WFL Publisher
Science and Technology

Meri-Rastilantie 3 B, FI-00980
Helsinki, Finland
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Journal of Food, Agriculture & Environment Vol.6 (3&4) : 397- 401. 2008

www.world-food.net

Input cost of tractor operations in Ghana using the Farmtrac 70 tractor

Aliu Aduna Mahama [1*], Malcolm Josiah [1], Richard Bani [1] and Seidu Musah [2]

[1] *University of Ghana, Agricultural Engineering Dept. Legon Ghana.* [2] *Winneba University College of Education, Agricultural Faculty, Mampong Ashanti.* [*]*e-mail: aamahama@ug.edu.gh, aliumaham@yahoo.com*

Received 11 May 2008, accepted 28 September 2008.

Abstract

The Government of Ghana in an attempt to modernize agriculture is embarking on establishing agricultural mechanization service and support centres using Farmtrac tractors. This is to make mechanization services readily available to majority of the rural farmers who cannot acquire their own machines. One of the most important but difficult jobs for the Ghanaian farmer is the management of farm machinery and equipment. Farmers in Ghana are faced with farm machinery operation charges that are not realistic. They are either too low resulting in poor maintenance and unsustainable management of farm machines by their owners, or too high with the resultant high production cost and low returns on investment. This study attempts to analyze and show application of field performance data of the aggregation using Farmtrac tractor. The technical specifications and other literature review were studied on the Farmtrac 70 tractor and its aggregations. Field capacities were investigated and used to determine input cost. It was concluded that tractor operations using the Farmtrac could be cost effective. Details of the results of study are presented in this paper.

Key words: Agricultural mechanization, input cost, tractor-implement aggregations, field capacity.

Introduction

Tractors are national assets that require large capital investment to get them imported into Ghana. Therefore, there is the need to protect much of these investments and at the same time provide more farm power to boost and increase agricultural production.

To improve agricultural production, there is the need to introduce an agricultural mechanization policy that in real terms promotes and encourages people to remain in the farming industry and use tractors and machinery. The key component of Ghana's economy is in the productivity of agriculture. Tillage is considered as the most costly operation and therefore the economics of power source should not be overlooked and should be considered as a factor of production. Presently the Government of Ghana in her bid to modernize agriculture is embarking on establishing nine agricultural mechanization service and support centres. The objective is to make mechanization services readily available to majority of rural poor farmers who cannot acquire their own machines.

A complex pool of machines or farm machinery has been planned by Ministry of Food and Agriculture/Agricultural Engineering Services Directorate (MOFA/AESD) for private operation using Farmtrac tractors for pilot project. Farm machinery utilization requires that every effort be made for the tractor to be rationally loaded or engaged, quantitatively and qualitatively in operation. This means that the yearly average use of machines (tractor) in terms of hours (quantitative) should be within the acceptable economic figure. The figure here varies depending upon the agricultural activities in a given area such as Ghana.

The cost of tractor ploughing services on one hectare is between ¢150,000 to ¢250,000 ($40-67) in 2006. This wide range should be of serious concern to the Ministry of Food and Agriculture so as not to just support some people to charge far beyond the acceptable profit margin. Results of earlier studies in 1994 by Mahama *et al.* [1] cannot be relied upon now since there have been a lot of changes in prices of input items. In light of this, a guide in the form of input cost should be studied or investigated and made public to serve as a monitoring document to help the centres proposed to operate effectively to enhance agricultural production towards the realisation of national food security.

Farmers normally will consider greatly the cost, field capacity and fuel consumption before procuring a tractor-implement aggregate. Further to this, the field performance in handling and after sales maintenance associated factors should be assured of no problems. Farm machinery and other equipment are major cost items in farm businesses. Tractors, implements and their prices for parts in recent times have all been on the rise. Lack of the data on the above is a serious deficit in helping the farmer arrive at the decision to buy the appropriate tractor-aggregate.

One of the most important roles of a farmer is the rational use and economic management of farm machinery. For that a farmer will only buy farm machinery which inputs match his farm requirement. The best strategy is to link machinery input cost to normal yield income. Some necessary factors to be considered in management of farm machinery are as follows: the rational use, the cost of operation and how to adjust the cost to improve income. Therefore, operational management on the other hand means efficient operation of the farm machinery such as aggregating the tractor appropriately; adjusting machinery properly to reduce lost time and most important of all is the use of the machinery at the right time.

