MACHINERY COSTS AND MECHANISATION SUPPLY

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Mechanisation as an Input

Mechanisation is a key input in all agricultural production systems. Like any other input, there are costs and benefits associated with the use of machinery. Unlike most other farm inputs, however, these costs and benefits are very difficult to quantify. Costing is made difficult by the need to predict depreciation and repair costs over the full life of a machine. Equally, it is difficult to attribute a monetary value to many of the benefits that machinery brings, such as improvements in timeliness, labour reduction, health and safety benefits etc.

It is important to acknowledge the role that mechanisation has, and continues to play, in agricultural development. Developments in mechanisation more than any other input are responsible for the type and scale of production systems that we have. Improved quality of work, timeliness of operation and, most importantly, the ability of a relatively small labour input to manage and operate quite large enterprises, are all attributable to mechanisation.

Spend on Mechanisation

The amount of money spent annually on machinery is considerable. The Teagasc National Farm Survey records farm expenditure on a sample of approximately 1,100 farms each year. The average farm expenditure on machinery was £4,250 in 1998, representing 22% of all farm costs (direct and overhead). This amounts to approximately £546M for all farms in the country. On tillage farms, the average annual expenditure on machinery was £11,142, representing 32% of all costs excluding land rental. This equates to £204/ha annually, which corresponds to the £194/ha recorded over a three-year detailed survey carried out on 40 farms between 1991 and 1994 at Oak Park Research Centre. These costs do not include labour associated with machinery use. On individual farms, the level of expenditure will vary. The Oak Park cost survey recorded a range of costs from £93 to £340/ha.

While it is incorrect to assume that the lowest cost is the best, these figures stress the importance of mechanisation as an input.

Factors Influencing Future Mechanisation Supply

The importance of mechanisation as an input is unlikely to change. There are many factors which will influence the type of machinery that is used and the method by which it is employed on farms, such as self-ownership, contractor use, partnership etc. Ultimately, cost-benefit analysis should determine what system is used, but it is important to identify the factors that influence trends in mechanisation to ensure that viable options will be available in the future.

Decreasing Margins

All main farming enterprises are facing reducing output prices in the medium to long term. This will force growers to examine all production costs including machinery. Reducing margins will also influence the future structure of farms with a smaller number of intensive full-time farms and a greater number of part-time farms. This will have implications for mechanisation choices.

Developments in Machinery

Machines and mechanisation systems continue to evolve. Occasionally it is thought that a particular machine or system has reached the end of its development. In the 1990s, for example, most tillage farmers and contractors considered the 4-furrow reversible plough and 3 m one-pass cultivator/drill to be the ideal crop establishment system. Now many are seeking more labour efficient alternatives. Machine development will continue both in the area of scale (machinery size) and technology. These developments offer the potential of improved work quality and/or reduced production costs but lower costs are only possible if these machines are worked over sufficiently large areas.

Labour Supply

Labour availability for agricultural operations has changed dramatically, with other sectors competing for paid labour and also attracting many farmers own labour. This has consequences for machinery use on farms, as in the past many farmers either

relied on their own labour to maintain/operate older machines or relied on a readily available supply of casual labour to work machines at peak times. While contractors have similar problems, they generally have a more even distribution of labour demand.

Influence of Scale on Machinery Costs

For most categories of machines, an increase in scale usually results in potentially reduced costs provided there is a pro-rata increase in the quantity of work carried out by the machine. There are many reasons for this. The biggest factor is often labour cost. The greater the workrate of an individual machine, the lower the labour cost per unit area. For example, a combine with a 5 acre/hour capacity will have 50% of the labour costs per acre of a combine with a 2.5 acre/hour output. The machine purchase price per unit of capacity may also be less expensive. However, there are many exceptions to this rule. Draught cultivation equipment, for example, can often be more expensive per metre of working width for a wider machine, as the frame costs to cope with the extra power input increase disproportionately with machine width.

The general trend of decreasing costs with increasing scale is illustrated in Table 1 where two different combines are costed using the Oak Park costing program. A number of assumptions are made here. Repair costs are assumed to be related to the original machine purchase price. Increasing scale reduces the labour cost element substantially. The influence of labour demand on mechanisation decisions is even greater than just a cost element as the unavailability of labour may dictate certain choices.

Table 1 - The effect of scale on combine costs

	4-shaker basic spec.	**6-shaker mid. spec.**
Purchase price (£)	80,000	140,000
Replacement age (yr)	8	8
Annual use (ha)	200	400
Machine cost (£)	10,208	17,864
Machine cost/ha (£)	51.04	44.66
Fuel/ha (£)	5.80	4.69
Labour/ha (£)	6.66	3.33
Total/ha (£)	**63.50**	**52.68**

In the past, smaller- and medium-sized operators could match the cost saving benefits of scale by using second-hand machines and/or long machine replacement life. This can still be the case, but the unavailability or opportunity cost of labour, to operate and inexpensively maintain these machines makes this a less attractive option today.

