Purchasing a fuel-efficient tractor

If chosen correctly, modern tractors can deliver significant energy savings and operational efficiencies over earlier machinery. Tractors are increasingly specialised and complex, making it essential to match their features to specific farming tasks and environments. Below, fuel-efficiency factors are discussed in relation to usage requirements, dealer support, engine performance, chassis configuration, linkages and power take-offs, and wheel, tyre and ballasting features.

Introduction

The acquisition of a new tractor is a significant management decision involving hundreds of thousands of dollars and long-term commitment to a particular production system and ancillary equipment.

A tractor near the end of its life typically operates at well below its rated performance and is likely to be using outdated technologies. Correctly specified, a new tractor will use less fuel to perform the same job and may also incorporate digital technologies that help you to organise and monitor your farming operations.

Figure 1: If your tractors are older than you are, it is probably time to upgrade. But how do you select the right tractor for the job? And what considerations are most important?

Ideally, you will be able to select a machine at an attractive price that is inherently efficient and that also will help you and your operators to be more efficient in the paddock. This is easier said than done, however. The process warrants considerable time and effort, as investing in an unsuitable machine can lock in fuel wastage and other operational inefficiencies for decades.

Scope of this paper

This paper focuses on the energy-efficiency aspects of the tractor-purchasing decision. It does not cover all factors involved in selecting an appropriate machine. Having said this, it may surprise you how many of your general considerations have an energy-efficiency dimension.

Things can get complicated when price is the overarching driver of your decision. If a machine with poor energy efficiency is sufficiently cheap, the discount may be enough to cover the cost of the extra fuel it will consume. However, you will not be a position to make that call if you do not know the energy efficiency of the machine in question.

Summary of process

The process of selecting an appropriate, fuel-efficient tractor can be broken down into manageable steps. These are:

- identifying sources of independent advice and information,
- conducting a needs analysis, by:
  - analysing your existing fleet of tractors and trailers,
  - documenting the tasks you’ll need to complete to acquire a suitable new machine, and
- determining your goal power,
- making a preliminary analysis of suppliers,
- collecting data about candidate machines and suppliers,
- comparing the machines you’re considering,
- making a full evaluation of candidate suppliers,
- making a final evaluation, and
- making a business case for the purchase.

Quick tips

- Needs analysis and ‘priority usage’. Complete a thorough review of your requirements in relation to the intended priority usage of the tractor.
- Compare suppliers. You are not just purchasing a machine. Investigate and research the major suppliers of tractors in your region. Can they provide the information, support and backup needed to ensure the tractor’s fuel-efficient operation throughout its productive farm life?
- Read and compare manuals before making the purchase. Manuals are the best source of factual information about products and can be perused in your own time.
- Don’t purchase on ‘horsepower for dollar’. Power per dollar is generally a poor indicator of fuel efficiency and lower operating costs.
- Aim for the lowest horsepower required to meet your priority usage needs.
Purchasing a fuel-efficient tractor

Step 1: Identify sources of independent advice and information
You should begin by listing the organisations, experts and consulting groups that are available to provide you with objective advice and information. Agronomists and neighbouring farmers may be a good starting point.

Don't just take it on us!
The guidelines instanced in this paper offer one approach to selecting an appropriate tractor. Nonetheless, it is of value to obtain advice from experts and local industry leaders, and to adapt your selection plan to your particular needs and situation.

Step 2: Conduct a needs analysis

Analyse your existing fleet of tractors and trailers
You are looking at buying a new tractor for a reason. Are you replacing an outdated machine? If so, what was the role of the old machine on your farm? You may be able to use existing machinery to fill the void.

Many farmers have several tractors and a mix of ancillary equipment of different ages and linkage technology. This can complicate and potentially compromise replacement decisions. In this regard, it is important that you consider your next purchase in the context of your existing fleet and your capital-replacement strategy.

Document tasks for the new machine
If you are looking to buy a new tractor to expand production, think about what this new machine entails. Will it also substitute for some or all the functions of current machines? A new machine might be able to replace several machines – for example, a utility tractor with a power bulge may be able to replace a small tractor and a higher horsepower tractor.

It is important to identify the tasks you will require your new tractor to perform.

Find your goal power range
Having determined the tasks for which you will use your new tractor, the next step is to identify how powerful your machine should be. This can be a challenging task in and of itself, as many factors are involved, including implement size (working width), working depth, the physical location of the property, soil type, intended working speed, crop conditions, transport requirements, etc.

