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INTRODUCTION TO THE *GUIDE FOR MACHINERY COSTS 2015 – 2016*

1.1 INTRODUCTION

The "*Guide to Machinery Costs*" is compiled to assist farmers, extension personnel, and others involved in costing farm operations, and machinery decision making. These costs are updated annually and are based on available technical and financial data, in particular prices published in "*Agfacts".* Prices of similar agricultural machinery vary between firms and regions.

The performance of machines also varies under different working conditions. A 58kW tractor used to plough sandy soils will not have the same performance as a 58kW tractor used to plough heavier soils. The performance of a tractor is also dependent upon the type of work it is doing. For example, ploughing is considered to be a heavy operation using more diesel than light discing. The fuel consumption of a 1 ton 1800cc single cab driven on flat, tar roads will be better than the consumption of the same LDV drive on uneven, muddy roads. The performance of a machine will be partially determined by the competency and experience of the "driver/operator". The performance will also depend upon the age and condition of the machine. An older but well maintained tractor could perform better than a newer tractor which has not be serviced and maintained correctly. It is therefore important that the user interprets the information in this "*Guide to Machinery Costs*" intelligently, taking into account all the circumstances.

It is important to note that many machines are no longer available on the market, and new machines have entered the market. The price of machinery which is no longer available is increased by an appropriate percentage based on the previous year's price, as per the "*AGFACTS*" publication. Should an item not be listed in this "*Guide to Machinery Costs*" the user can choose to use the costs of a similar item, or costs can be established if the user knows the value of the item.

Technical information, such as life expectancies, fuel consumptions, maintenance and repair costs, and insurance rates are adjusted from time to time, based on information received from researchers, manufacturers and users of equipment. However, it must be stated that the publishers of the "*Guide to Machinery Costs*" are dependent upon these sources of information and advice, and any information of this nature is welcome, together with any constructive criticism which can assist in improving this publication.

The Introduction has a brief description of the costs published in this "*Guide to Machinery Costs*". More detailed information can be found in any number of technical books, of books relating to agricultural economics. There is a summary of the machinery groups, the individual sub-groups, and

the individual machinery and equipment items which are included in this "*Guide to Machinery Costs*". The last two sections deal with the "field capacities/operating time" (the time needed to perform an operation such as ploughing) of some tractors and equipment. There are a couple of formulae which can be used by the reader to determine these operating times.

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1.2 NOTES ON MACHINERY COSTS

The costs of owning and operating machinery can be divided into two categories – namely fixed costs and variable costs. All the costs are based on either the purchase price or the average investment in the equipment. All costs use either the life expectancy of the item or the annual usage (hours, kilometres). According to Culpin (1959), it is unwise to assume a life expectancy beyond 15 years for any implement or machine. These figures are therefore suggested, and serve as a guideline where specific information is unavailable.

1.2.1 FIXED COSTS are those costs which DO NOT VARY with the usage of a machine.

Fixed costs are related to machinery ownership and occur regardless of whether the machinery is used or not. Fixed costs per kilometre/hour of usage are inversely proportional to the amount of annual usage. For instance the annual licence cost of a car is fixed amount, irrespective of how many kilometres the car travels in the licence year. The greater the distance travelled the lower will be the fixed cost per kilometer. If finance has been used to acquire the car, the repayment per month will not change with the distance the car travels in a month.

In the "*Guide to Machinery Costs*" there are four Fixed Costs.

i) Depreciation is the reduction in value of a machine with the passage of time. The straight line method gives a constant annual charge for depreciation throughout the life of the machine, and this is the method used in the "*Guide to Machinery Costs*".

ii) Interest is included as a fixed cost because the money which is invested in machinery could have been invested in other productive enterprises or investments. The interest rate that is used in the "*Guide to Machinery Costs*" is the interest rate that can be obtained on a medium- term (5 year) investment.

The value of the machine decreases over time as reflected by annual depreciation charges. Consequently the amount of money invested in the machine decreases, from the initial purchase price to the scrap value at the end of the machine's useful life. The interest charge takes this into account as it is based on the average investment during the life of the machine. The average investment is the average of the purchase price plus the salvage value of the item.

iii) Licence Costs are imposed by the state, but some agricultural machinery does not require a licence.

iv) Insurance Costs are determined by the various companies which insure vehicles and machinery. In some instances the farmer may opt to not insure a piece of machinery because the risks of theft or damage are minimal, or the farmer can afford to cover the cost if the item is stolen or damaged. In many instances, insurance is compulsory if the item is purchased with a loan from a financial institution.

In most instances insurance charges are assumed to be a percentage of the average investment of the machine.

v) Total Fixed Costs

The total fixed costs are the sum of the above four costs. However, total costs excluding interest are also used in certain situations.

1.2.2 VARIABLE COSTS are those costs which DO VARY with the usage of a machine.

Variable costs are directly related to the degree of utilization of the machine, and include factors such as repairs and maintenance costs, fuel and lubricants, and tyres. For instance the fuel used depends upon the distance driven by a vehicle, and other factors. Consequently, the fuel cost will depend upon the usage of the vehicle. The distance the vehicle is driven, and how it is driven, will affect the life of the tyres, and hence the trye cost.

i) Repair and Maintenance Costs

These costs are difficult to estimate as they vary greatly depending on operating conditions, management, maintenance programs, local costs, *etc*. It is generally agreed that repair costs will increase with age but are unlikely to increase proportionally. Repair costs will increase with age, but tend to level off as the machine becomes older (Kepner *et.al.,*1978, page 36).

Accurate estimates of repair costs are not easily obtainable. However, work done by the Directorate of Agricultural Engineering has been used where appropriate (see Reference 4). Repair costs are calculated as a percentage of the purchase price of the machinery, divided by the annual use. The percentages are kept constant over the life of the machine, thereby obtaining an average cost during the machine's useful life. There are disadvantages to this method, but for general reference purposes it is the most practical.

