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PRODUCTION ECONOMICS FACT SHEET

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ARE YOU MAXIMISING YOUR PROFITS?

Getting the most profitable results from your farm business requires a careful balance of input costs to produce the optimum yield.

KEY POINTS

- Every business has limited productive resources, including land, labour, management and capital.
- Production economics provides a framework for decision making about how best to use these limited resources to maximise profit.
- Maximising yield is not the most useful basis on which to make decisions about production.
- Understanding 'marginal cost' and 'marginal return' is very important when making production decisions.
- It is critical to know the impact of increasing inputs on working capital – does it limit your ability to do other things?

Scarcity and Opportunity Cost

Every business has to confront ***scarcity*** (i.e. limited resources). We each have a limited capacity to fulfil a potentially unlimited list of wants and needs. From a consumer perspective, fulfilling our needs and wants provides a level of ***utility*** (satisfaction) to the consumer. For most people, income limits our capacity to fulfil our needs and wants, and we have to make choices about how we spend our (relatively scarce) income to maximise the satisfaction we gain from it.

For example, a decision to do one thing, such as purchasing the latest header, may limit the capacity to do another thing, such as purchasing additional land. This decision therefore has an ***opportunity cost*** - i.e. something else is given up in order to make this choice possible, which in this instance is purchasing more land.

Production economics is about the decisions farmers face while aiming to maximise profit from limited available resources.

The Production Function

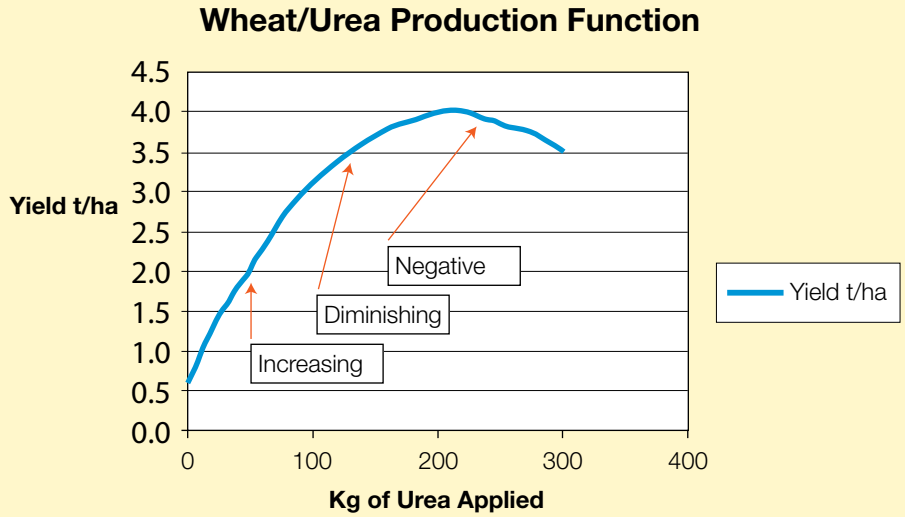
A ***production function*** is the relationship between resources used (land, labour, capital, water) and the resulting output. Generally speaking, if we have a fixed amount of one resource, such as land, more output can only be generated by adding additional resources to it, such as fertiliser, labour, irrigation and so on. Unfortunately in agriculture, this function is not necessarily a linear relationship. For example, a predetermined amount of fertiliser will not always grow a known amount of grain; nor will doubling or tripling the amount of fertiliser necessarily double or triple the yield, even if all other conditions are identical. If no fertiliser were applied at all, there is usually sufficient residual soil nutrition to generate some level of yield as long as reasonable rainfall occurs during the growing season.

Knowing the production function of your crops will help you to identify the input levels required to give you the best profits.

The Law of Diminishing Returns

The ***Law of Diminishing Returns*** describes the relationship between varying levels of an input (eg. fertiliser) and the resulting output (eg. grain yield). As outlined above, output from a certain input is not linear. Typically, beyond a certain point, further units of input can actually decrease output. Figure 1 illustrates this

Figure 1 Yield response to fertiliser input



Source: Tony Hudson, Hudson Facilitation

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effect when increased levels of nitrogen are applied to wheat: the first 125kg/ha of fertiliser gives a clear and strongly positive increase in yield, from about 0.5t/ha to around 3.5t/ha **(i.e. increasing returns**). However, as more units of nitrogen are added, the additional grain produced from each additional unit of nitrogen applied becomes less (**i.e. diminishing returns**). Eventually, a point is reached where additional fertiliser input has a toxic effect and leads to a decrease in yield (**i.e. negative returns**).