NSW Farmers has put together an information paper and calculator tools that you can use to develop an informed estimate of the tractor power you require.

Refer to supplementary paper, Estimating tractor power needs.

Step 3: Make a preliminary evaluation of potential suppliers
Evaluation of suppliers comes first and last in the process of purchasing a tractor. You want to purchase from a firm that understands fuel efficiency, a firm that will actively and intelligently support your selection process, and that will provide effective after-sales service in the long term.

List your local dealerships and evaluate them based on some initial key factors, such as:
- whether the supplier is located near your farm,
- whether it provides good after-sales support, and
- what experts and/or other farmers have said in relation to this dealer/supplier.

Use this information to rule out any suppliers you definitely do not wish to approach.

Step 4: Find available tractors
Contact the suppliers and dealerships that meet your initial requirements (as listed previously) and obtain the model numbers and characteristics of tractors they offer that meet your goal power range. We recommend constructing a table for collecting and comparing the specifications and features of tractors that might be candidates for the job.

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<th>Manufacturer</th>
<th>Model</th>
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<th>Trans</th>
<th>ENG</th>
<th>Rated power (kW)</th>
<th>Fuel use (kW/litre)</th>
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Table 1: Tractor test data from the Nebraska Tractor Testing Laboratory. Adapted by NSW Farmers from (Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2009).
Purchasing a fuel-efficient tractor

Step 4: Compare candidate tractors
Typically, manufacturers and suppliers of tractors in Australia do not make it easy to assess the relative energy efficiency of their products and those of their competitors.

Obtain fuel-consumption figures
Ask selected dealers to supply all the relevant information they can regarding the performance of tractors you’re considering. Not only will you require information regarding power output; you’ll also need to make assessments about the engine’s torque output, and the speed at which this is produced (engine flexibility), and get hold of official fuel consumption figures if these are available. Try to obtain information on key parameters such as:

- fuel consumption at rated engine speed,
- fuel consumption at rated power,
- fuel consumption at maximum power, and
- fuel consumption at 80 percent engine speed and 80 percent engine power.

If the information dealers provide is inadequate, you can supplement it with data from the following independent testing bodies:

The Nebraska Tractor Testing Laboratory
The Nebraska Tractor Testing Laboratory was established in 1919 in Lincoln, Nebraska. It was set up in response to laws that were enacted to protect farmers from exaggerated performance claims by tractor manufacturers.

The laboratory now stands as the largest objective international body that conducts tractor performance tests and publishes its results. The Nebraska laboratory follows the standards established by the OECD and is the principal testing ground for standardised tractor performance tests among 25 participating countries.

You can access the results for specific tractors by visiting the Nebraska laboratory web page: 
tractor.testlab.unl.edu/testreports

See Further information, below, for links to materials that will help you use Nebraska lab test results to compare tractors.

Other OECD tests
Other independent testing bodies have made their results available for given tractors via the OECD’s website. You can access these results at the OECD web page: 
www2.oecd.org/agr-coddb/index_en.asp

Reading and comparing fuel-efficiency figures
By modern test standards, fuel consumption is measured and typically expressed in grams or kilograms per kilowatt hour (g/kWh or kg/kWh). This can be defined as the amount of fuel, in grams or kilograms required to produce one kilowatt of power for one hour. This may seem a little confusing, since fuel is generally purchased by the litre and engine/PTO power is often quoted in units of horsepower (hp). Nonetheless, it is safe to say that a lower fuel consumption figure in g/kWh is an indication of greater engine fuel efficiency.

Once you have collected this information, incorporate it into your comparison table so that you can continue to evaluate and compare the tractors you’re considering.

Caveats of test results/performance metrics

- Remember that often, tractor metrics are obtained when the engine is ‘standalone’ on the engine dynamometer. When installed in the tractor, overall fuel efficiency will be affected by many factors: transmission type/efficiency, hydraulic system, electrical power consumption, etc.
- Specifications reported online might not exactly match those of ‘equivalent’ machines available in Australia. Look carefully at details of the engine specifications for the actual machine you are purchasing. A machine sold in Australia may have inferior engine specifications to a machine with same model number sold in European or North American markets.
- Be careful comparing results between machines. Fuel consumption parameters at rated engine speeds may not provide a full picture of a given tractor’s performance.
- Different tests are sometimes conducted for different tractors, so test results are not always comparable. Engine power test standards can provide either ‘gross’ or ‘net’ engine power output figures. In addition, tests on American tractors are often quoted in PTO horsepower while those on European tractors are quoted in engine ‘flywheel’ horsepower (some European tractors quote both measures). Ensure that you know and understand which test standards are being used.

