Australian Government

Grains Research and Development Corporation

High profit farming in northern Australia

A new era in grain farming

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Grains Research & Development Corporation

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1. INTRODUCTION TO HIGH-PROFIT FARMING

WHAT ARE THE key drivers of profitability? What are the most important changes we can make to improve farm profitability? What are the most important advances in farming systems over the past 20 years?

This report looks at these issues and how farmers can improve profitability – now and in the future.

Grain production is set to change dramatically in the short term, with higher prices brought about by the fact that grain has been too cheap relative to oil. Farmers have done a good job of keeping productivity ahead of demand and creating surpluses of grain and other commodities. But the massive tonnages of grain going into ethanol have now created a shortfall – a permanent hunger for grain – which will inevitably lead to a conflict between the use of food for fuel. Agriculture is now in a new age: the energy age.

It is an age when Australian farmers will be on a more level playing field. Commodity prices have risen to the point where most farm subsidy programs will no longer be needed. This should not be an excuse to become complacent. Farmers in Australia are still in competition with farmers around the world.

The key drivers of profit from grain growing are identified below. A key message here is that crop yield is only one of six profit drivers. In some cases there is too much emphasis placed on agronomy, where the large gains are to be made from fine-tuning the whole business.

Fine-tuning

Fine-tuning should be an integral part of the management process; where small changes are made each year in response to a review of the farm business and the key profit drivers which include:

1. **Growing the most profitable rotation or mix of crops**
2. **Productivity – turning water into grain**
3. **Optimising costs**
4. **Marketing**
5. **Climate risk management**
6. **Implementation and timeliness**

But fine-tuning is not enough to keep the farm business up to date, profitable and competitive with farmers around the world, over time.

Over the past 20 years major changes in farming have included new crops such as chickpea, canola and dryland cotton, zero-tillage, controlled traffic and increasing use of precision agriculture technologies. Farm machinery has improved and become larger.

Reinvention

Farmers need to keep an eye on the future and not assume things will stay the same. Reinvention of farming is required at times, with a need to consider the big picture, as well as a continuous process of fine-tuning. Some opportunities for reinvention include:

1. **A change to an 'energy'-driven and more energy-efficient agriculture**
2. **Continued expansion of farm size, but**
3. **Less labour and better use of capital by using contractors, sharing equipment and diversified summer/winter cropping**
4. **Better people management – encouraging staff to be more reliant and productive and being competitive with other employers**
5. **Farming carbon – halting the decline in organic matter and improving soil health**

All change involves some risk and it is important to analyse the benefits and risks associated with any changes which are being considered. However, one of the biggest risks to farm viability is failing to change and becoming uncompetitive over time.

If the pace of change off-farm is greater than on the farm, then over time there will be a problem.

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2. A NEW ERA FOR GRAIN FARMING

FARMING HAS ENTERED a new era of improved profitability, with the doubling of grain prices over the past 15 months as a result of ethanol production in the US. The website of the Renewable Fuels Association provides details of the expansion of the ethanol industry (see table: www.ethanolrfa.org/industry/locations) where (in January 2008) 139 ethanol plants have the capacity to produce 29,857 million litres a year and consume 76 million tonnes of corn. Another 68 plants being built will produce an additional 20,954 million litres and use an extra 54 million tonnes of corn.

When these plants are fully operational the total use of corn will be 130 million tonnes, with net use, after the use of 40 million tonnes of distillers grains by the feed industry, of 90 million tonnes. This represents 30 per cent of the total production of corn in 2007 and is in excess of the normal tonnage exported by the US.

World coarse grain production of 981 million tonnes (mt) fell 28mt short of total world demand (1,009mt) in 2006-07, according to USDA supply and demand data. US farmers will grow more corn this year, but unless it is a bumper crop, the shortfall for 2007-08 is projected to be 10.8mt. Prices for corn increased, from about US$2.10 per bushel (A$112/t) in November 2005 to about US$5.00 per bushel (A$220/t) in February 2008. Prices may need to increase further to stimulate additional production around the world to keep up with demand for grain as ethanol production continues to expand.

In Australia, five ethanol plants are in the planning stages in eastern states: at Swan Hill, Gunnedah, Lemon Tree (near Milmerran), Brisbane and two to be built at Dalby. If these plants were all completed the estimated capacity is to produce 420 million litres of ethanol per annum, requiring around one million tonnes of sorghum, corn or other grains.

However, the current export parity price (of about $220/t) for grain has moved above the level at which ethanol can be produced and still provide a reasonable return to investors in an ethanol plant. All of these plants are not likely to be constructed without a mandate for ethanol. The ethanol price probably needs to be about 85 cents per litre, with grain at $220/t, for the construction of an ethanol plant to be viable for investors.

