

The horse-drawn hitch cart

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Abstract

A National Animal Traction Survey carried out in South Africa in 1994, indicated that a substantial number of commercial as well as small scale farmers are using or would like to use draught horses on their farms. A major draw back for such farmers is the unavailability of suitable animal-drawn implements. As a result, although many farmers would like to use draught horses, few do because of the difficulty they have in obtaining suitable equipment. Recent research in the United States of America has resulted in the development of a range of horse-drawn hitch carts, behind which, with the more simple types it is possible to use trailed tractor drawn implements, while with the more sophisticated models it is possible to use most Category one tractor mounted implements. This paper discusses these developments, the capital and operating costs involved and the possibilities, which exist for using such hitch carts in South Africa.

Introduction

A National Animal Traction Survey carried out in South Africa in 1994 under the auspices of the South African Network of Animal Traction (SANAT), has indicated that some commercial farmers as well as a substantial number of small scale farmers are using, or would like to use, draught horses on their farms (Starkey *et al.*, 1995).

The only animal-drawn implements currently available in South Africa comprise the well known range of "Safim" ox-drawn equipment (Starkey *et al.*, 1995). Apart from this the only other animal-drawn implements which may be obtained comprise an antiquated range of ox and horse drawn mowers, ploughs, harrows, dump rakes and cultivators, which may still be found on the scrap heaps of South African farms. These implements are rarely found in working order and are usually in need of major repair.

As a result of this situation although many farmers would like to use draught horses on their farms few do.

Recent research in the United Kingdom as well as in the United States of America has resulted in the development of a range of horse-drawn hitch carts, which are now widely used in these countries (Pinney, 1996; Damerow and Moore, 1997).

Various designs are available from two wheeled models fitted with a simple hitch for pulling trailed animal or tractor drawn implements, to sophisticated four wheeled models fitted with brakes a hydraulic three point hitch and a ground wheel or engine powered, power take off (PTO) capable of enabling all 'category one' tractor mounted implements to be

used behind teams of two, three or even four horses (Damerow and Moore, 1997).

This paper discussed these developments as well as the different designs which are available. It considers also the opportunities, which currently exist for using such carts in South Africa as well as the capital and operating costs, which are compared with those incurred when using a small 33 kW tractor.

Hitch cart designs

The standard hitch cart

This cart has two wheels and the horse or horses are hitched between shafts (single horse) or to a dissel boom (two horses) (Damerow and Moore, 1997). The implement is attached at the rear to a drawbar with multiple hitch points. Between the wheels mounted on a sturdy frame is an expanded metal platform with a safety guard rail across the front and a sprung seat from which the driver can control both the team and the implement. The wheels are fitted to hubs with tapered or standard roller bearings and may be pneumatic rubber tired or of ribbed steel.

The category one hitch cart

In addition to the standard hitch cart are a number of variations of what are generally called 'Category One' hitch carts, with three and sometimes even four wheels. The rear wheels are similar to those of the standard hitch cart being pneumatic or ribbed steel on hubs fitted with tapered or standard roller bearings (Pinney, 1996; Damerow and Moore, 1997). The front wheel (wheels) are generally not steered and most often are castered. In one or two of the more sophisticated models proper steering is provided for the front wheels. The frame of these carts differs from that of the standard hitch cart to allow for the

fact that implements may be mounted and it is necessary to provide counter weight balance. In addition to the expanded metal floor, the guard rail and the sprung seat these carts may be provided with mechanically operated brakes, as well as a hydraulically controlled three point linkage system, which can accommodate all category one tractor mounted implements. PTO power may also be provided, either from the rear wheels through a gear box or from a petrol or diesel fuelled engine, mounted on the frame. Such engines may be capable of developing up to 30 kW of power.

The arched two-wheeled logging frame

The logging frame is used entirely in the forestry industry, for the extraction of logs (Wadsworth, 1997). This logging frame is fitted with shafts or a dissel boom between, or onto which, the horse or horses respectively are harnessed and a winch or mechanical arrangement, which enables the logs to be raised off the ground to reduce the pulling friction.

Makes of hitch carts

The Pioneer Equipment Company of the Dalton Ohio in the USA produces a Standard Hitch Cart (Damerow and Moore, 1997). They also produce a category one hitch cart which is supplied with a Kubota V1505-E four cylinder, 22 kW diesel engine. This unit also has a hand lever clutch, an hour meter, low oil pressure/high temperature shut down, battery operated starting, hydraulic brakes and drawbar weight compensation, as well as 540 rpm, power take off, (PTO) facilities, hydraulically operated three point linkage system and remote hydraulics for use with trailed hydraulic operated implements.