Methods of Achieving Scale

How can the advantages of scale be gained on individual farms? There are a number of options:

- Purchase land
- Rent land (con-acre or long-term)
- Farm partnerships: for all farming practices or machinery
- Use contractors/machinery rings

All of these options allow high-capacity machines to be operated over larger areas, but there are many other factors that determine the viability of each option. Land purchase is the least accessible option for most. Short-term rental is the most used option in the tillage sector. The rents paid usually result in the net margin being equivalent to the economies-of-scale benefit in machinery use, i.e. the normal production margin is used to pay the rental. Farm partnerships are a viable option, particularly where the partners want to maintain a level of involvement in the farming operation. There are many different types of possible partnerships, all of which offer the potential to reduce machinery costs. The most commonly used method of achieving economies of scale in Ireland is to employ contractors. Contracting simplifies organisation and solves both mechanisation and labour supply problems. They are the primary source of mechanisation supply on grassland farms. On tillage farms, they supply a significant level of service, but because of the central role that mechanisation plays in tillage operations and the ability to rent additional land, farmers often prefer to retain the machinery operations. Machinery rings are simply an alternative method of supplying contracting services.

The central co-ordination of services embodied in the ring system facilitates the supply of individual machines and labour units as a source of mechanisation supply.

There is little doubt that the use of contractors to provide mechanisation services is a cost-effective and sensible solution to machinery supply for a large number of farms. However, a more managed approach to contracting is necessary to ensure a stable supply of economic services to the farmer and a sustainable level of work and income for the contractor. Improved management must include accurate machine and operation costings, good pricing systems and better planning of services between the farmer and contractor.

Machinery Costing

Whatever method is used to supply mechanisation, accurate costing is necessary. A farmer with his own land and own machines needs machinery cost information for management purposes. For land rental, accurate machinery costings are essential to determine economically viable rent levels. Partnerships could not function without accurate machine costs to determine the value of individual machinery operations. Contracting cannot survive without accurate costing.

Machine Costing and Job Costing

To accurately cost any machine, it is necessary to attribute all the costs associated with its use to the job being carried out. Costs associated with machinery use can be divided into four categories: machine costs, labour costs, fuel costs and overhead costs.

Machine Costs

Machine costs include depreciation, interest and repairs and maintenance. Estimating these costs is difficult as the proportion and level of these costs vary during the lifetime of the machine. In many situations, the depreciation and interest component is paid for in the finance payment. However, this may not be an accurate reflection of the true costs if the machine is owned for a longer period than its finance term and/or the residual value of the machine at trade-in is different in real terms from the value of the original trade-in. Similarly, repairs and maintenance costs are difficult to predict because of their variable nature and the tendency of the costs to increase over the lifetime of a machine. Despite the difficulties associated with calculating depreciation, interest and repairs, estimates must be made to determine

the profitability of an individual operation and to arrive at a proper pricing structure for the job.

Where the facilities of the business are being used to maintain and service machinery, these should be costed (building, equipment and labour) and apportioned to individual machines where possible. Other costs that should be apportioned to machines include insurance and tax.

Fuel Costs

Fuel should be attributed to specific operations. The importance of fuel depends on its price. Accurate record keeping would facilitate this.

Overhead Costs

A contracting business can have significant overhead costs which can be difficult to assign to particular machines. These include office costs, transport costs and machine storage/workshop facilities. Other costs that should be considered include training, visits to conferences, meetings etc. All overhead costs should be assigned arbitrarily to individual operations.

Operation Costing Example

The one-pass cultivation/sowing operation is used as a costing example, as it includes tractor costs that must be calculated and attributed on an hourly basis, and machine costs which are assigned on an area basis. The machine costs for tractor and one-pass unit are given in Table 2. Prices in this example exclude VAT. The 95 kW tractor is costed at a use rate of 1000 hr/year. Depreciation and interest costs are based on age and use rate and are determined by the Oak Park costing program. The one-pass is replaced at 5 years with an annual use level of 300 ha.

The second part of the costing exercise outlined in Table 3 allocates fuel and labour costs to the tractor. A charge for road transport (assuming 20% of the total time is spent between working sites) is added at this stage to give a tractor and labour cost for each hour worked in the field.

The final part of the costing is to convert the tractor hourly cost to a per-ha cost and to add the one-pass costs, other overhead costs and a profit margin. If all the cost and workrate estimates are accurate, the net margin and necessary price should be realistic.

Table 2 - Machine costs – 95 kW tractor (8-year life), 3 m one-pass (5-year life)

(1) Machine Costs

	95 kW tractor (£)	**3 m one-pass (£)**
List price	50,000	22,000
Cost price	40,000	17,600
Residual value	11,340	6,487
Depreciation	3,582	2,223
Interest	1,400	933
Repairs	1,553	1,615
Insurance	800	-
Total annual cost	**7,335**	**4,771**
Cost/hr (1,000 hr/yr)	***7.33***	
Cost/ha (300 ha/yr)		***15.90***

Table 3 - Tractor, Fuel and Labour Costs

	£
Tractor cost/hr	7.33
Fuel cost/hr	5.50
Labour cost/hr	7.00
	19.83
Surcharge for 20% time at transport (£16.00/hr transport x 20%)	3.20
Tractor costs/hr	**23.03**

Table 4 - Complete Operation Costs

System workrate: 1.3 ha/hr (3.25 ac/hr)

	£	
Tractor cost/ha	17.72	
One-pass cost/ha	15.90	
Overhead costs (10% machine costs)	3.19	
Profit margin	5.00	
Price	**41.81/ha**	**+ VAT**

Opportunities to reduce costs in this example are highlighted in Table 5.