In management, cost of farm machinery operation should be controlled to minimize cost. Therefore, to do this, the machinery as much as possible should engage in doing productive work, thus reducing the cost per unit time. Prevention of waste of time and money also helps to cut down cost of operating machinery. Good maintenance also reduces cost (i.e. cost of wear and tear) since the factual rate of depreciation is slowed down. Mostly healthy machines get work done on time and also machines kept in good condition do better work.

Ghana has tractor marks such as the Massey Ferguson, Shangai, Swarag, Belarus, Lanborgini, Zetor, David Brown, etc. Most of the models from the various tractor marks are normally aggregated with three bottom disc ploughs. The Government intention of using the Farmtrac in the pilot programme requires that background of this tractor is described. The Farmtrac tractor is manufactured in India. The Escorts established the Escort Tractor Limited and commenced the manufacturing of Ford tractors in 1971 in collaboration with Ford, UK. Data collected by Singh and Doharey[2] rated the Farmtrac tractor in India in 3rd position of preference after Mahindra & Mahindra and TAFE tractors. This attest to the assumption that tractors developed from Ford tractors could be reliable with little frequency of breakdowns.

This study attempts to analyze and show application of field performance data of Farmtrac tractor, envisaged should be beneficial not only to the Ghanaian farmers but also to financial institutions and policy makers concerned with the development of agriculture in the country.

The overall objective is to assess the feasibility cost and modality of operating the Farmtrac tractors in Ghana. For publicly owned tractors, the objective will include proposals for implementing the sale of tractors to the private sector. A secondary objective is to provide guideline information for the programme to strengthen the private support services for mechanization. Therefore this can be itemised as follows: determined viable tractor mechanisation services through field capacities, input cost and project levels of commercialization charges for mechanized services; make recommendations for follow-up activities for the promotion and management of the proposed mechanization centres.

Materials and Methods

In deciding to aggregate a power source like a tractor to any implement as proposed, it is necessary to calculate the tractor-implement aggregate expectation where tractors and varied implements are in a pool and one will have the choice to define and determine the appropriate aggregation.

In this study, the aggregation already defined as Farmtrac 70 represents many models of the tractor makes with 3 bottom disc plough, an offset disc harrow and a 5-ton trailer. Fields of operations were carried out in November 2006 at the University Agricultural Research Centre (ARC) and on a private farm at Dodowa. Some mechanical properties of the soil at the experimental sites were defined to fall within the acceptable ploughing conditions that avoid the negative soil frictional effects.

Tillage operations were performed with rate of operation on speed, fuel and area. Measurement of speed of operation was done by defining specific distances on the field or road against the time of travel. Speed of operation (m/sec) of the tractor for a given set of conditions and depth of ploughing was measured using the tape, a metered stick, wooden pegs, stop watch and a straight edge to determine the depth of cut.

The theoretical field capacities were calculated in terms of quantity of ploughed land to time spent. Also the actual output was measured against the theoretical field capacity. It gives the data on relative productivity of the tractor under the Ghanaian field conditions of operations.

Costings of mechanised operations were done with the combined methods of TIIAME transact [3] and Edwards [4] on hourly basis and area productivity. Cost of operations had some few adjustments and assumptions to suit the Ghanaian situation.

Discussions and conclusions on findings were made and presented at an open seminar of colleague engineers and some stake holders for wider discussions.

Results and Discussion

Determination of machine field capacity and fuel consumption: Effective utilization of the Farmtrac tractor was measured in relation to the field capacity, time and with some comparison with theoretical provisions. The theoretical field capacity for tillage operation was also calculated for comparison.

Analysis showed that it is more effective with the use of 1st high gear which gives a ground speed of 6.48 km/h than the 2nd high. In this regard, the hectare/litre and litre per area comparison favours gear 1st high. Hourly productivity can be derived from Table 1 that gives 2.3 hours to plough one hectare and 1.6 hours to harrow one hectare. It should be noted that conditions of moving from farm to farm in the bush to plough will not be the same but could be as high as 4.26 hours per hectare.

The fuel consumption was highest at Dodowa as 18.23 litres per hectare. The Legon ARC trials at two different ground speeds (6.48 and 9.18km/hr) gave a range of 11.62 and 12.65 litres per hectare. At Dodowa, operations were done on three different plots and the field capacity was lower than the ARC fields as there were fallow movements.