However, both the Queensland and NSW governments have indicated they will mandate ethanol use in petrol. Some pricing mechanism will be needed to provide a return of 85cpl or thereabouts to the ethanol plant, while oil prices are close to US$60 a barrel and grain A$220/t. This would not make much difference to fuel prices. If an extra 10cpl is needed to make ethanol viable, then it would only add one cpl to the cost of E10 and 0.2cpl to the average petrol price. E10 would still be cheaper than other alternatives for an increasing number of cars that require 95 octane fuel. The problem is that extra price support may be needed when the excise is applied to ethanol

Better grain prices are positive news for the grains industry, but there is a lot of catching up to do with profits eroded by higher costs from fuel, fertiliser and labour.

Prices of beef and other meats will rise over the next few years to reach a new equilibrium with grain prices. Consumers will have to pay more for food, but that is because their food prices in the future will be determined more by the price of petrol than the cost of production of grain or beef.

- **Grain has been too cheap relative to petrol. It is inevitable that grain is going to be used for fuel at low prices.**
- **The grain price will eventually settle at a price where it is profitable to produce fuel.**
- **Grain prices in Queensland are higher than ‘up-country USA’ and investment in ethanol may not be attractive.**
- **Beef, poultry and pork prices will rise to a new equilibrium with higher grain prices.**
- **Ethanol production will result in a shortfall in world coarse grains this year.**

3. KEY DRIVERS OF PROFIT

OVER THE PAST 30 years farmers have had to find an extra two per cent a year of improved productivity or lower costs to keep ahead of a 60 per cent decline in farmers' terms of trade. Higher grain prices may provide some relief, but farmers should not be complacent or ignore the potential improvements in profitability which come from fine-tuning.

Fine-tuning should be a continuous process across the whole business in the following areas:

1. **Growing the most profitable rotation or mix of crops**
2. **Productivity – turning water into grain**
3. **Managing costs**
4. **Marketing**
5. **Risk management**
6. **Scheduling and timeliness**

The big gains in profit come from putting it all together well.

3.1 Growing the most profitable rotation or mix of crops

a. Compare profit margins – after overheads as well as input costs
b. Add in rotation benefits: for example nitrogen, diseases and weeds
c. Diversity may spread workload and reduce costs
d. Profit must take crop frequency into account

Fine-tuning is needed each planting season to examine crop prices and gross margins and the optimum mix of crops in accordance with other objectives for productivity and low costs, such as having well-planned rotations to reduce weeds and disease.

For example, grain sorghum might not be as profitable as wheat in the drier grain-growing areas, but can reduce weeds and disease in subsequent wheat crops. It will also spread risk and reduce costs by not requiring as much labour and machinery.

Profit from different rotations needs to allow for rotation benefits, including nitrogen contributed from legumes. If fallow length varies, the profit needs to be considered for a rotation program over several years. This is difficult due to the desirability to be flexible by growing more crop on long fallows in dry seasons and double-cropping where appropriate in wetter than average seasons.

The profit from dryland cotton (using a long fallow), with a crop frequency of 0.66 crops a year, needs to be almost twice that of an opportunity-cropping program with wheat, chickpea and sorghum, which may have a crop frequency of 1.2 crops per year.

3.2 Improving yields and productivity

a. Fallow moisture storage is crucial
b. Spot-on agronomy (varieties, fertilisers, weed control etc)
c. Good establishment
d. Planting time may influence water-use efficiency

The main business of farming is converting water into grain, so optimum water-use efficiency (WUE) is an important indicator of success.

This starts with good fallow management and requires yields to be optimised by fine-tuning the various aspects of varieties, fertilisers, weed and disease control, and other agronomic issues. Good establishment of the appropriate plant numbers is also important and is being facilitated by modern planters.

WUE in summer-rainfall areas is calculated by dividing yield by water available to the crop. If an allowance for evaporation (for example, 100 millimetres) is subtracted from the total water, it will distort the results in dry years when in-crop rainfall can be less than 100mm.

WUE is significantly affected by planting time, both for wheat and sorghum, with efficiency reduced by heat during grainfill. In general, WUE for wheat will decline by six per cent a week of planting delay past the optimum time in May. WUE from a late June planting may have declined from 12kg/ha/mm to 9kg/ha/mm. Moisture-seeking planting techniques can be used in some years to achieve more crops planted at the right time.

The icing on the cake of better yields is soil health. A good program of zero-tillage, controlled traffic, crop rotation and manure use will optimise soil structure, build soil organic matter (SOM) and improve the storage and conversion of water into grain. (See page 13: 'Best practice for farming carbon'.)