What are the **financial implications** of this yield response? If a farmer's aim was purely to maximise yield, then in the example above, the farmer would apply 200kg of fertiliser to his wheat crop. However, most profit-driven farmers would advise against this level of input: not only does it increase the risk of a negative gross margin if maximum yield is not achieved, it also ties up significant additional working capital in the wheat crop. Most fertiliser recommendations are based on 90% **maximum economic yield (MEY)**, so check with your adviser if this is the standard they provide.

How then, do you decide on the appropriate level of inputs?

Marginal Cost and Marginal Return

The ***marginal cost*** is the additional cost of applying one additional unit of input. To use the previous example, if the fertiliser in question was urea priced at $600/t, and one 'unit' was 25kg/ha, the cost per unit of urea is $15.00/ha. So the marginal cost of an additional 25kg 'unit' of urea is $15.00.

Similarly, the ***marginal return*** is the additional income generated as a result of the addition of that last unit of input. So if we are paid a farm gate price of $200/t for wheat, each additional kg of grain earns us an extra 20 cents.

Table 1 illustrates this relationship. Each 25kg 'unit' of urea costs $15.00 and the first 'unit' of urea results in an additional yield of 0.7t of wheat. At $200/t, this produces a marginal return of $140. Clearly the first unit of urea is highly profitable - you will earn $140 in gross income at an added cost of only $15!

This information becomes more useful in decision making when we consider that **maximum yield** does not necessarily result in **maximum profit**, and reflect on risk. In the above example, the maximum yield of 3.7t/ha of wheat is achieved by applying 200kg/ha of urea. However, the maximum profit of $535/ha is achieved by applying only 150kg/ha of urea to produce a yield of 3.6t/ha of wheat.

The application of 125kg/ha of urea produces 3.5t/ha of wheat. The additional 25kg/ha of urea to reach maximum achievable profit at 150kg/ha costs an extra $15/ha. Considering that this produces only a further $20/ha in revenue, it may not be worth the added risk to achieve the resulting $5/ha in additional profit.

In production economic theory, maximum profit is achieved at the point where:

Marginal cost = Marginal return

In Figure 1 (see page 1), this occurs at a urea application rate of somewhere between 150-175kg/ha. Beyond this point, the cost of the additional unit of urea is greater than the resulting income it generates. In theory, this is the level at which urea should be applied in the above scenario. The reality however, of applying an additional $15 of urea to gain an additional $20 of wheat, is for most farmers too risky to consider.

Obviously, there is uncertainty in agriculture surrounding climate, yield, disease and prices of both inputs and outputs. However, with effective marketing strategies, many farmers can know with some certainty the price they are likely to receive at harvest for some or all of their produce. Similarly, the costs of inputs such as urea will be known precisely when such application is being considered, as will stored soil moisture and medium range weather forecasts. So with a degree of variation, the theory holds true.

Take home message: *Next time someone recommends you add an additional input, don't just think about the possible yield benefit - check the marginal cost and marginal return and you may reconsider!*

PHOTO: P2PAgri.

Adding more inputs to increase yields may not maximise profits.

Table 1 Example of Marginal Cost and Marginal Return

Urea (kg/ha)	Marginal Cost $/ha	Yield t/ha	Additional Yield t/unit	Marginal Return $/unit	Marginal Profit $/unit	Profit $/ha
0	0	1.00	0.60	120.00	105.00	105.00
25	15	1.70	0.70	140.00	125.00	230.00
50	15	2.30	0.60	120.00	105.00	335.00
75	15	2.80	0.50	100.00	85.00	420.00
100	15	3.20	0.40	80.00	65.00	485.00
125	15	3.50	0.30	60.00	45.00	530.00
150	15	3.60	0.10	20.00	5.00	535.00
175	15	3.65	0.05	10.00	-5.00	530.00
200	15	3.70	0.05	10.00	-5.00	525.00
225	15	3.65	-0.05	-10.00	-25.00	500.00
250	15	3.60	-0.05	-10.00	-25.00	475.00
275	15	3.40	-0.20	-40.00	-55.00	420.00
300	15	3.10	-0.30	-60.00	-75.00	345.00

Source: Tony Hudson, Hudson Facilitation

Equi-Marginal Returns

So far we have only provided the simple application of nitrogen on wheat example to illustrate the theory of marginal cost and marginal return. Farming is more complicated than this and on most farms there is a range of potential crops which would benefit from the addition of extra nitrogen. How do we decide where and when to apply it? Remember, we are aiming to maximise profit, not yield.

A production function such as that presented in Figure 1 exists for every crop which may be grown, not just wheat. In an environment of scarcity, it is useful to estimate the production function of each enterprise which may benefit from additional units of nitrogen. Estimating the marginal cost and returns borne from each enterprise's production function will assist with decisions around whether we should apply the next unit of input, such as nitrogen to wheat, canola or peas.