Fuel consumption in relation to tank capacity (60 litres) has not been good and the consequences are very many. From the studies, consumption in ploughing was recorded from 12.6 to 18.23 litres per hectare and therefore the tractor has to refill after about 2.5 to 4 hours of field operation. Frequency of refill on the field can

Table 1. Fuel consumption and production or operations.

Operation	Consumption rate					
	Time-Litres/Hour		Area-Litres/Ha		Hours/ha	
	ARC	Dodowa	ARC	Dodowa	ARC	Dodowa
Ploughing (1st & 2nd High)	5.44	4.28	12.6	18.23	2.3	4.26
Harrowing (3rd High)	3.71	3.73	5.93	5.96	1.6	>1.6
Trailer + 1120 kg	4.15	-	-	-	-	-
Idling	1.6	-	-	-	-	-

Table 2. Different travel situations with tractor-plough aggregate.

Situation	Distance/Consumption km/Litre	Ground Speed km/h	Consumption/Hour Litres/h
Town travels	5.60	20	3.57
Farm to farm	7.30	30	4.00
Highway travels	4.55	32	7.03
Average	5.82	27	4.87

result to introduction of dust or dirt into the tank from the transfer of fuel from dirty containers. Fuel can drop on the tractor during refill from containers most times which attract dust onto the tractor. Finally there will be delays in progress of work as the operator refills on the field and will affect the productivity of the day.

Investigations were conducted on travel fuel consumptions so as to determine the input of travels from far off farms to home or town in situations where tractor is not kept on the farm. The data recorded in Table 2 on speeds during travels are 20, 30 and 32 kilometers per hour for town, farm to farm and highway travel respectively. Fuel consumption at different conditions of operation is shown in Table 2. Consumption is highest on highway travel and followed by town travel. The least was found to be movement from farm to farm at very low speed.

Highway travel with the tractor gave 4.55 to 7.30 km per litre and this will require the tractor to refill at least after 254.0 to 408.8 km. This can be accepted as it will be possible to refill at clean fuel stations during highway travels but for field operations that extends into evening on the farms will be inconvenient with serious consequences on the fuel system of the tractor to refill from containers other than the filling station.

Input cost of the tractor-implement aggregated operations: Farm machinery input cost can be divided into mainly two categories: ownership costs, which occur regardless of machine use, and operating costs, which vary directly with the amount of machine use. The interest of this study will be on ownership cost and hiring services.

The Farmtrac 70 tractor has 45 kW power output. The tractor and accompanying implements prices provided by Agricultural Engineering services Directorate/MOFA are stated in Table 3.

The determination of input costs will require having some further information about machine lifespan, annual use in the operational location, fuel and labor prices and others. The publication of Edwards [4] provided ASAE assumption worksheets that can be used to calculate costs for some particular factors of operation.

It is usually difficult to obtain accurate lifespan in hours since these manufacturers are very silent on this for the purposes only known to them. However in Ghana, farmers will expect any tractor mark or model to be used for at least 10 years. Studies conducted by Igbeka [5] in Nigeria that is in the same ecological zone estimated a range of 5000…6000 hours. However, earlier studies by Mahama[6] on tractor maintenance in the Northern Region of Ghana indicated yearly engagements of any tractor to an average of 800 hours (fallow and productive activities). Therefore, an economic life of 8000 hours and an average interest rate of 12 percent were therefore assumed for further calculations.

Operations of farm machinery are planned in order to know how much goes into the production of any agricultural product. The aim here is to determine the unit operational cost of Farmtrac tractor on hourly basis so that it can be used at any point in time to find its total operational cost within a specific period of time. The main components of costing that are classified as fixed and variable costs were calculated with the field data of operation. The results are shown in Table 4.

Table 3. Cost of import of Farmtrac 70 Tractor and other accompanying implements.

Item	Unit price ($)	Freight & insurance ($)	Total cost ($)
Farmtrac 70 tractor head	10,975	837.10	11,812.10
5–Ton tipping trailer	2,695	205.52	2,901.00
Plough	1,325	101.14	1,426.00
Harrow	895	74.84	969.84
Total	-	-	17,108.84

Source: AESD/MOFA 2006.

Table 4. Results of hourly input cost ($) of operation of the Farmtrac 70 and implements.