For further information on the formulae used to determine repair and maintenance costs the reader can consult the reference list, with particular attention to references 1 and 6.

ii) Fuel and Oil Costs

Fuel consumption is a contentious issue, and can vary greatly from area to area, machine to machine, and even operator to operator. The figures used in the "*Guide to Machinery Costs*" are based on the results of surveys done in South Africa and the U.S.A. For further information consult references 1, 5 and 6.

In the case of tractors the fuel consumption is determined by the power demand. There are three levels of power demand– Light, Medium and Heavy – depending on the type of work being done. The fuel consumption is in litres per kW-hour and varies for each level of power demand. There is also variation in the percentage of available kW that is used at each level. (See notes at the foot of each page.)

A single level of power demand is used for self-propelled combine harvesters, and the loaders for cane and timber. The fuel consumption is in litres per kW-hour and varies with the engine power (kW).

In the case of LDVs and Trucks the fuel usage per 100km are the average figures supplied by the dealerships and manufacturers.

Clearly these consumption figures will vary from vehicle to vehicle, driver to driver, and circumstances in general. The listed fuel usage figures are for information purposes only, and users of the "*Guide to Machinery Costs*" need to adjust the fuel costs if their consumption figures are noticeably different.

An oil cost is calculated for LDVs, trucks, and the loaders for cane and timber. The oil consumption is assumed to be a percentage of the fuel consumption.

The prices of diesel, petrol and oil were those prevailing on the highveld at the time of updating this "*Guide to Machinery Costs*". Users may need to adjust the fuel costs if current prices are significantly different to those used in this "*Guide to Machinery Costs*". (See notes at the foot of each page.)

iii) Tyre Costs

Tyre costs are determined for LDVs, trucks, and the loaders for cane and timber. The sizes and prices of the tyres are displayed in a separate table. Readers need to ensure that these values are applicable to their equipment. Tyre sizes, tyre life, and prices are difficult to obtain from manufacturers and suppliers. The tyre life is greatly influenced by the work conditions of the tyres.

iv) Total Variable Costs

This total cost is the sum of the three variable costs discussed above.

1.2.3 TOTAL COSTS

Total costs are the sum of the Fixed and Variable costs, with or without the interest cost include in the calculation.

The division into fixed and variable costs is not always an absolute one. There is a valid argument for considering depreciation charges as being made up of two main components, one of which is determined by obsolescence and is a fixed cost, and the other which relates to "wear and tear" and is considerably influenced by the use of the machine. In this case depreciation could be considered to be a variable cost.

1.3 GROUPS OF MACHINERY AND EQUIPMENT

There are 7 major groups of machinery and equipment :-

1. Tractors
2. Implements
3. Self-Propelled Combine Harvesters
4. Trailers
5. LDVs
6. Trucks
7. Electric Motors.

1.3.1 TRACTORS

There are 4 groups of tractors

i) 2-wheel drive “normal” tractors
ii) 4-wheel drive “normal” tractors
iii) 2-wheel drive “orchard” tractors
iv) 4-wheel drive “orchard” tractors

Within each group there will be a variety of tractors of varying engine sizes (kilowatt ratings).

For each tractor type three fuel costs costs are calculated for three levels of power demand – low, medium and high. The power demand affects the fuel consumption. The fuel consumption depends upon the kilowatts used (which is not the same of the kilowatt “size” of the tractor) and the litres used per kilowatt hour, as follows :-

	Low Power Demand	Medium Power Demand	High Power Demand
Percentage of kW used	35 per cent (35%)	45 per cent (45%)	60 per cent (60%)
Litres used per kilowatt hour	0.40 Litres per kW hour	0.35 Litres per kW hour	0.30 Litres per kW hour

These factors are listed at the end of each table of costs. They apply to 2 wheel-drive and 4-wheel drive tractors, both “normal” and orchard tractors.

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The following list shows the fuel consumption figures for a variety of 2 wheel drive and 4wheel drive tractors (WD represents wheel drive), both "normal" and orchard tractors.

Tractor Size and Type			Percentage of kW used			Litres used per kilowatt hour			Fuel consumption (L/hour)		
kW	2-WD/ 4-WD	Normal/ Orchard	Power demand			Power demand			Power demand		
			Low	Medium	High	Low	Medium	High	Low	Medium	High
22	2-WD	Normal	35%	45%	60%	0.40	0.35	0.30	3.08 A	3.47 I	3.96 Q
83	2-WD	Normal	35%	45%	60%	0.40	0.35	0.30	11.62 B	13.07 J	14.94 R
60	4-WD	Normal	35%	45%	60%	0.40	0.35	0.30	8.40 C	3.62 K	4.14 S
260	4-WD	Normal	35%	45%	60%	0.40	0.35	0.30	36.40 D	70.56 L	80.64 T
48	2-WD	Orchard	35%	45%	60%	0.40	0.35	0.30	6.72 E	7.56 M	8.64 U
65	2-WD	Orchard	35%	45%	60%	0.40	0.35	0.30	9.10 F	10.24 N	11.70 V
44	4-WD	Orchard	35%	45%	60%	0.40	0.35	0.30	6.16 G	6.93 O	7.92 W
68	4-WD	Orchard	35%	45%	60%	0.40	0.35	0.30	9.52 H	10.71 P	12.24 X

a) Low Power Demand

A = (22 x 35% x 0.40) = 3.08 B = (83 x 35% x 0.40) = 11.62 C = (60 x 35% x 0.40) = 8.40

D = (260 x 35% x 0.40) = 36.40 E = (48 x 35% x 0.40) = 6.72 F = (65 x 35% x 0.40) = 9.10