The Three-point Hitch Cart Company of Benton Kentucky in the USA produces a small four wheeled hitch cart (Damerow and Moore, 1997). One three point hitch is raised by a hand operated cable lift while the controlled drop is operated by a foot pedal. The front wheels are castored and are thus steerable. No PTO facility is provided.

Gateway Manufacturing Company of Clare Michigan in the USA produces a small Category one hitch cart with a Kohler V-twin 15 kW engine and hydraulically operated three point hitch and brakes (Damerow and Moore, 1997). It is supplied with a 540 rpm, PTO and quick coupling for remote hydraulics.

Cart Horse Machinery Ltd., in Devon, UK, manufactures the "Pintow Hitch Cart" which comes as a standard hitch cart for trailed implements or in the Category one form with hydraulically operated three point hitch and one or two speed PTO points.

The latter may be powered from the ground wheel or from a 20 kW Perkins diesel engine (Pinney, 1996).

White Horse Machine Company of GAP Pennsylvania produces several hitch carts including a Category one hitch cart with a rotary hydraulic pump driven by a roller chain from a sprocket on the furrow wheel (Damerow and Moore, 1997). A hydraulic fluid tank and a pressure accumulator allow the system to build up and hold reserve pressure. This reserve pressure is monitored by a gauge and is available to lift an implement when the wheels are not turning. Two remote hydraulic couplings are provided, which enable slave cylinders on trailed implements to be operated. This cart is supplied with either pneumatic rubber tired or steel ribbed wheels. It does not have a PTO.

The company also produces a hitch cart with a similar hydraulic pump and accumulator system as well as the remote hydraulic connections. This model also includes a category one hydraulically operated three point hitch and a hydraulically powered axle swing to ensure front to rear load balance, it does not have a PTO.

Willeheim Acres of Vankleek Ontario in the USA produces a two wheeled standard hitch cart, which can be used either with shafts for a single horse or a dissel boom to accommodate two horses (Damerow and Moore, 1997). This company specialises in logging carts and one feature of particular interest is an angled leg, which reduces up lift of the dissel boom. Another feature includes a hand cranked winch and notched steel plate for anchoring the choke plate when lifting logs into position for transporting.

Easy Skid Log Carts of Burton Ohio, produced a two piece, four wheeled logging cart (Damerow and Moore, 1997). The front wheeled section can be used alone as a standard logging arch to lift the front end of logs for skidding, while the rear two-wheeled, arched section may be used with the front section to lift high value logs clear of the ground when hauling.

The Bergan Arch "Logging Frame", manufactured in Norway, comprises an arched steel frame with two wheels and a winch and grapple complete with a set of shafts, which enable one horse to pull bundles of small logs, or a single large log up to 750 mm in diameter and 4 meters long (Wadsworth, 1997).

Hitch cart activities

The Standard Hitch Cart is suitable for trailed implements, which do not require to be mounted or powered. Typically they can be used with trailers, small ploughs, three sectioned spike toothed harrows, small rollers, small cultivators and long box shaped

seeder-cum-fertiliser distributors. They are not generally provided with brakes and braking when it is required is provided by the harness breaching.

Category One Hitch Carts depending on the design, PTO power available and whether or not remote hydraulic power is available, can be used to carry out all the activities, of which a standard 33 kW tractor is capable. These carts because they are pulled by horses limit the speed of all activities to between 5 and 5,5 km per hour, which mean that activities inevitably take a little longer than would be the case with a tractor. In general a tractor will carry out most agricultural activities in about three quarters the time that a pair of horses in a hitch cart will.

Category one tractor mounted implements can be used for ploughing, harrowing, planting, rolling, cultivating, fertiliser distributing, boom spraying, mowing, raking and even baling with such carts. The latter activity however, would require four horses and an engine powering the PTO capable of developing some 20 kW of power. The smaller hydraulically operated trailed or semi-mounted implements can also be accommodated when remote hydraulic facilities are provided. The use of boom sprayers is confined to herbicides and fungicides, i.e. chemicals which will not be harmful to the horses.

The Standard Arched "Logging Frame" Wheeled Cart can be used to move bundles of smaller logs or a single large log out of the forest, or from the point of extraction along a road to the loading point. The reduced dragging resulting from hoisting one end of the log clear of the ground increases the number of logs which a horse or a pair of horses can pull for each load (Wadsworth, 1997).

The capital and operating costs of using hitch carts

Capital costs

One point in favour of the horse and hitch cart when compared with the tractor, is the low capital cost when starting out (Dommett, 1995; Wadsworth, 1997). At the present time, late 1997, the following prices for horses and equipment hold: (1 US\$ = R 6).

- A pair of two and a half year old heavy horses, ready to train, cost about R5 000. Two trained heavy horses can be acquired for about R10 000.
- A double harness with bridle and reins cost, for 'Webbing' type R1 750 for 'Leather' R4 500.
- A standard hitch cart, with drawbar connection for trailed implements, costs about R5 000.