Item	Farmtrac-70 Plough Aggregate				Tractor+	Tractor	Tractor
	ID	Town	Farm	Hi-W	Plough	+Harrow	+Trailer
Depreciation	1.102	1.102	1.102	1.102	1.221	1.186	1.356
Repair maintenance cost	0.812	0.812	0.812	0.812	0.918	0.870	1.048
Insurance & housing	0.148	0.148	0.148	0.148	0.166	0.160	0.184
Interest on capital	0.248	0.248	0.248	0.248	0.276	0.267	0.304
Fuel-tractor plus	1.367	3.051	3.418	6.008	4.649	3.188	3.546
Lubrication (15% fuel)	0.205	0.458	0.513	0.901	0.697	0.478	0.532
Salary of operator	2.340	2.340	2.340	2.340	2.340	2.340	2.340
Sub-total	6.222	8.159	8.581	11.559	10.267	8.489	9.310
Miscellaneous at 15%	0.933	1.224	1.287	1.734	1.540	1.273	1.397
Total cost (TC)	7.155	9.383	9.868	13.293	11.807	9.762	10.707

Further analyses were done on fuel consumption as illustrated in Table 5 to establish the impact of increase in fuel consumption in connection with the aggregations and operations of the study (operation fuel difference). The percentage of fuel cost compared to the total of input cost is stated in each operation. Given that the idling of a tractor without any operation will be considered as the base, then any further increase in consumption will be taken as the cost of consumption against the aggregation and operation after idling (operational cost difference). Therefore, Table 5 shows the extra fuel input cost of each of the operations. The consumption computed in terms of litres per hour with the assumption minus the idling consumption is also given.

In order to approximate the cost of fuel increase and its impact on the mechanized services charges, Table 5 gives the percentage of increases as against the total cost (running cost/fuel cost ratio). This can help to arrive at the input cost of operation when fuel price changes. For example, tractor-plough aggregate's fuel consumption is 39.74% and therefore the ratio will be 1:2.25. Akcelik [7] gave the cost model parameters using the ratio of the following countries as New Zealand 1: 2.50, Australia and USA as 1: 3. It therefore indicates that the cost of fuel is very high for production in Ghana.

The computed relativity index will be used to determine the input cost of production in an hour. For production purposes the recommended indexes shown in Table 6 for different operations could be used in further calculations.

Total cost of operations and analyses in Ghanaian Cedis: The present exchange rate of the Cedi to a dollar (¢9,200) as at 2006 and input cost is calculated further below and Table 7 is developed for profit analyses.

The total input cost of operations the different tractor aggregations in one hour are below:

Total cost of input for Idling the tractor- $ 7.155 x 9200 = ¢65,826.00

Tractor-plough aggregate movement in town $ 9.383 x9200 = ¢86,323.60

Tractor-plough aggregate movement on the farm to farm $9.868 x 9200 = ¢90,786.98

Tractor-plough aggregate movement on the highway $13.293 x 9200 = ¢122,295.60

Tractor-plough aggregate in operation $11.807 x 9200 = ¢108,624.40

Tractor-harrow aggregate operation $ 9.762 x 9200 = ¢89,810.40

Tractor-trailer aggregate operation $ 10.707 x 9200 = ¢98,504.40

The cost of operations of different fields but same size can vary significantly if the time used on each field is different. If you use 2 hours to plough a field and also 4 hours for the same area size the operational costs will give different values. What has been calculated cannot be compared to other countries as the factors of inputs may be influenced by the Government policies such as subsidy on tractor price, fuel, tax, etc.

Table 8 shows units of operation such as a hectare, acre and a kilometer and comparison of profit margins. The most important findings are in Table 7, but Table 8 is prepared for policy making for determining the average operation of the Farmtrac 70 tractor. What has been worked out can be compared to the present cost of ploughing using the Farmtrac 70 tractor.

In calculating any cost of operation, one has to combine all inputs of fallow operations like travel and idling costs. In the case employing these tractors for pool service then management input has to be added to the total cost and therefore note should be taken not to engage a large size of administrators that will tend to erode the profitability of the set up especially when the pool is not large enough for that administrative size.

Table 5. Fuel consumption impact on some field operations in an hour.