G = (44 x 35% x 0.40) = 6.16 H = (68 x 35% x 0.40) = 9.52

b) Medium Power Demand

I = (22 x 45% x 0.35) = 3.47 J = (83 x 45% x 0.35) = 13.07 K = (60 x 45% x 0.35) = 9.45

L = (260 x 45% x 0.35) = 40.95 M = (48x 45% x 0.35) = 7.56 N = (65x 45% x 0.35) = 10.24

O = (44 x 45% x 0.35) = 6.93 P = (68 x 45% x 0.35) = 10.71

c) High Power Demand

Q = (22 x 60% x 0.30) = 3.96 R = (83 x 60% x 0.30) = 14.94 S = (60 x 60% x 0.30) = 10.80

T = (260 x 60% x 0.30) = 46.80 U = (48 x 60% x 0.30) = 8.64 V = (65 x 60% x 0.30) = 11.70

W = (44 x 60% x 0.30) = 7.92 X = (68 x 60% x 0.30) = 12.24

It is clear that the fuel consumption (litres/hour) increases with the kilowatt rating of the tractor, and with the power demand.

The fuel consumption figures above (and in the body of the "*Guide to Machinery Costs*") are giving in litres per hour. If this figure is multiplied by the time it takes to complete an operation - hours per hectare - (*e.g.* plough, discing, planting, fertilizing, spraying, harvesting) then it is possible to calculation the fuel consumption per hectare. The time required to perform an operation is discussed in a later section. There are examples to illustrate these calculations.
Both fuel consumption figures (litres/hour and litres/hectare) can be multiplied by the fuel price (Rand/litre) to determine the cost per hour and the cost per hectare. There are examples to illustrate these calculations.

The fixed costs and repair and maintenance remain unchanged, irrespective of the level of power demand.

Since the fuel costs increase with the level of power demand, the total variable costs and the total costs (fixed plus variable) will differ according to the power demand.

1.3.2 IMPLEMENTS

Implements are divided into nine groups.

i) Tillage equipment - rippers, ploughs, harrows, rotovators, tillers, cultivators
ii) Planting equipment - single-kernel (maize), seed drills, wheat, potato, vegetable, fine seed seeders, land rollers
iii) Fertilizer equipment - fertilizer, manure, and lime spreaders
iv) Spraying equipment - mist blowers, boom sprayers
v) Hay and Silage equipment - mowers, mower conditioners, slashers, haymakers, hay rakes, tedders, hay balers, bale handling equipment
vi) Harvesting equipment - trailed combines, forage harvesters, threshers, potato lifters
vii) Feed Processing equipment - hammer mills, feed mixers, roller mills
viii) Earth Moving equipment - front end loaders, rear mounted graders, dam scoops
ix) Cane and Timber equipment - cane loaders, timber loaders

1.3.3 SELF-PROPELLED COMBINE HARVESTERS

i) Maize
ii) Wheat

1.3.4 TRAILERS

i) 2-wheeled trailers

ii) 4-wheeled trailers

iii) Tip trailers

, iv) Fire-fighting water carts

v) Cane trailers

vi) Timber trailers

1.3.5. LDVs

i) 2-wheel drive - petrol, diesel

ii) 4-wheel drive - petrol, diesel

1.3.6 TRUCKS

i. Single diff

ii. Double diff

1.3.7 ELECTRIC MOTORS

There are several motors of different sizes. The key factors which determine the costs are the expected life (hours) of the motor, and is the annual usage of the motor (hours).

The purchase prices in this "*Guide to Machinery Costs*" are AVERAGE market figures, excluding the Value Added Tax, at the month of updating the publication.

Every effort was made to obtained prices from as many manufactures and dealers as possible. However, this is sometimes an extremely difficult because suppliers are reluctant to reveal their prices, despite the fact that no mention is made of the make of the tractor, implement or vehicle. The authors are extremely grateful to those companies and persons who co-operated by providing prices and other information. Their co-operation improved the value of this "*Guide to Machinery Costs*". These companies and persons are listed under the section "ACKNOWLEDGEMENTS". In cases where no market value was available the prices was taken from "*AGFACTS*".

The equipment and machinery in any "*Guide to Machinery Costs*" are largely those for which market prices were available, or which are still listed in "*AGFACTS*". Undoubtedly there are items which were not included in past publications. The readers and users are encouraged to suggest other machinery and equipment which should be included in future publications of the "*Guide to Machinery Costs*".

At the end of the "*Guide*" there is a section which explains the concept of field capacity. Simply put, this is the time it takes a piece of machinery to complete a given task; *e.g*. plough a hectare. That is followed by a table of predetermined capacities.

1.4 COST TABLES

Each of the seven groups listed above will have its own set of tables. These tables give the basic descriptive facts needed for the calculations, and from these facts it is possible to calculate the fixed, variable and total costs.