3.3 Cutting production and overhead costs

a. Rotation can reduce costs of weeds and disease
b. Legumes can reduce the need for nitrogen fertiliser
c. Feedlot manure can provide cheaper nutrients
d. Overhead costs need to be optimised

Not much can be done about the costs of fuel, repairs, seed and fertiliser. Some farms need to spend more on these 'productive' inputs.

Apart from maximising the benefits of rotation to reduce costs associated with weed and disease control, and using legumes wherever possible to reduce nitrogen (N) fertiliser costs, there is not much that can be done to reduce farm input costs.

Feedlot manure can save money on fertilisers. A tonne of

■ Top farms make two to three times the profit of the average farm, not because they have much higher yields, but because they are doing a good job managing most areas.

aged manure contains 18kg of N and 7kg of phosphorus (P), worth about $38 if applied as urea and MAP (mon-ammonium phosphate). If manure costs $22/t (spread), it is cheaper and an extra bonus comes from organic matter and nutrients such as potassium (K), sulfur (S) and zinc (Zn). (See page 12.)

Overhead costs on a typical Darling Downs farm are $55/ha for administration (phone, power, rates, insurance etc), $80/ha for machinery depreciation and $100/ha for labour. On Western Downs farms, which are generally double the size, overhead costs are about half those of farms on the Darling Downs. Added together these overhead costs can be just as important as input costs.

There is more scope to reduce overhead costs than input costs, by increasing output or the scale of production through leasing land or using contractors. Another approach is to use farm machinery for contracting.

3.4 Marketing strategies which lift the average price

a. Good timing of sales (using storage) can enhance price
b. Quality and premiums can enhance price
c. Marketing options: futures, bank swaps, options
d. Risk management and price smoothing can help

Top marketers improve their price by intervention in marketing. This does not necessarily mean using a lot of forward selling, futures or fancy tools.

Farmers need to develop a marketing strategy to suit their farm and their personality and to make decisions based on information sources that help them to understand markets and price fluctuations. This means being aware of harvest-time price trends – locally and around the world – which may suggest opportunities to take advantage of price fluctuations.

In some cases there may be opportunities to use various market options to lock in a good price. In other situations, storage or deferred selling of grain may help to average-up the price. Good risk management is needed to avoid locking in production before the crop is planted. Futures and swaps are ways of pricing grain without locking and production and may help.

Storing grain costs between $1 and $2 a tonne per month. It costs about $20/t to store grain for 12 months, which means a 12-month contract to supply should have a premium of at least $10/t.

3.5 Fine-tuning climate risk management

a. Manage climate events, such as rain at harvest
b. Select varieties that provide insurance against diseases (for example, yellowspot)
c. Moisture management: zero-tillage and moisture-seeking planting help manage drought and reduce planting-time delays.
d. Watch for new climate forecasts – current ones are not accurate enough.

- **Adjustment of the most profitable mix of crops could double profit on most farms.**
- **Crop rotation may improve profit by maximising yields and reducing costs.**
- **Evaluation of the profitable mix needs to take into account rotation benefits and crop frequency.**

- **Water-use efficiency is a good indicator of productivity.**
- **Optimum sorghum production is 15kg/ha/mm, which means 6t/ha from 150mm of stored soil water and 250mm of in-crop rain.**
- **Wheat should produce 12kg/ha/mm or 3.6t/ha from 150mm of soil water and 150mm of in-crop rain.**

- **Good farmers focus on yields and profit, rather than trying to save money.**
- **It is not economic to own large machines such as headers, which are used for only a few weeks a year.**

Dry seasons, rain at harvest and losses that occur in wet seasons cause major setbacks to farm profitability. A succession of these may contribute to farm business failure.

The opportunities to manage risk should be examined and developed into a plan for each major risk. It is important to keep risks in perspective as too much income could be lost trying to avoid the risk. For example, planting late to avoid frost may result in greater yield loss than from the frost.

As an example, harvest risk can be managed better by considering all the management options, such as crop diversification, spreading flowering and harvest dates, aeration and extra headers. These options should be put together in a package to minimise the risk of weather damage at harvest. A sense of urgency combined with a good package of harvest-management practices might save a great deal of this loss.

3.6 Scheduling and timeliness

Good planning, good equipment, a sense of urgency and the use of extra labour or contractors can all help to improve the scheduling and timing of farm operations.

Fallow weed spraying, planting and harvesting are all critical events where the timing can upset profitability greatly. It is important to keep track of these events and devise ways to improve at the next planting or harvest time.

- **The more attractive the price, the more incentive there is to use marketing tools to lock it in on some portion of the production.**
- **There is a risk when selling grain that has not been produced.**
- **Climate forecasts need to improve before they are useful for making decisions.**
- **There is a need to manage climate events, such as rain at harvest and crop disease. Good programs can boost profit by minimising crop losses.**
- **High-flow aeration systems can dry grain in silos and reduce harvest losses.**

4. TEN BIG IMPROVEMENTS

THE FOLLOWING PRACTICES are suggested as the 10 biggest improvements to 'northern' cropping systems over the past 20 years. Many farmers have implemented these practices, but overall adoption is less than 50 per cent.