Table 5 - Possible Cost Reduction Options

		Cost reduction (£/ha)
1.	Improved tractor fuel consumption (15%)	0.63
2.	Extra tractor utilisation (1500 hr/yr)	1.35
3.	Reduced repair cost estimates (30%)	2.17
4.	Improved workrate (20%)	6.00

These options may not be available in every situation. Using a tractor with improved fuel consumption has a relatively small influence on costs, although at current prices fuel consumption is certainly worth considering when replacing a tractor. Increasing the annual use rate of the tractor would reduce the hourly cost quite significantly, with a consequent reduction in per-hectare costs. The repair cost reduction option may not be achievable in practice, although the repairs estimates produced by the Oak Park cost program tend to overstate costs. The final option of increasing workrate has the biggest impact on costs, as it effectively reduces all the cost elements, including labour. Note that this option assumes all the machine costs remain at the same level. It doesn't allow for increased wear and tear by forcing more work from the machine. Workrate could be increased by having better work practices in the field, working at a shallower depth or by having consolidated or more weathered ploughed soil to work on.

The practice of job costing is essential to identify the operations that are profitable and those which need attention either by reducing costs or increasing the charge. The costing process is not easy and the result is only as good as the figures which are inputted.

Charging Systems

Devising equitable and appropriate charging systems for machinery operations can be difficult. The charge arrived at in Table 4 is correctly based on machine costs, but is the area-based charge the best method? There are many factors which influence operating costs in the field. These include: soil type and condition; field size/shape; distance to travel to field etc. Harvesting costs are significantly influenced by the

yield of the crop being cut. A charging system should reflect the costs of the operation, but must also be transparent to the customer and be relatively simple to operate. The area-based charge is a good compromise in most situations. It usually is the best single measure of the work done. However, it fails to take into account factors which influence the workrate, such as crop yield, difficult soils, haulage distance for grass etc. The argument is often made for per-hour charging, but this system, while good if operated fairly by an individual contractor, is unacceptable to the customer for most operations. It does not allow comparison between different systems (i.e. different contractors would have different workrates) and is not necessarily based on the amount of work done. Time-based charging is only used where there is no other descriptor of the work to be done, e.g. digger hire or tractor/trailer hire etc.

The area-based charging system can be improved on. For grass harvesting, for example, a charge based on area and yield would be more equitable. Although this partly exists with second-cuts, if it was introduced for first cut, it would contribute to a greater spread in the length of harvest and it would make more second-cuts attractive. One of the main attractions of baled silage is that it is charged for on a per-bale basis. Research at Oak Park has shown that on-harvester yield measurement of grass is possible. Many of the forage harvester manufacturers are currently developing grass yield sensing equipment which would be the ideal basis for a better silage harvesting charge. Instead of £60/ac, a more equitable charge may be £25/ac + £2.50/t. In the meantime, a more formal date-dependent cutting charge, where later first cuts would attract an extra charge, would have merits.

Marginal-Cost Charging

The argument is often made that extra work can be carried out for the marginal costs of doing that work, e.g. an extra job is profitable if the labour and running costs of the machine are covered. There are potential pit falls with this approach. The marginal costs are often greater than realised. Most of the costs incurred by a contractor are directly related to the work being done. Labour, fuel, and repairs and maintenance costs are attracted at the same level as the core work. In many cases, machine depreciation is also increased. The residual value of a self-propelled forage

harvester is dependent on its condition and the amount of work done rather than its age, for example.

However, there is merit in using an element of the marginal cost approach to attract out-of-season work, where the customer has the choice of taking this option. Discounts for early-season grass harvesting or using a 2-cut system rather than a single cut, for example. Similarly, attractive rates for cultivation/sowing and harvesting of winter barley, when equipment may otherwise be idle, can also be sensible. It is important that this approach is only used to attract additional out-of-season work that all customers have an option of providing. It should not be used to attract additional customers at a low price during the core working period. This is not equitable and will alienate existing customers.

Conclusions

1. Mechanisation is a key input in modern agriculture that accounts for significant costs and brings considerable benefits.
2. Decreasing farm margins, labour shortages and developments in mechanisation will influence future mechanisation supply.
3. The need to pursue economies-of-scale in machinery use will ensure a continuing demand for contractor services and other systems which impact on machinery use, such as partnerships etc.
4. Estimation of machinery costs is essential to ensure competitive production at farm level and to ensure viability in a contracting operation.
5. A job costing approach is essential for contractors to identify operations where change is necessary.
6. Contracting charging systems could be improved to reflect costs more accurately and to attract out-of-season work.