection

These sled and stoneboat draft measurements can be used as guidelines in matching a load with the power available.

Example 1: In training and conditioning a young team of working steers a teamster seeks to load a stoneboat to achieve a load measured as tension in the towing chain equal to 8% of the team's body weight. Each steer weighs about 400 lb. The load will be hauled over level pasture and hay ground. Estimate a combined weight for the load and stoneboat to achieve this level of draft.

Answer: 139 lbs.

Solution: The team weighs 800 lb. Eight percent of the teams body weight equals 64 lb (800 lb*.08 = 64 lb). Referring to Table 1, stoneboat draft (lbf) on hay ground will be about 46% of the weight of the stoneboat. In order to achieve the desired draft the total weight of the stoneboat plus the load should be 139 lb (64 lbf/0.46 = 139 lb).

Example 2: Estimate a representative draft for a 750 lb sled on tilled, settled ground.

Answer: 480 lbf.

Solution: Referring to Table 1, sled draft on tilled, settled ground will be about 64% of the total load. Sled draft measured as tension in the towing chain will be about 480 lbf (750 lb*0.64 = 480 lb).

Suggested Reading

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