Research has provided information to allow the fine-tuning of these practices, and on many farms there is still a lot of room for improvement by 'trouble-shooting' and 'integrating' practices in a good farming-systems package.

4.1 Zero-tillage

Many trials conducted over the years have shown improvements in moisture storage using zero-tillage to increase grain yields by 15 to 25 per cent compared with land that has been cultivated, providing nutrient supply is adequate for the higher yields.

Fallow trials at Billa Billa (Thomas QDPI&F) provide an example of this yield gain, where for six sorghum crops grown between 1988 and 1995, grain yield improved from 2.48t/ha when cultivated to 3.05t/ha when zero-tilled – an increase of 23 per cent.

As well as short-term moisture benefits there are long-term effects from zero-tillage on soil structure and organic matter.

Farm costs are reduced, with fuel savings and reduced costs of labour and machinery depreciation. The combination of increased yields and reduced costs from zero tillage will more than double profit on many farms which are not making the most of this technique.

Zero-tillage is also the most important method of controlling soil erosion. Maximising stubble cover and reducing both runoff and the soil content of runoff water can result in 70 to 90 per cent less soil erosion, compared with a 10 to 20 per cent reduction in soil erosion from contour banks, long regarded as the 'classical solution' to soil erosion.

Additional benefits include much better water quality as a result of less soil, nutrients and farm pesticides in the runoff water.

Another benefit from zero-tillage is that farmers have found it extends planting time, allowing moisture-seeking planting. Moisture stays closer to the surface and in some cases it has been possible to plant wheat in May and sorghum in September, many weeks after the last fall of rain.

4.2 Controlled traffic

Reduced compaction from controlled traffic results in better moisture storage and improved root growth in crops.

Most farmers making the change to zero-tillage have used some form of 'tramlines' for planters and sprayers. This provides a large portion of the benefits of 'controlled-traffic farming' and research has still not quantified the extra benefits in setting up traffic lanes to fit headers and field bins as well as planters and sprayers.

There is no doubt that harvesting when soils are wet causes damage, but the challenge for farmers and researchers is to discern whether the benefits of the full system outweigh the costs. To date there has not been a lot of good economics applied to this question.

One problem is that the full conversion of machinery, including grain harvesting equipment, is expensive. A second issue is that most farms cannot justify the ownership of a grain harvester. Using contractors may involve headers with different wheel tracks, while the width of header fronts has changed several times over the past 10 years.

Controlled traffic can result in savings if there is reduced overlap for planting and other operations. Farmers say this is not as great in practice as in theory, even with the use of satellite guidance of machines.

Self-steerage systems are now in common use. Most of the benefits claimed are in reduced driver fatigue and being able to use less experienced or less focused operators to operate expensive machinery.

- **Zero-tillage improves moisture, reduces compaction and improves soil health.**
- **A reduction in costs, improved soil structure and better moisture storage can more than double profits on most farms.**
- **Zero-tillage, with tramlines for sprayers and planters, eliminates 80 per cent of compaction.**
- **It is expensive to put headers and tractors on the same wheel tracks: more evidence of benefits is needed to justify full CTF.**
- **Most farms cannot justify ownership of a grain harvester.**

4.3 Yield maps

The big potential of yield maps is to conduct trials of crop varieties, fertilisers and other management strategies to check responses across variable soils in a landscape or paddock. It does not require a lot of time to set up nutrient trials across a paddock, but farmers should receive advice as to how to best conduct such trials. The information from such trials is invaluable for fine-tuning production and costs.

Yield, protein and soil maps can help to quantify spatial variability within a paddock. This may allow more accurate diagnosis of nutrient deficiency and its relationship to yield potential. It may be possible to identify zones in a paddock that are low in phosphorus, sulfur or zinc, and then to make a 'bulk' application of these nutrients, by using feedlot manure, gypsum or zinc sulfate, to make the nutrient levels across a paddock more uniform.

Yield maps are the essential ingredient in being able to assess whether there is potential in the variable rate application of inputs such as fertilisers, seed (planting rate), pesticides and other products such as growth regulators, based on information gathered using yield/protein mapping and other spatial data sets.

Research on the economic benefits of VRA fertiliser in broadacre grain crops has, to date, shown little benefit, due primarily to the flat yield response curves that apply in most seasons. However, there may be potential to save money on fertilisers where yield maps indicate variability and it can be clearly linked to nutrient levels.