1.4.1 DESCRIPTIVE FACTS, CONSTANTS, AND PRICES

i) Description, including the size, of the item (*e.g.* 45kW 4-wheel drive tractor, 5 ton 2-wheel trailer, 3 furrow mounted disc plough)
ii) Average purchase price (excluding VAT)
iii) Expected life of the item (in hours or kilometres)
iv) Expected average annual usage of the item (in hours or kilometres)
v) Salvage percentage (*e.g.* the salvage value of a tractor is 10 per cent of the purchase price)
vi) a) Percentage used to determine the combined licence and insurance cost, or
b) Percentage used to determine the insurance cost, and the actual licence cost
vii) Percentages used to determine the repair and maintenance costs
viii) Interest percentage
ix) Fuel and oil consumption rates
x) Fuel and oil prices
xi) Tyre descriptions and sizes, and the number of tyres, in cases where a tyre cost is included in the item's variable cost
xii) Average purchase price of a new tyre
xiii) Expected tyre life

1.4.2 FIXED COSTS

i) Depreciation cost
ii) Interest cost
iii) Insurance cost
iv) Licence cost (actual Rand value)
In some instances the Insurance and Licence costs are combined (percentage)

v) Total fixed cost, including and excluding interest

1.4.3 VARIABLE COSTS

i) Repair and maintenance costs
ii) Fuel cost
iii) Oil cost, if applicable
iv) Tyre costs, if applicable
v) Total variable cost

1.4.4 TOTAL COSTS

i) Total cost, including interest
ii) Total cost, excluding interest

Whilst formulae are used to calculate the costs in the tables, it is a simple exercise to calculate the costs with a pen and calculator.
All the costs originate from the item's the life period, and the annual usage, the average purchase price of the item, the salvage percentage, and the average investment of the item. The purchase price and the salvage percentage determine the average investment. All the costs are determined by using either the average purchase price, or the average investment.

The relevant formulae are

i) Salvage value = Average purchase price x Salvage percentage

ii Average investment = (Average purchase price + Salvage value) ÷ 2

iii) Depreciation cost = (Average purchase price - Salvage value) ÷ Life period

iv If the licence and insurance costs are combined then

Licence and Insurance cost = [(Licence and Insurance percentage) x Average investment] ÷ Annual usage

v) If the licence and insurance costs are separate then

a) the insurance cost depends upon the average investment, the insurance percentage, and the annual usage;
b) the licence cost is the actual annual licence cost per unit of the annual usage.

vi) Interest cost = (Interest rate x Average investment) ÷ Annual usage

vii) Repair and maintenance costs = (R & M percentage x Average purchase price) ÷ Life period

viii) The fuel cost will depend on the fuel consumption and the fuel price.

The fuel consumption value is determined differently for each of the machinery items where there is a fuel cost (*e.g.* 35% of tractor kilowatts, 8 litres per 100Km for an LDV)

ix) The oil cost will depend on the oil consumption and the oil price.
The oil consumption is generally a percentage of the fuel consumption.

x) The tyre costs are case specific; *i.e.* the tyre cost for LDVs, trucks, and trailers are not calculated the same way.

1.4.5 EXAMPLE 1 : TRACTOR COSTS

1.	Purchase price	=	R450 000		
2.	Life period	=	12 000 hours		
3.	Annual usage	=	1 000 hours		
4.	Salvage percentage	=	10 %		
	Salvage value	=	R450000 x 10%	=	R45 000
5.	Average investment	=	(R450000 + R45000) / 2	=	R247 500
6.	Depreciation cost	=	R(450000 – 45000) / 12000 Hr	=	R33.75 / Hr
7.	Licence and Insurance percentage	=	1.75 %		
	Licence and Insurance cost	=	(R247500 x 1.75%) / 1000 Hr	=	R4.33 / Hr
8.	Interest rate	=	9.50 %		
	Interest costs	=	(R247500 x 9.50%) / 1000 Hr	=	R23.51 / Hr
9.	Total Fixed Costs including Interest	=	R(33.75 + 4.33 + 23.51) / Hr	=	R61.59 / Hr
10.	Total Fixed Costs excluding Interest	=	R(33.75 + 4.33) / Hr	=	R38.08 / Hr
11.	Repair and Maintenance percentage	=	120 %		
	Repair and Maintenance cost	=	(R450000 x 120%) / 12000 Hr	=	R45.00 / Hr
12.	Fuel consumption	=	9.20 L/Hr		
	Fuel price	=	R13.84/L		
	Fuel cost	=	9.20 L/Hr x R13.84/L	=	R128.37 / Hr
13.	Total Variable Costs	=	R(45.00 + 128.57) / Hr	=	R173.57 / Hr
14.	Total Costs including Interest	=	R(61.59 + 173.57) / Hr	=	R235.16 / Hr
15.	Total Costs excluding Interest	=	R(38.08 + 173.57) / Hr	=	R211.65 / Hr

1.4.6 EXAMPLE 2 : 3 FURROW MOULDBOARD PLOUGH COSTS

1.	Purchase price	=	R16 900		
2.	Life period	=	2 500 hours		
3.	Annual usage	=	250 hours		
4.	Salvage percentage	=	10 %		
	Salvage value	=	R450000 x 10%	=	R45 000
5.	Average investment	=	R(16900 + 1690) / 2	=	R9 295
6.	Depreciation cost	=	R(450000 – 45000) / 12000 Hr	=	R33.75 / Hr
7.	Licence and Insurance percentage	=	1.75 %		
	Licence and Insurance cost	=	(R247500 x 1.75%) / 1000 Hr	=	R4.33 / Hr
8.	Interest rate	=	9.50 %		
	Interest costs	=	(R247500 x 9.50%) / 1000 Hr	=	R23.51 / Hr
9.	Total Fixed Costs including Interest	=	R(33.75 + 4.33 + 23.51) / Hr	=	R61.59 / Hr
10.	Total Fixed Costs excluding Interest	=	R(33.75 + 4.33) / Hr	=	R38.08 / Hr
11.	Repair and Maintenance percentage	=	120 %		
	Repair and Maintenance cost	=	(R450000 x 120%) / 12000 Hr	=	R45.00 / Hr
12.	Fuel consumption	=	9.20 L/Hr		
	Fuel price	=	R13.84/L		
	Fuel cost	=	9.20 L/Hr x R13.84/L	=	R128.37 / Hr
13.	Total Variable Costs	=	R(45.00 + 128.57) / Hr	=	R173.57 / Hr
14.	Total Costs including Interest	=	R(61.59 + 173.57) / Hr	=	R235.16 / Hr
15.	Total Costs excluding Interest	=	R(38.08 + 173.57) / Hr	=	R211.65 / Hr

The cost per hour of using the tractor and the plough would be obtained by adding the individual costs.