Once the marginal return per input of nitrogen to each crop is established, the next unit of nitrogen should then be applied to the crop which will achieve the highest marginal return for that additional input. While this looks obvious, have you ever calculated the numbers yourself? Many farmers continue to make these types of decisions based on instinct or past practices, but it might be time to be a little more scientific in your approach!

Budgeting is critical

Having an appreciation of production functions and returns supports decision making but, as with any partial analysis, it fails to consider all issues. A decision to increase production from what may historically have been a 'normal' level of inputs to one which is higher in an attempt to increase profit, should create additional harvest income. However, it will also require significant additional working capital to implement. If you were to crop 1,000 ha of wheat and apply an extra 3 units of nitrogen (as per the example used above), you would require an additional $45,000 in working capital throughout the year. Do you have access to this much extra cash? Could it limit your ability to do other things? Could it place pressure on marketing strategy?

All farm management decisions should be supported by thorough budgeting, to ascertain full working capital requirements and the likely profits from a range of outcomes, such as good and poor seasons. If it still stacks up as being OK, then go for it!

PHOTO: P2PAgri.

They all both great … but which is the best profit? Know your balance of costs against income.

FAQs

How do I calculate a production function for my crops?

Speak to your agronomist – there are established rules for the yield potential for most crops, given a variety of climatic conditions and soil moisture levels.

How do I decide where to stop spending on inputs as diminishing returns start to occur?

The answer varies with the individual. Aiming for maximum profit carries associated risk. Consider the likelihood that you will achieve the projected additional return and how much downside you are comfortable with if you don't quite get there.

How difficult is it to match input on the farm given the variation of seasonal results?

It is often difficult to know what type of season you are experiencing until harvest is finished. For example, there are seasons when the crop has grown well, only to experience a frost at grain filling stage which then results in significant yield loss. This can be financially devastating, especially if a high input cost strategy had been adopted. So in effect, the optimum decision can only be made in hindsight!

Advisers are often asked which management strategy is best: to be optimistic and plan for a Decile 7 season (good season) so that the opportunity can be maximised; or be conservative and manage for a Decile 3 season (poor season) and minimise the losses. Both of these strategies can be equally successful depending on the sequence of seasons experienced, which are not known in advance.

A farm management game called 'Future Farming Business', developed by the Future Farm Industries CRC (see Useful Resources), provides some insight into this complex question. This simulation game has been modelled on the farming conditions and expectations for the Merredin area in WA, a relatively low growing season rainfall cropping region.

This game is played over a number of seasons. Each player starts with the same farm and resources, and makes annual planning decisions with uncertainty, not unlike real farming. Decisions of enterprise mix, grain marketing and input levels are taken before the full understanding of the season is known.

The winners of the game are those that generate the highest net worth, which means the best sustained profits over the seasons played. The most common strategies used by the winners are to adopt a conservative management style, which would imply minimising losses was a better strategy that maximizing gains. It could be argued that this is probably a good strategy for a low rainfall cropping area.

In reality, it is probably best to plan for a Decile 5 (average) season and then be responsive to the season as it develops. If the season shows good signs of being above average, then consider increasing the inputs and vice versa. The challenge to management is not to be too influenced by the previous season.

Recent research shows that farmers are greatly influenced in their decision making by the previous season: if it was good, they feel more confident and think that the next season will also be good. Likewise after a drought, farmers' management for the following season is often based on the assumption that it also will be poor.

While some seasonal patterns can occur, there is little statistical evidence that one seasonal outcome is related to the next. This is where it is good to have an excellent set of management data (physical and financial) and be guided by average results when planning for each season.

USEFUL RESOURCES

Related GRDC Fact Sheets
Other fact sheets in this Farm Business Management series provide further detail on farm financial tools: Farm Business Overview (Order Code: GRDC909), Cash Flow Budget (Order Code: GRDC913), Profit and Loss Budget (Order Code: GRDC916), Balance Sheet (Order Code: GRDC917), Crop Gross Margin Budget (Order Code:914), Livestock Gross Margin Budget (Order Code: GRDC915) and Farm Business Costs (Order Code: 935).

Copies of all the above fact sheets are FREE plus P&H and available from:

Ground Cover Direct Freephone: 1800 11 00 44 or email: ground-cover-direct@canprint.com.au

These can also be downloaded from www.grdc.com.au/fbm

Plan to Profit (P2P), a whole-farm financial management program that can help calculate a farm's financial budgets: www.2PAgri.com.au

'Future Farming Business', a farm business simulation training program: Dr Amir Abadi

http://www.futurefarmonline.com.au/about/future-farm-business.htm

MORE INFORMATION

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