4.4 Better planting techniques

Planter technology has improved in recent years to enable more accurate plant populations in heavy stubble and no-till situations. Combined with better seed dressings, particularly insecticide treatments on summer crops such as sorghum, this has allowed farmers to use less seed and achieve better control over plant populations.

Moisture-seeking planting techniques are important in being able to achieve more crops planted at the optimum time. With winter crops there is a loss in WUE and hence yield potential of 25 to 30 per cent for a month delay in planting after the optimum date in May.

Chickpea is ideally suited to moisture seeking, because it is planted in rows and can emerge from a depth of 10 to 12 centimetres. Farmers should be aware that the soil needs to be levelled after planting to ensure as much height as possible between the ground and low-set pods, and to avoid crop damage from concentration of herbicides in the seed trench if there is rain during the early stages of growth.

Moisture seeking has generally involved deep sowing with tine planters, whereas much of the improved planter technology is with single and double disc planters. But disc planters have been successfully used for moisture seeking. With minimum soil disturbance it is possible to obtain a strike with shallower planting than a tine planter. A further possibility is to use trash whippers or a small tine in front of the disc opener to remove 2 to 3cm of dry soil.

Care needs to be taken when applying significant amounts of starter fertiliser in a narrow band created by a disc planter.

- **Chickpea is ideally suited to deep sowing using moisture seeking, provided the ground is levelled after planting.**
- **Better N decisions result from yield mapping test strips and using N budgets in combination with paddock history and soil tests.**
- **N budgeting in hindsight provides information on the supply of N from the soil.**

4.5 Nitrogen management

Decisions on nitrogen fertiliser are likely to be improved if there is an input of information from a variety of sources – not just soil tests.

Using soil tests to determine the amount of nitrogen to apply has significant errors, even if soil test readings from zero to 10cm and 10 to 60cm are used. There are sampling errors and significant variation in N mineralisation between seasons and during the growth of the crop.

Other ways to improve the outcome of soil testing is to use it in conjunction with paddock test strips (item 4.3) and N budgeting. A nitrogen budget calculates the potential demand for a crop of a particular yield and protein. Table 1 shows some estimates of the nitrogen required for different crops in the northern region.

For example, wheat at Dalby (650mm rainfall area) should yield about 3.5t/ha, which requires a total of 100kg N/ha to grow the crop and 70kg N to match the removal of N. Further west, (580mm rainfall) a wheat crop yielding 2.8t/ha requires a total of 86kg of N to grow the crop, while 60kg of N is removed in grain.

Nitrogen budgeting can be conducted in hindsight – using the yield and protein content of past crops to estimate the amount of N supplied by the soil.

For example, if a wheat crop yielded 4t/ha with 12 per cent protein and 60kg N was applied as urea and in MAP, then the total crop demand could be estimated to be 112kg, comprising 80kg in the grain and 32kg in the stubble (4000kg by 0.8 per cent). If 60kg N was derived from the fertiliser, then the soil is assumed to contribute 52kg N.

There are problems or errors in this approach because only part of the applied fertiliser is used in the same year and the protein content in grain is variable depending upon seasonal conditions. However, used over a number of years, these N calculations can provide valuable information in hindsight.

Another alternative approach is to use N fertiliser at, or slightly above, the crop removal level. This is appropriate where there are no other impediments to yields and on clay soils, where any N left over in the soil from a poor year is likely to remain stored until the next big crop. It is good to have a reserve to make the most of good seasons. Some adjustments can still be made using soil test results and yield potential, but cutting back too much in any one year may limit yield potential if the season turns out better than expected.

An important question about the use of nitrogen is the efficiency of the fertiliser used. It has commonly been said that about 50 per cent of fertiliser applied to cereal crops in any one year contributes to the N in the grain. But this does not mean that fertiliser needs to be applied at twice the replacement level to maintain soil fertility.

The long-term efficiency of nitrogen fertiliser is much higher than 50 per cent. Long-term experiments show that it is in the vicinity of 90 per cent if there are no major losses from denitrification, leaching and soil erosion. Small amounts of N coming from free-living algae and lightning during thunderstorms will also help to balance the losses.

4.6 Crop rotations – opportunity cropping

Crop rotation may help to manage soil-borne diseases in farming systems, as well as to reduce the costs of weed control and provide diversification and risk management.