Item	Farmtrac-70 Plough Aggregate				Tractor+	Tractor	Tractor
	ID	Town	Farm	Hi-W	Plough	+Harrow	+Trailer
Fuel-tractor /plus:($)	1.367	3.051	3.418	6.008	4.649	3.188	3.546
Operational Fuel difference	0	1.684	2.051	4.641	3.282	1.821	2.179
Total (TC) ($)	7.155	9.383	9.868	13.293	11.807	9.762	10.707
% Fuel cost to TC	19.10	32.52	34.64	45.20	39.74	32.66	33.12
Operational cost difference ($)	0	1.23	2.71	6.14	4.65	2.61	3.55
Fuel consumption (L/Hr)	1.6	3.57	4.00	7.03	5.44	3.73	4.15

Table 6. Determination of input cost using the running cost /fuel cost ratio per hour.

Operation	% of Input Cost	Ratio	Consumption L/h	Relativity Index	Recommended Index
Idling	19.10	5.24	1.60	8.38	8
Ploughing	39.74	2.25	5.44	12.22	12
Harrowing	32.66	3.06	3.73	11.43	12
Tractor trailer	33.12	3.02	4.15	12.53	13
Highway travel	45.20	2.21	7.03	15.54	16

Table 7. Summary input cost analysis and profit making in an hour operation.

Operation	Estimated profit levels- Cedis				
	Break Even	50%	100%	150%	200%
Idling	65,826.00	98,739.00	131,652.00	164,565.00	197,478.00
Town movement	86,323.60	129,485.40	172,647.20	215,809.00	258,970.80
Farm to farm	90,786.98	136,180.47	181,573.96	226,967.45	272,360.94
Highway movement	122,295.60	183,443.40	244,591.20	305,739.00	366,886.80
Ploughing	108,624.40	162,936.60	217,248.80	271,561.00	325,873.20
Harrowing	89,810.40	134,715.60	179,620.80	224,526.00	269,431.20
Carting (Trailer)	98,504.40	147,756.60	197,008.80	246,261.00	295,513.20

Table 8. Cost of operations per unit of production and estimated profit margins.

Operation	Unit of production	Estimated profit levels- Cedis				
		Break Even 0%	50%	100%	150%	200%
Ploughing	Hectare	249,836.2	374,754.3	499,672.4	624,590.5	749,508.6
	Acre	101,148.3	151,722.4	202,296.6	252,870.8	303,444.8
Harrowing	Hectare	143,696.6	215,544.9	287,393.2	359,241.5	431,089.8
	Acre	58,176.8	87,265.1	116,353.5	145,441.9	174,530.3
Carting	Kilometer	5,794.4	8,691.6	11,588.8	14,485.9	17,383.1

To stay updated for some time before a review, the calculation done with Tables 5 and 6 can be considered appropriate on relativity basis and be applied for commercial value. Reference to fuel impact assessment given earlier with percentages the commercial charges figure could be increase by 0.5 or 1.0 or 1.5 or 2.0, etc. The cost of any field operation like ploughing as shown above will be the recommended relativity index 12 x fuel cost of a litre x time in hours taken for a unit of ploughing operation x chosen commercial profit margin (50%, 100%, 150%, 200% etc).

Conclusions

The Farmtrac 70 tractor has proven to be potentially economical in operation for the plant pool system proposed in Ghana. The operation of the tractor has been very much simplified for easy handling. No major breakdowns of the tractor-aggregations were established as it was new. Highway travel with tractor as transport is the most costly operation. Movement at high speeds results in high consumption of fuel with small outputs. First gear high was observed to be more economical in fuel consumption but the second high was more productive. Refill of fuel will be frequent as the tank capacity is not large enough for ploughing operation beyond four hours.

Recommendations

1. The tank holding capacity should be increased rationally. 2. Ploughing is economically recommended at the 2nd gear high at about 9km/hour. 3. Highway engagements with the tractor as transport should be discouraged. 4. Profit making could be acceptable between 50 - 100% increases in input cost. 5. Regional workshops should be organized for farmers on tractor aggregation and economic application.

Acknowledgement

Our sincere gratitude goes to Mr. Yakubu Abdulai, Agricultural Engineering Services Directorate (AESD), Ministry of Food and Agriculture, Accra; Mr John Atia, Agricultural Research Center (ARC), University of Ghana, Legon and the National Director of AESD, Mr. J. K. Boamah and his supporting staff who were key players in providing the opportunity through this study to contribute knowledge for the development of mechanizations in the country with a better focus. The courtesy and cooperation received from the Directorate of Agricultural Research Centre (ARC) of the University of Ghana was excellent, without which, the smooth and successful implementation of the assignment would have just been impossible.

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