1.	Total Fixed Costs including Interest	=	Trac = R61.59 / Hr ; Plough = R10.16 / Hr	=	R(61.59 + 10.16) / Hr = R71.75 / Hr
2.	Total Fixed Costs excluding Interest	=	Trac = R38.08 / Hr ; Plough = R6.63 / Hr	=	R(38.08 + 6.63) / Hr = R44.71 / Hr
3.	Total Variable Costs	=	Trac = R173.57 / Hr ; Plough = R7.44 / Hr	=	R(173.57 + 7.74) / Hr = R181.31 / Hr
4.	Total Costs including Interest	=	Trac = R235.16 / Hr ; Plough = R17.60 / Hr	=	R(235.16 + 17.60) / Hr = R252.76 / Hr
5.	Total Costs excluding Interest	=	Trac = R211.65 / Hr ; Plough = R14.07 / Hr	=	R(211.65 + 14.07) / Hr = R225.72 / Hr

The cost to plough one hectare would depend upon the time it would take to plough one hectare. The calculation would merely involve multiplying the cost per hour by a factor which is the hours per hectare. For example, if it requires 2.5 hours to plough one hectare, then

1.	Total Fixed Costs incl. Interest	=	R71.75/Hr x 2.5 Hr/Ha	=	R179.38	2. Total Fixed Costs excl. Interest	=	R44.71/Hr x 2.5 Hr/Ha R111.78
3.	Total Variable Costs	=	R181.31/Hr x 2.5 Hr/Ha	=	R453.28			
4.	Total Costs incl. Interest	=	R252.72/Hr x 2.5 Hr/Ha	=	R631.80	5. Total Costs excl. Interest	=	R225.72/Hr x 2.5 Hr/Ha R564.43

1.4.7 EXAMPLE 3 : LDV COSTS

1.	Purchase price	=	R245 000	
2.	Life period	=	160 000 Km	
3.	Annual usage	=	20 000 Km	
4.	Salvage percentage	=	10%	
	Salvage value	=	R245000 x 10%	= R24 500
5.	Average investment	=	(R245000 + R24500) / 2	= R134 750
6.	Depreciation cost	=	R(245000 – 24500) / 160000 Km	= R1.38 / Km
7.	Insurance percentage	=	6.9 %	
	Insurance cost	=	(R134750 x 6.9%) / 20000	= R0.4649 / Km
8.	Annual Licence fee	=	R498.00	
	Annual Licence cost	=	R498.00 / 20000 Km	= R0.0249 / Km
9.	Interest rate	=	9.50 %	
	Interest costs	=	(R134750 x 9.50%) / 20000 Km	= R0.6392 / Km
10.	Total Fixed Costs including Interest	=	R(1.38 + 0.46 + 0.00249 + 0.64) / Km	= R2.51 / Km
11.	Total Fixed Costs excluding Interest	=	R(1.38 + 0.46 + 0.00249) / Km	= R1.87 / Km
12.	Repair and Maintenance percentage	=	50 %	
	Repair and Maintenance cost / Km	=	(245000 x 50%) / 160000	= R0.7656 / Km
13.	Fuel consumption	=	9.14 L/Km	
	Fuel price	=	R13.68 /L	
	Fuel cost	=	9.14 L/Km x R13.68/L	= R125.03 / Km
14.	Tyre cost / Km	=		= R0.1096 / Km
15.	Total Variable Costs	=	R(45.00 + 128.57) / Km	= R125 91 / Km
16.	Total Costs including Interest	=	R(2.51 + 125.80) / Km	= R128.41 / Km

17. Total Costs excluding Interest = R(1.87 + 125.80) / Km = R127.77 / Km

1.5 COST PER HECTARE

The following remarks need to be kept in mind concerning the costs of using tractors and implements.

1) The driver/operator and labour costs are not included in the listed costs
2) The costs of materials (*e.g.* baling twine, wire, seed, fertilizer, *etc*) are not included in the listed costs.

1.5.1 COST PER UNIT OF MEASURE

Machinery costs included in this "*Guide to Machinery Costs*" are listed below, together with the unit of measure.

Tractors	R/Hour	(R/Hr)	The cost per hour is based on clock hours and not tractor hours.
Implements	R/Hour	(R/Hr)	
Self-Propelled Combine Harvesters	R/Hour	(R/Hr)	
Trailers	R/Hour	(R/Hr)	
LDVs	Cents/Kilometre	(c/Km)	
Trucks	Cents/Kilometre	(c/Km)	
Electric Motors	R/Hour	(R/Hr)	

If the necessary conversion factors are available these costs can be translated into the cost per hectare, per tonne, *etc*.

1.5.2 DURATION TIME PER HECTARE AND PER KILOMETRE

The duration time per hectare depends upon the working width of an implement, the work speed, and the effectiveness of the machinery being used to carry out an activity. The following formula can be used to calculate the duration time per hectare:

$$Duration\ per\ hectare\ \left(\frac{Hr}{Ha}\right) = \frac{10000}{[\ work\ width\ (m) \times \left[work\ speed\ \left(\frac{Km}{Hr}\right) \times 1000\right] \times effectiveness\ (\%)\ ]}$$

To calculate a Rand per hectare value, information is required on the time requirement of the machine per hectare. Some rough guidelines of these figures are listed in the "Field Capacities" section at the end of this publication. Take note that this figure will largely depend on the shape of the field, speed of the machine, area, *etc*.