TABLE 1: NITROGEN DEMAND AND FERTILISER REQUIREMENTS FOR DIFFERENT CROPS AND YIELDS

	Grain yield (kg/ha)	Grain protein (%)	N in grain (kg/ha)	N in plant tops (kg/ha)	Total N required by crop (kg/ha)	N from soil (kg/ha)*	Deficit: minimum fertiliser required
Wheat 650mm rainfall	3500	12	70	28	98	40	58
Wheat 580mm rainfall	2800	13	60	22	82	40	42
Sorghum 650mm rainfall	5600	9	84	56	140	40	100
Sorghum 580mm rainfall	3200	11	60	32	92	40	52

* Approximate N supply from 60-year-old cultivation, where organic carbon is 1% or less

Opportunity cropping involves making the best use of rainfall by planting crops according to soil moisture reserves. In some instances this will involve double-cropping, at other times long fallows might be used to build soil moisture for a more reliable crop.

Important disease problems that require crop rotation to maintain profitable production include crown rot, root rot and yellowspot in wheat, and phytophthora root rot and ascochyta blight in chickpea. An example of the response to disease control comes from tillage trials at Billabilla (near Goondiwindi) where wheat after wheat yielded 2t/ha, compared with wheat after chickpea, which yielded 2.6t/ha and 2.7t/ha where the soil was experimentally fumigated to eliminate disease.

Sorghum grown in rotation with winter crop can provide rotation benefits for disease control as well as weeds. A sorghum phase is still one of the most efficient ways to control wild oats. If there are problems with herbicide resistance, the summer crop rotation will also help to eliminate or prevent resistance developing.

Sorghum, or other summer crops, in rotation with winter crop also provides diversification and spreads risk. A 2000-hectare property growing all winter crop requires more labour and machinery (greater capacity in hectares per day) than a program that has 1200ha of winter crop and 800ha of summer crop.

Opportunity cropping not only increases crop opportunities, it facilitates a change from winter to summer crop without involving long fallow. It can also contribute to reduced soil erosion and salinity. There are times when the soil profile can fill rapidly after crop harvest. Continuing to fallow for another four to five months over summer can be a serious erosion risk.

Rotation planning considerations:

- a Profit – asses the optimum mix of crops
- b Disease and pest build-up and the need to change crops
- c Weeds – management strategies to control seeding
- d Legume benefits and nitrogen supply to other crops
- e Stubble cover and carbon input
- f Diversification and risk management
- g Minimising labour and machinery requirements

4.7 Feedlot, pig and poultry manure

Feedlot and other manures are available in large quantities in the northern grain belt and provide one of the most economical and effective ways to supply nutrients to crops.

A relatively simple way to manage the use of feedlot manure is to use it as P fertiliser and to boost the N supply according to needs. One tonne of aged manure contains about 7kg of P, which is enough to replace the P removed in 2t/ha of grain. An application of 8t/ha will supply 56kg of P/ha, enough for four to five grain crops, or more, if the soil P levels are reasonably high and the normal strategy is to apply about 7 to 10kg P/ha/year (using 32 to 45kg/ha of MAP).

Feedlot manure also applies significant quantities of K and S, which will rectify deficiencies or maintain soil levels of these nutrients.

The N component of the feedlot manure adds to the value. In a good summer season, about half the total N should be released during the first crop. If 8t/ha of manure is applied, this means that, of the 128kg of N in this manure, about 64kg should be available to the sorghum crop and could be deducted from the fertiliser requirement.

In subsequent years, the extra N release should be considered a bonus that may boost yields in a good year. In this way, manure applications can provide a little extra reserve of N, in an organic form, which can help boost yields in a wet summer.

For farms within 60km of a feedlot, the cost of manure is typically about $22 to $25/t, including freight and spreading on the paddock, which means manure is good value compared with the equivalent cost of N and P totalling $38. If potassium is of use, the value of nutrients in manure is more than $57/t. Zinc and sulfur add another $2/t to the value of the manure.

TABLE 2: NUTRIENT CONTENT AND VALUE OF FEEDLOT MANURE

	Water content	Nitrogen (N)	Phosphorus (P)	Potassium (K)	N & P
Aged manure (wet)	26-32%	16kg/t	7kg/t	18kg/t	
Value of nutrients*		$18	$20	$16	$38

* Nutrients valued at cost of urea, MAP and MOP

- **Grain protein content divided by 6 estimates N content. For example, 12 per cent protein = 2 per cent N or 20kg/N/tonne.**
- **Wheat stubble has about 8kg N of per tonne; sorghum about 10kg N a tonne.**
- **A 3t/ha crop of wheat with 12 per cent protein will have 60kg of N in the grain and 24kg of N in the stubble: a total of 84kg of N.**

4.8 Grain storage and aeration

Demand for feed grain has increased in Queensland and a deficit of feed grain is met by grain moving from northern NSW. There is a serious shortfall in some years and a need to store more grain in Queensland, rather than export in some years and have to import grain in others.