- A 'Category one' three point linkage hitch cart, with ground wheel driven PTO, will cost the equivalent of about R20 000 in the United Kingdom.
- A 'Category one' three point linkage hitch cart, with an engine powered PTO, will cost the equivalent of about R34 000 in the United Kingdom.
- A 'Bergan Arch' Logging hitch cart will cost the equivalent of about R3 500 in Norway.

This implies that, for a capital outlay of between R12 000 and R48 000 it is possible to acquire a power source comprising horses, harness and a hitch cart, capable of performing most, or all of the activities of which a 33 kW tractor, with a retail price at the present time of about R100 000, is capable.

Operating costs

The cost of owning and operating farming machinery can be divided into two categories, namely fixed costs and variable costs (Berry *et al.*, 1991). Fixed costs are related to the ownership of the machinery and occur regardless of whether the machine is used or not. Fixed costs per hour of use are inversely proportional to the annual hourly usage. Variable costs are generally related directly to the degree of utilisation of the machine.

A number of different methods have been devised for arriving at realistic costs of owning and operating farm machinery. In this discussion for the purpose of comparing the operating costs of horse drawn hitch cart activities with those of conventional three point linkage mounted tractors, the method recommended by Perry *et al.* (1991) has, with modifications where necessary to accommodate the use of draught animals, been used to compare the operating costs of:

- Draught horses used alone in traces
- A standard horse drawn hitch cart
- A category one hitch cart having a three point hitch and ground speed PTO
- A category one hitch cart with three point hitch and engine powered PTO, with a conventional 33 kW tractor.

The annual hourly operating time is an important factor when it comes to deciding on whether or not a tractor, or any power option for that matter, will be economically viable. Perry *et al.* (1991) used a figure of 1 000 hours per annum, which is probably above the average annual hourly usage for tractors in South Africa. The annual hourly usage affects the hourly fixed cost directly and also, to an extent, the hourly variable costs, since the repairs and maintenance charges are dependant on it. The higher the annual

hourly usage, the lower the hourly charge out rates will be.

For the purpose of comparing the horses and hitch cart combinations with the small tractor, it was decided to base the calculations on the assumption that in all cases 600 hours per annum of work would be reasonable for a pair of draught horses and just acceptable for a small tractor.

The fixed costs per hour for the tractor were arrived at by calculating the depreciation, interest, insurance and licensing costs assuming 600 hours of annual usage.

The variable costs for the tractor were arrived at by calculating repair and maintenance costs per hour, the fuel and lubrication costs per hour, as recommended by Perry *et al.* (1991), and adding to this the cost per hour of the driver. In all cases involving both the horses and the tractor it was assumed that only one driver would be required.

Hourly operating costs for the various category one tractor implements used with the tractor or the horses were also calculated, in a similar manner, and then combined with those of the tractor to obtain an operating costs per hour for typical tractor powered on-farm activities.

The field capacities for the various activities were calculated using standard accepted speeds and field efficiencies and the respective effective widths. These field capacities were then divided into the hourly operating costs to obtain the respective costs per hectare. These costs per hectare are tabulate in Table 1, which lists the activity costs of operating various horse drawn combinations with those for operating the small 33 kW tractor.

In order to calculate the operating costs for the horse drawn hitch cart, the method outline by Perry *et al.* (1991) was modified to account for the make up the horse drawn hitch cart combination.

Fixed costs were arrived at by calculating the depreciation, interest and insurance for the horses as well as, but separately from, the harness and hitch cart. An additional cost was included to account for the management costs of operating the horses, namely the costs of maintenance feeding, labour and providing veterinary care.

Variable costs were arrived at by calculating the repair and maintenance costs for the horses (shoeing), harness and the hitch cart as well as the cost of the supplemental feeding necessary to keep the horses in work and the cost of a single labourer to operate the hitch cart.

The fixed and variable costs for the horses and hitch cart combinations were added to obtain their hourly operating costs. To these costs were added the hourly operating costs, as shown above, for the various category one implements to determine the overall operating costs for the activities. These hourly costs were then divided by the field capacities for the respective activities, to reach an activity cost per hectare. These activity costs are tabulated in Table 1.

Tables 1 and Table 2 which includes the comparative transport costs, per ton-kilometre, for the various hitch-cart combinations and the tractor give an idea of the relative operating cost of the various options.

Comparison of the capital as well as the operating costs involved with the various hitch cart combinations and the tractor will provide an idea of the reduced capital investment needed with even the most sophisticated of the high carts and also, in most cases, the considerable reduced operating costs.