In the case of vehicles, and the cane and timber equipment, the duration time is given by the following formula:

$$Duration\ per\ kilometer\ \left(\frac{Hr}{Km}\right) = \frac{1}{\left[\ average\ speed\ \left(\frac{Km}{Hr}\right)\right]}$$

In other words, the duration time per kilometre is the inverse of the average speed.

1.5.3 COST PER HECTARE

To determine costs per hectare from the data in the "*Guide to Machinery Costs*", the following formula can be used:

Costs per Hectare (R/Ha) = ***Cost per Hour*** (R/Hr) ***x Duration time per Hectare*** (Hr/Ha)

In other words, the duration time of the activity (*e.g.* ploughing, spraying, fertilizing) is multiplied by the cost per hour.

The cost per hour will be that of the tractor, plus the cost of any implement used with the tractor to perform the activity (e.g. tractor and plough, tractor and boom sprayer, tractor plus trailed combine harvester). The cost of a self-propelled combine harvester will replace the cost of the tractor when appropriate.

The costs per ton (unit of yield) can be determined by using the following formula:

Costs per Ton (R/Ton) = ***Cost per Hectare*** (R/Ha) ÷ ***Tons per Hectare*** (Ton/Ha)

Costs per Ton (R/Ton) = ***Cost per Hectare*** (R/Ha) x ***Hectare per Ton*** (Ha/Ton)

The following tables give some indication how the information in the "*Guide to Machinery Costs*" can be used to determine the costs of using equipment to perform a range of farming activities. Fixed costs are the total of depreciation, licence, insurance, and interest. Variable costs consist of repairs and maintenance, fuel and oil, and tyres. No labour costs are included in these examples.
The cost per hour is based on clock hours and not tractor meter hours. The costs in the following tables are taken from the "*Guide to Machinery Costs 2015-2016."*

INTRODUCTION TO THE *GUIDE FOR MACHINERY COSTS 2015 – 2016*

TABLE 1 A : TRACTOR AND IMPLEMENT

a) **Activity Duration Times : Tractor and Implement**

Activity	Tractor			Implement				Duration Time
	Power (kW)	Drive (2W/4W)	Power Demand (L/M/H)	Description	Working Width (m) (A)	Working Speed (km/hr) (B)	Effectiveness (%) (C)	(hr/ha) (= 10000 ÷ (A x Bx1000 x C/100))
Plough	60	4W	H	3 furrow Disc Plough	2.6	2.6	85	1.74
Plant	60	4W	M	3 Row (1.5m) Maize Planter	1.5	3.0	85	2.61
Fertilize	60	4W	M	4000l Double-disc Fertilizer Spreader	3.2	3.2	85	1.15
Spray	60	4W	L	12m Boom Sprayer	12	6.0	85	0.16

b) **Activity Costs per Hour and per Hectare : Tractor and Implement**

The duration times are those shown in the previous table. The tractor and implement costs are taken from the "*2015-2016 Guide to Machinery Costs*". The fixed costs include the interest costs.

"H" refers to a high power demand, "M" refers to a medium power demand, and "L" refers to a light power demand.

Activity	Duration Time (Hr/Ha) (A)	Tractor		Tractor Costs			Implement	Implement Costs			Total Costs	
		kW 2/4 WD	Power Demand (L/M/H)	Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (B)	Description	Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (C)	Per Hour (D = B + C)	Per Ha (D x A)
Plough	1.74	60 4W	H	74.90	152.82	266.37	3 furrow Disc plough	15.73	11.40	27.14	293.51	510.71
Plant	2.61	60 4W	M	74.90	173.99	248.89	3 Row (1.5m) mtd. Air Maize planter	224.46	128.77	373.23	622.12	1 623.73
Fertilize	1.15	60 4W	M	74.90	173.99	248.89	4000l Double-disc mtd Fert spreader	643.31	415.04	1 058.35	1 307.24	1 503.33
Spray	0.16	60 4W	L	74.90	160.39	235.29	12m mtd. (1000l) Boom sprayer	122.77	40.42	163.19	398.48	63.76

This information indicates that it costs R510.71 to plough one hectare using a 60kW 4-wheel drive tractor which is pulling a 3 furrow disc plough, assuming that ploughing is a high power operation, and assuming that it takes 1.74 hours to plough one hectare. It indicates that it costs R1 623.73 to plant one hectare using a 60kW 4-wheel drive tractor which is pulling a 3 row (1.5m) mounted air planter, assuming that planting is a medium power operation, and assuming that it takes 2.61 hours to plant one hectare. No costs are included for labour, or seed and other materials.

Table 1 B : MAIZE SELF-PROPELLED COMBINE HARVESTER

a) Activity Duration Time : Self-Propelled Combine Harvester - Maize

Activity	Combine details					Duration Time
	Engine Size (kW)	Description / Head Size and Row Size	Working Width (m) (A)	Working Speed (km/hr) (B)	Effectiveness (%) (C)	(hr/ha) (= 10000 ÷ (A x Bx1000 x C/100))
Harvest	278	8 row 0.9 snapper maize combine	7.2	5.0	90	0.309
Harvest	313	12 row 0.9 snapper maize combine	10.8	6.0	90	0.171

b) Activity Costs per Hour and per Hectare : Self-Propelled Maize Combine Harvester

The duration times show that it takes less time to harvest one hectare if a harvester with a higher kW rating and bigger head (row size) is used. Harvesting, in this example, is regarded as a high power demand operation.

Interest costs are included in the fixed costs, but no costs for labour are included in these calculations.