Moving from export surplus to domestic shortfall in the past

- **Crop rotation can optimise yields by managing disease and optimise costs by managing weeds and incorporating legumes to supply some free N.**
- **Changing from winter to summer crop will help manage herbicide resistance.**
- **Feedlot manure can supply nutrients at half the cost of mineral fertilisers.**
- **Manure helps to manage the N demands of high-yielding sorghum.**
- **In a good season, as yield levels and N demand climbs, more N is released from organic N in feedlot manure.**
- **Grain storage can help achieve market premiums for grain.**
- **It costs about $20/t to store grain for 12 months.**
- **Agriculture has contributed more carbon dioxide (CO2) to the atmosphere than fossil fuels.**
- **There is a win–win situation by halting the decline in soil carbon and storing more in the soil.**
- **Greenhouse gas emissions can be further reduced by saving fuel and reducing energy use on farms.**

has resulted in a price increase of about $40/t. This is more than the $20/t cost of storing grain for 12 months and gives farmers an opportunity to make money out of storage and/or to add significant flexibility to their marketing to improve their average grain price.

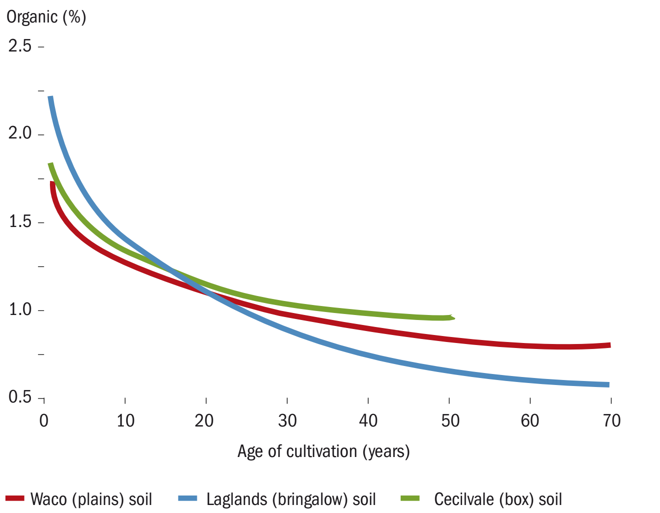
Aeration (two to three hours per night by timer or controller) will keep grain cool (below 15°C) and stop insect growth for most of the year. A further development is to use 'high flow' aeration, which involves higher capacity fans capable of not only cooling grain but, if left on continuously, drying grain in a silo over a period of a few days.

Grain drying costs about $15/t of grain (four per cent moisture) when the interest and depreciation costs of ownership are taken into account. Large dryers are generally not viable, but high-flow aeration can dry grain for about $5/t. This can be an extremely profitable practice in years when there are harvest losses from bad weather.

4.9 Farming carbon – low-energy farming

Soil fertility and soil organic matter (SOM) have declined over 50 to 100 years of cropping in Australia.

FIGURE 1: SOIL ORGANIC MATTER AND AGE OF CUTIVATION
Decline in organic matter with cultivation



About 50 per cent of SOM has been lost in northern cropping soils. This means that less nitrogen is mineralised to help produce good crops in high-rainfall years. The general decline in organic matter not only means lower soil fertility, it will generally result in poorer soil structure, more runoff and soil erosion.

Global warming – a result of increasing carbon dioxide (CO_2) concentrations in the atmosphere – has, in part, been triggered by land clearing and the decline in soil carbon.

Farming practices that build rather than deplete soil carbon include:

a. Grow high-yielding, high-biomass crops to maximise carbon input
b. Eliminate tillage (which stimulates SOM breakdown)
c. Use appropriate fertilisers to maintain soil fertility
d. Use animal manure as a fertiliser
e. Pasture leys that include perennial grasses will build SOM
f. Minimise soil erosion
g. Maximise crop frequency – avoid long-fallows
h. Good grazing management
i. Agroforestry

Greenhouse gas emissions can be further reduced by seeking energy savings and managing soils to minimise release of nitrous oxide (N_2O). Zero-tillage will significantly reduce fuel use on farms. The use of manures and legumes reduces the large energy input of nitrogen fertilisers into agriculture, while the nitrogen is less likely to be lost as N_2O.

BEST PRACTICE FOR FARMING CARBON

1. HIGH YIELD, HIGH BIOMASS CROPS

In the northern cropping areas, grain sorghum will produce about 1.5 times the biomass of wheat and twice the biomass of dryland cotton and chickpea. Growing high-yielding crops of sorghum will build SOM, while dryland cotton after a long fallow, combined with pupae busting is likely to deplete it.

2. ELIMINATE TILLAGE

One cultivation a year is likely to result in a continuing decline in SOM. Zero-tillage is the most important practice to build SOM. In conjunction with controlled traffic, zero-tillage will minimse compaction. This can enhance moisture intake and reduce surface ponding (from a plough pan) which is conducive to loss of N as N_2O.