Step 5: Full evaluation of suppliers
What dealers don’t tell you
Australia is a small market, so it tends to be a dumping ground for machines that can’t be sold in other markets. Excess stock of machines that are designed and specified for far larger markets often ends up here, sometimes at attractively discounted prices. The price may be attractive but it is essential to understand that the machine might not be ideally configured for your soils or for other conditions prevalent in Australia.

Also, Australian machines may have been cheapened and may not meet the specifications required by more demanding peak markets such as the USA and Europe. Make sure that material you are reading about the machine applies exactly to what you will be purchasing.

Add additional columns to your tractor-candidate table to help you to compare and evaluate the attributes of each tractor’s supplier (for example, your columns may include: ‘Provides quality after service’, ‘Distance from farm’, ‘Understands emphasis on fuel efficiency’, ‘Knowledgeable staff’, ‘Provides quick onsite support’ and so on).
Purchasing a fuel-efficient tractor

Selecting a good supplier
Take the time to investigate and research the suppliers of tractors in your area. Can they provide the information, support and backup needed to ensure the tractor’s efficient operation throughout its productive farm life?

There are many technical decisions to be made in the purchase and operation of a tractor. The supplier should be able to support you in this decision-making, both at the time of purchase and throughout the life of the tractor.

- Does the dealer agree that maximising return on fuel investment is an important criterion? If they try to talk down fuel efficiency as an aim, this may be a cue to look elsewhere.
- Can the dealer fully explain and document the relative energy efficiency of its products and how the machine the dealership recommends is fit for purpose and will help you save energy?
- Does the vendor provide strong after-sales service with respect to energy-efficient tractor set-up and general maintenance?
- Can the supplier document and clearly explain the performance optimisation and energy-efficiency features of the machine?

Step 6: Conduct a final evaluation
Conduct a final review of your list of prospective tractors and their respective suppliers. Home in on the two or three tractors that offer the best combination of attributes (from the machines and from the suppliers). Before finalising your list, be sure to consult the additional sections of this information paper for a summary of some other key considerations.

We recommend you then contact your chosen supplier(s) to organise and schedule a test run of tractors on your short list. Allow enough time to familiarise yourself thoroughly with the machines you’re considering and determine which is the best fit for your farm.

Step 7: Develop a business case
Before taking the plunge, NSW Farmers recommends that you develop a formal business case for this major equipment purchase, in consultation with your accountant.

Horticulture Australia and AusVeg have put together a detailed business-case guide for tractor replacement that we recommend reviewing even if you’re not in that sector (see Further information, below).

Other critical considerations
The points listed above provide a brief outline of how to select a tractor for your property; however there are various other efficiency-related factors you should consider.

Careful consideration of the facts at the time of purchase will pay lifetime dividends in efficient tractor operation.

Options can make or break efficiency outcomes
The engine/transmission’s efficiency, tractor mass and weight distribution, as well as the correct wheel/tyre package, play significant roles in maximising performance and fuel costs per hectare. We suggest that you review key aspects, as outlined below, to help guide your selection and business case.

Read and compare manuals before purchase
A tractor manual may be able to tell you more about the machine than your local supplier and will certainly be more informative than sales brochures. Manuals are the best source of factual information about the product and can be scrutinised in your own time.

Many vendors provide excellent manuals online. These can provide clear information regarding tractor set-up and operation. Be aware, however, that the information in these manuals is likely to have been written for USA or European environments and will not have been modified for Australia.

Tractor dimensions
Take your farm’s cropping regime into consideration so that the physical size of the tractor you buy (i.e. its length, width and height) will suit your farm. Make sure it will fit in your warehouses and that it will allow for your desired row spacing.

Ballast and chassis configuration
When talking with dealers and distributors, it is important that you gather information regarding the mass and weight distribution of tractors you’re considering.

The tractor’s mass and weight distribution (% front/rear weight split) can be adjusted by the addition of cast-iron ballast or different types of wheel equipment. However, if additional weight is required, the most cost-effective method of providing it is at the factory or in the provider’s yard or warehouse; therefore, the most cost-effective time to get these basic details right is when purchasing a tractor.