Activity	Duration Time (Hr/Ha) (A)	Engine Size (kW)	Engine Costs			Description / Head Size and Row Size	Head Costs			Total Costs	
			Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (B)		Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (C)	Per Hour (D = B + C)	Per Ha (D x A)
Harvest	0.309	278	1 694.22	1 017.33	2 711.55	8 row 0.9m snapper head	290.89	63.41	354.30	3 065.85	947.35
Harvest	0.171	360	2 393.53	1 360.91	3 754.44	12 row 0.9m snapper head	522.60	113.92	636.52	4 390.96	750.85

TABLE 1 C : WHEAT SELF-PROPELLED COMBINE HARVESTER

a) **Activity Duration Time : Self-Propelled Combine Harvester - Wheat**

Activity	Combine details					Duration Time
	Engine Size (kW)	Description / Head Size and Row Size	Working Width (m) (A)	Working Speed (km/hr) (B)	Effectiveness (%) (C)	(hr/ha) (= 10000 ÷ (A x B x 1000 x C/100))
Harvest	146	6.0 m wheat combine	6.0	5.0	90	0.370

Harvest	216	9.1 m wheat combine	9.1	5.0	90	0.244

b) **Activity Costs per Hour and per Hectare : Self-Propelled Combine Harvester - Wheat**

Activity	Duration Time (Hr/Ha) (A)	Engine Size (kW)	Engine Costs			Description / Head	Head Costs			Total Costs	
			Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (B)		Fixed (R/Hr)	Variable (R/Hr)	Total (R/Hr) (C)	Per Hour (D = B + C)	Per Ha (D x A)
Harvest	0.370	177	1 158.28	665.07	1 823.25	6.0 m wheat combine	230.37	50.22	280.59	2 103.84	778.42
Harvest	0.244	360	2 393.53	1 360.91	3 754.44	9.0 m wheat combine	332.80	72.54	405.34	4 159.78	1 014.99

TABLE 1 D : TRUCK

a) **Activity Duration Time**

Activity	Truck Details		Average Speed		Duration Time	
	Description	Capacity (Ton) (A)	Km/Hr (B)	Hr/Km (C = 1 ÷ B)	Km/Hr.Ton (D = B ÷ A)	Hr/Km.Ton (E = C ÷ A)
Transport 8t grain	8.0t Single-differential Truck	8.0	80.0	0.0125	10.00	0.0016

b) **Activity Costs per Kilometre, per Hour, and Per Ton**

Activity	Truck Description	Truck Costs		Total Costs			
		Fixed (R/Km)	Variable (R/Km)	R/Km (F)	R/Hr (G = F x B)	R/Km.Ton (H = F ÷ A)	R/Hr.Ton (I = F x D)
Transport 8t grain	8.0t Single-differential Truck	3.28	6.95	10.23	818.40	1.28	102.30

c) **Example - Truck Activity Costs**

Assume that a maize farmer achieved a yield of 8t/Ha on 2 hectares. He needs to transport 16t of grain He is using an 8.0t single-differential truck, with an average speed of 80Km/Hr. This means that 2 trips will have to be done. The total distance travelled for both return trips is 50km. Using the tables above, as a guideline, the following costs can be derived.

Activity	Tonnage Transported (Tons) (A)	Total Distance Travelled 2 loads (Km) (B)	Truck 8T Single-diff.	Truck Cost (Fixed + Variable)	Average Speed		Duration Time		Total Costs			
			Ton (C)	(R/Km) (D)	Km/Hr (E)	Hr/Km (F = 1 ÷ E)	Km/Hr.Ton (G = E ÷ C)	Hr/Km.Ton (H = F ÷ C)	R/Km (D)	R/Hr (I = D x E)	R/Km.Ton (J = D ÷ C)	R/Hr.Ton (K = I ÷ C)
Transport 8t grain	16.0	50.0	8	10.23	80.0	0.0125	10.00	0.00156	10.23	818.40	1.28	102.30

The total distance travelled = 50km (B)
The total cost per kilometre (R/Km) = R 10.23 (D)
The total cost of the return trip = R511.50 (L= B x D)
Tonnage transported = 16 tons (A)
Cost per ton = R 31.97 (M = L ÷ A)
The 16t maize grain yield was from 2 hectares
= 8T/Ha (N)
Cost per hectare = R 225.75 (M x N)

TABLE 1 E : TRACTOR AND TRAILER

a) **Activity Duration Time**

Activity	Tractor			Trailer		Average Speed		DurationTime	
	Power (kW)	Drive (2W/4W)	Power Demand (L/M/H)	Description	Capacity (Ton) (A)	Km/Hr (B)	Hr/Km (C = 1 ÷ B)	Km/Hr.Ton (D = B ÷ A)	Hr/Km.Ton (E = C ÷ A)
Transport grain	98	4W	H	10T 4-wheel Trailer with dropsides	10.0	10.00	0.10	1.00	0.01

b) **Activity Costs per Hour, per Kilometre, and per Ton**

Activity	Tractor	Tractor Costs			Trailer	Trailer Costs			Total Costs			
	kW; 2/4 W; L/M/H	Fixed (R/Hr)	Var. (R/Hr)	Total (R/Hr) (F)	Description	Fixed (R/Hr)	Vari. (R/Hr)	Total (R/Hr) (G)	R/Hr (H = F + G)	R/Km (I = H x C)	R/Hr.Ton (J = H ÷ A)	R/Km.Ton (K = I ÷ A)
Transport	98 4W; H	153.06	333.91	486.97	10T 4-wheel Trailer with dropsides	69.34	17.34	86.68	573.65	57.37	57.37	5.737

c) **Example - Tractor and Trailer Activity Costs**

Assume that a maize farmer has to transport 10 tons of maize from the field to the silo. He is using a 98kW (4-wheel) drive tractor and a 10T 4-wheel trailer (with dropsides), with an average speed of 20Km/Hr. This means that 1 trip will have to be done. The total distance travelled from the field to the silo 10km. Using the tables above, as a guideline, the following costs can be derived.