3. MAINTAIN SOIL FERTILITY

A decline in fertility will reduce crop biomass and carbon input. Less ground cover produced by nutrient-limited crops may result in less moisture stored and also lower yields. One of the problems of soils with low organic matter is that there is not enough N reserve to mineralise extra N for big yields in years with good rainfall.

4. FEEDLOT, PIG AND POULTRY MANURE

Animal manures can not only add nutrients more cheaply than mineral fertilisers, they also add useful amounts of organic matter.

About 500,000t of manure are produced in southern Queensland each year. With 5kg of P/t of feedlot manure, this is enough to replace P fertilisers (applied at 8kgP/ha) on 300,000ha of farmland.

Manure is valuable where K is needed as well as N and P. K is more frequently deficient as cultivation gets older. If 200t of grain are harvested over 60 years of cultivation, about 600 to 800kg of K have been removed without replacement.

5. PASTURE LEYS WILL BUILD SOM

A grass–legume pasture can build soil carbon levels by more than 1t/ha/year, which could lift organic carbon (OC) by 0.05 per cent a year.

Perennial grasses grow a big root system, which contributes to below-ground SOM return as well as surface litter. Excessive tillage should be avoided if possible at the end of pasture phase, or much of the added SOM will be rapidly depleted.

6. MAXIMISE CROP FREQUENCY

Opportunity cropping with more than one crop per year is likely to add more biomass and build carbon much better than cropping systems that have long fallows.

Planting wheat as a double-crop after dryland cotton and using feedlot manure can offset some of the potential depletion of SOM where dryland cotton is grown after a long fallow.

4.10 Labour and machinery management

Two serious issues for farmers are rising machinery costs and the recruitment and retention of labour. There is an impact on farm profits and the farm lifestyle. One of the answers is to use more contractors – mechanics, sprayers, harvesters and so on. It is generally cheaper and provides labour at busy times as well.

Competition for labour has escalated with unemployment rates falling and the mining and energy sectors, in particular, competing for labour trained on farms. The question becomes 'How can we attract and keep farm labour at lower rates of pay than other industries?' The main solution is to value employees, to involve them in the business and to let them know they are appreciated.

Move from the common situation:

- Work is drudgery that I put up with for pay
- I don't need to think, I just wait for orders
- There is no reward for extra effort
- The house and garden is pretty crummy
- Perhaps if I change jobs the next one will be better – more interesting

To a better environment for workers:

- Work is interesting. I feel part of a team
- The boss values my ideas and contributions
- We set goalposts for the week and go on with it
- The house is better with air conditioning
- Three nights at Sea World was a good surprise for extra work last harvest

- **Recruiting good labour is now difficult.**

- **Employers need to change their thinking and ask 'Why would people want to come and work for us?'**

Times have changed. Young people want more than a pay cheque: they are mobile and recognise that their skills can be used in other jobs. They do not see themselves staying in one place for ever.

Staff are more likely to leave because they are not being involved or treated with respect, rather than because of low pay. However, hours of work are becoming more important as young people seek more than a 'daylight-to-dark' working life.

Modern labour management

A package to find and keep good staff should include:

- Careful recruitment and selection – find the right person who wants to work on your place
- A formal job description – helps choose the right person and indicates where training is needed
- A contract of employment – sets out benefits and conditions, time off and working hours
- Induction training and a manual – how things are done, especially regarding safety
- Performance reviews – at least every six months, involving two-way feedback – how am I going as a boss?
- Ongoing training and bonuses – surprise bonuses can be small, but should be connected to effort
- Participation of labour in decision making – a feeling of belonging to a team

There is a lot of satisfaction in growing and harvesting good crops or livestock. If employees can share in some of this glow they will be more inclined to stay in agriculture and give the mining industry a miss.

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5. TRENDS AND OPPORTUNITIES

1. A change to an 'energy'-driven and more energy-efficient agriculture
2. Minimal exports of grain on the east coast of Australia, requiring storage of grain in good years for the not so good years
3. An increase in large-scale horticulture with higher returns per megalitre of scarce irrigation water
4. Continued expansion of farm size, but
5. Less labour and better use of capital by using contractors, sharing equipment and diversified summer/winter cropping
6. Better people management – encouraging staff to be more reliant and productive, and being competitive with other employers
7. Farming carbon – halting the decline in organic matter and improving soil health and sustainability
8. Managing climate change requires more heat-tolerant varieties of wheat and sorghum, planting earlier and improving the efficiency of moisture use
9. Increased competition for land and water by urban and peri-urban communities
10. New opportunities exist, such as large-scale development of irrigated agriculture in northern Australia

Copies of this report can be downloaded from www.grdc.com.au

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