Be careful, however! Redundant ‘suitcase ballasts’ can sometimes be offered to justify a premium price. NSW Farmers recommend that you consult our supplementary paper, Tractor ballasting, so that you can determine the configuration that will suit your needs best.
**Purchasing a fuel-efficient tractor**

**Wheel/tyre equipment**
Modern tractor tyres have provided huge performance gains in many areas, including tractive performance, soil compaction, ride quality and in-cab noise levels, as well as fuel efficiency. However, there are so many markings, sizes and specifications available that selection of suitable tyres can be a daunting task in itself. Often, farmers simply resign themselves to asking for exactly the same tyre set-up as that supplied with their previous tractor, even though the new tractor may be more powerful and heavier than the original machine.

The NSW Farmers’ Association has put together materials to explain the various types of tractor tyres available, and to help with tyre selection. Refer to our supplementary paper, Tractor tyre selection.

**Feedback and performance-monitoring systems**
In the farm environment and from a high cab, it can be difficult to hear a tractor’s engine and to interpret other signs of engine performance. Modern tractors, therefore, incorporate a number of technologies to optimise performance automatically and/or provide continuous feedback to operators. The quality and practicality of these features, we believe, should be key considerations when purchasing new equipment. Check the performance monitors and telemetry options that are available for any machine you’re considering.

- Does the machine provide useful feedback around engine efficiency (e.g. clear instrumentation, warnings and other feedback for operators)?
  Add-ons such as wheel-slip monitors may seem unnecessary, but they can provide invaluable feedback on driving efficiency.
- Does the system generate digital records in a form that you can incorporate readily into your general farm-management process?
- Does the system make it easy to separate and track records for individual users and/or tasks?

**Tractor management systems (TMS)**
Modern farm machinery is equipped with advanced telemetry, such as tractor management systems (TMS), which enable the farmer to assess the actual fuel efficiency of farm machinery as it is being used.

TMS systems also allow the driver and manager to monitor transmission and engine functions; monitor and adjust hydraulic flow settings; and collect data for future use.

We recommend that you invest time in investigating the capability and suitability of the TMS offered by various manufacturers before purchasing pricey new equipment. In addition, ensure that the supplier you’re considering is capable of demonstrating the TMS in action and that you are confident the system you choose can provide you with useful feedback that is clear and accessible to you and your staff.

**Tier emissions standards**
Over the past decade, the diesel engines produced in many of the world’s leading economies have been subjected to ever more stringent exhaust-gas emissions regulations. These regulations are mandatory for engines sold in these ‘selected’ economies and are designed to reduce detrimental effects of diesel engines on the environment. In some cases, these regulations have had significant impacts on the manufacturer’s engine performance with regard to torque output (performance) and fuel efficiency (g/kWh).

Against this backdrop has been the introduction of new engine technologies such as exhaust gas recirculation (EGR), diesel oxidation catalyst (DOC), diesel particulate filter (DPF) and selective catalytic reduction (SCR), among others.

**Selective catalytic reduction (SCR)**
SCR technologies require diesel exhaust fluids (DEF), known as AdBlue, to be carried on the tractor. This fluid reduces particulate matter and nitrous oxide emissions but does not affect tractor performance directly. However, the combustion process in SCR engines is designed to be more carefully controlled; therefore, an SCR engine is likely to be more fuel-efficient.

**Quick tips**

**Chassis weight.** Consult your supplier regarding the options for installed weights. Making correct ballasting decisions at the beginning of your new tractor’s life will greatly improve performance and efficiency from the outset.

**Tyre options.** With information supplied from relevant sources, choose the correct tyre for what will be the tractor’s primary application. This research will pay ‘lifetime’ dividends for the owner/operator in regard to performance and efficiency.

**Wheel equipment.** Choose a wheel style that’s suitable for the priority application of the tractor. Factors that require careful consideration include weight-carrying capacity for the wheel rim, adjustability to suit individual cropping and/or physical requirements, the overall impact of the wheels on tractor mass, and weight-carrying capacity.

**Further information**
Using Tractor Test Data for Selecting Farm Tractors
This paper outlines how you can use data from the Nebraska Tractor Testing Laboratory to compare fuel consumption between similar tractors.

[pubs.ext.vt.edu/442/442-072/442-072.html](pubs.ext.vt.edu/442/442-072/442-072.html)

**Tractor replacement business case**
Horticulture Australia and AusVeg have put together a detailed business case for tractor replacement.


**Acknowledgements**
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Purchasing a fuel-efficient tractor

References