Activity	Tonnage Transported (Tons) (A)	Total Distance Travelled (Km) (B)	Tractor 98 4W; H	4 W Trailer 10 Ton **(D = 10)**	Aver. Speed		Duration		Total Costs			
			Total Cost R/Hr (C)	Total Cost R/Hr (E)	Km/Hr (F)	Hr/Km (G = 1 ÷ F)	Km/Hr.Ton (H = F ÷ D)	Hr/Km.Ton (I = G ÷ D)	R/Hr (J = C + E)	R/Km (K = J x G)	R/Hr.Ton (L = J ÷ D)	R/Km.Ton (M = K ÷ D)
Transport grain	10.0	10.0	486.97	86.68	20.0	0.05	2.00	0.005	573.65	28.68	57.37	2.969

The total distance travelled	=	10km	(B)
The total cost per kilometre (R/Km)	=	R 28.68	(K)
The total cost of the trip	=	R286.80	(N = B x K)
Tonnage transported (Yield)	=	10 tons	(A)
Cost per ton (R/T)	=	R 28.68	(O = N ÷ A)

The 10t maize grain yield was from 2 hectares

= 5T/Ha (P)

Cost per hectare = R 143.40 (O x P)

Other combinations of tractors, vehicles and equipment can be determined using the illustrations above. It must be noted that the preceding examples do not include the costs of drivers and assistants. The cost of twine is not included in the case of the hay-making and baling operations.

1.6 OPERATING COSTS ASSOCIATED WITH DRYLAND MAIZE PRODUCTION

The following table is an example of how the costs in the "*Guide to Machinery Costs*" could be used in an enterprise budget to determine the operating costs of growing one hectare of dryland maize grain. The machinery costs only including repair and maintenance costs and diesel costs – *i.e.* only the variable costs are included in the budget. It is assumed that the yield is 5.0 tons per hectare. The "power re'q" can be light (L), Medium (M), or high (H).

OPERATION	TRACTOR and IMPLEMENT	Power Re'q	Hours/ Ha	Cost per Hour (R/Hr)		Total Cost per Hour	Total Cost per Hectare	Total Cost per Ton
				Tractor	Implement			
Disc in Stalks	46 kW trac + 2.3m trl offset disc	L	1.0	109.90	42.24	152.14	152.14	30.43
Lime	60 kW trac + 3t trl lime spreader	L	0.8	153.36	155.92	309.28	247.42	49.49
Plough	60 kW trac + 3 furrow mtd moulboard plough	H	2.3	184.44	15.60	200.04	460.09	92.02
Fertilize	46 kW trac + 700l mtd double-disc	L	0.5	109.90	53.38	163.28	81.64	16.33
Disc	60 kW trac + 2.3m trl offset disc	M	1.0	166.96	42.24	209.20	209.20	41.84
Weedicide & Pesticide	46 kW trac + 600l mtd boom sprayer	M	0.4	120.33	13.92	134.25	53.70	10.74
Plant	60 kW trac + 4 row (0.9m) mtd air planter	L	0.9	153.36	105.00	258.36	232.52	46.50
Sidedress	46 kW trac + 700l mtd double-disc	L	0.5	109.90	53.38	163.28	81.64	16.33

OPERATION	TRACTOR and IMPLEMENT	Power Re'q	Hours/ Ha	Cost per Hour (R/Hr)		Total Cost per Hour	Total Cost per Hectare	Total Cost per Ton
				Tractor	Implement			
Weedicide & Pesticide	46 kW trac + 600l mtd boom sprayer	L	0.4	109.90	13.92	123.82	49.53	9.91
Harvest	177kW self-propelled combine + 4 row (0.75m) snapper head	H	1.4	665.07 + 30.40		695.47	973.66	194.73
TOTAL			9.20			2 409.12	2 541.54	508.32

This simplified example shows how tractor and implement costs can be combined for different operations. If the time of each operation is known it shows how the cost per hour of the tractor and implement can be converted to a cost per hectare. If the yield is known, or assumed for a budget, it is possible to determine the operating costs per ton.

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1.8 DISCLAIMER

Although all possible precautions were taken to ensure the correctness of this "*Guide to Machinery Costs"* (- *"Guide"*), the Sub-directorate: Economic Research (National Department Agriculture, Forestry and Fisheries; Directorate: Statistics and Economic Analysis) and the Sub-directorate: Agricultural Economics (KwaZulu-Natal Department of Agriculture and Rural Development; Directorate: Farmer Development Support) - herein referred to as the authors - do not accept responsibility for any incorrect information herein.

Users of the "*Guide"* must take into account that some equipment prices were taken from the latest "*AGFACTS*" publication and these values are not actual market prices. Other prices were obtained from dealerships which were prepared to give the authors their prices. These prices will vary between dealerships and regions, and could be affected by the buyer's ability to get equipment at lower prices. The equipment costs are used to

calculate most of the Fixed Costs (Depreciation, Insurance, and Interest), as well as the Repair and Maintenance costs. The Interest rate was that applicable when the "*Guide"* was compiled. Clearly this rate will vary over time, and also depend on the buyer's credit rating. Similarly fuel prices will vary over time and, in the case of diesel, could also depend upon the source (the diesel price is not fixed like the petrol price). Other costs which can

vary are insurance, licenses, oil and tyres. If prices change dramatically, or the user's prices are very different to those in the "*Guide"*, the user can adjust the costs using the information in the "NOTES" at the bottom of the tables. Guidance can be sought from the authors, or from the regional agricultural economists in the various provincial departments.

The authors accept no responsibility for the manner in which readers use the information in the "*Guide".* Neither can they be held accountable if users change the information in the "*Guide"*, unless this is done with the consent and knowledge of the authors.

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