Farming systems where the horse-drawn hitch cart can be used

The small-scale commercial “emerging” farmers

These farmers will benefit from the horse drawn hitch cart because not only is the capital investment lower, but so also are the operating costs. For such farmers, with operations, which cannot justify economically the purchase of a tractor, it is possible to obtain a power source, which although slightly slower, is capable of carrying out the majority of his agricultural activities with a capital outlay, at most only half that of a new tractor and where the operating costs will generally be considerably lower (Table 1). The flexibility of a pair of draught horses on small farms, where they can be used either as a pair or separately for weeding row crops and pulling small carts is also an added advantage.

The medium sized commercial farmers

There are medium sized commercial farmers who own more tractors that they can justify economically, who may be over capitalised. Although they may be unaware of it, such farmers are suffering a substantial drain on their financial resources and as a result a decrease in their annual net profit. In such cases it may be possible for the farmer to sell a number of tractors and invest in a hitch cart combination, which would then insure that the remaining tractors were used more effectively, with an increased annual hourly usage and resultant lower hourly operating cost. At the same time such farmers would be able to achieve some of their other activities, using the hitch cart, at a lower hourly cost. The complimentary of tractors and animal traction can be beneficial.

Table 1: Comparative activity operating times and costs for draught horse hitch cart combinations and a small tractor

Combination	2 horses in harness and traces		2 horses in hitch cart		2 horses in 3 point hitch cart and grd spd PTO		2 horses in 3 point hitch cart and engine powered PTO		33 kW tractor with 3 point link and PTO	
	Cost/h R12		Cost/h R15		Cost/h R19		Cost/h R22		Cost/h R78	
Activity	Field cap. ha/d	Cost /ha R:C	Field cap. Ha/d	Cost/h a R:C	Field cap. ha/d	Cost /ha R:C	Field cap. ha/d	Cost/ ha R:C	Field cap. ha/d	Cost/ha R:C
1. Ploughing	0.42	198	0.42	224	0.42	284	0.42	312	3	330
2. ST harrowing (3 section)	5	15	5	20	5	24	5	28	15	55
3. Lt disc harrow (3 horses needed)	-	-	-	-	3	88	3	94	8	112
4. R.C. planting	1.2	60	1.2	75	2	100	2	108	5	205
5. Seeding	-	-	-	-	4	72	4	75	12	112
6. Rolling (3 horses needed)	3.5	30	2.5	33	2.5	40	2.5	43	8	108
7. Cultivating 1 horse needed	2.5	26	-	-	-	-	-	-	10	87
8. Boom spraying (NB animal safety)	-	-	-	-	10	22	10	23	25	40
9. Fertiliser spreading	-	-	-	-	6	30	6	32	12	70
10. Mowing	-	-	-	-	-	-	3.5	64	8	130
11. Raking	-	-	-	-	4	22	4	24	15	50
12. Baling (4 horses needed)	-	-	-	-	-	-	4	297	15	261

Table 2: Comparative transport costs for various draught horse hitch cart and trailer combinations and a small tractor and trailer

Combination	2 horses in harness and traces	2 horses in hitch cart	2 horses in 3 point hitch cart and grd spd PTO	2 horses in 3 point hitch cart and engine powered PTO	33 kW tractor with 3 point link and PTO
	1.5 ton trailer Cost/h R12	1.5 ton trailer Cost/h R15	1.5 ton trailer Cost/h R19	1.5 ton trailer Cost/h R22	3 ton trailer Cost/h R78
Speed in km/h	5.5	5.5	5.5	5.5	15
Cost in R:C/h	16	19	23	26	92
Cost in R:C/ton.km	1:94	2:30	2:79	3:15	2:04

The large commercial farmer

There are certain activities on large scale commercial farms, which can be carried out by a hitch cart combination very effectively. Although these activities may take a little longer, the time factor may not be important, the cost saving however could be of considerable advantage to the farmer and such farmers could benefit from the introduction of a horse drawn hitch cart combination.

The commercial logging contractor

The capital and operating costs of using heavy timber moving equipment on plantations is extremely high. Opportunities for small scale logging contractors living near timber plantations exist in many areas of the country. The introduction of the environmentally friendly logging arch and teams of heavy horses into the timber industry could benefit both large scale and small-scale operators.

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Conclusion

In the United Kingdom, Europe and particularly the United States of America, the horse drawn hitch cart is used with considerable effect. The concept has been researched and developed now for some ten years and modern hitch carts have become an effective part of the mechanisation plan on many farms, as well as in the timber industry.

Apart from the existing range of Safim, animal drawn, equipment it is unlikely that the modernised versions of animal drawn equipment such as planters, fertiliser distributors, mowers and rakes, to name but a few, will be obtainable for many years to come. The use of category one tractor mounted equipment behind a hitch cart drawn by heavy horses, provides a practical, immediate and effective solution to this problem, which will benefit not only the small scale emerging, but also the existing commercial farmer.

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