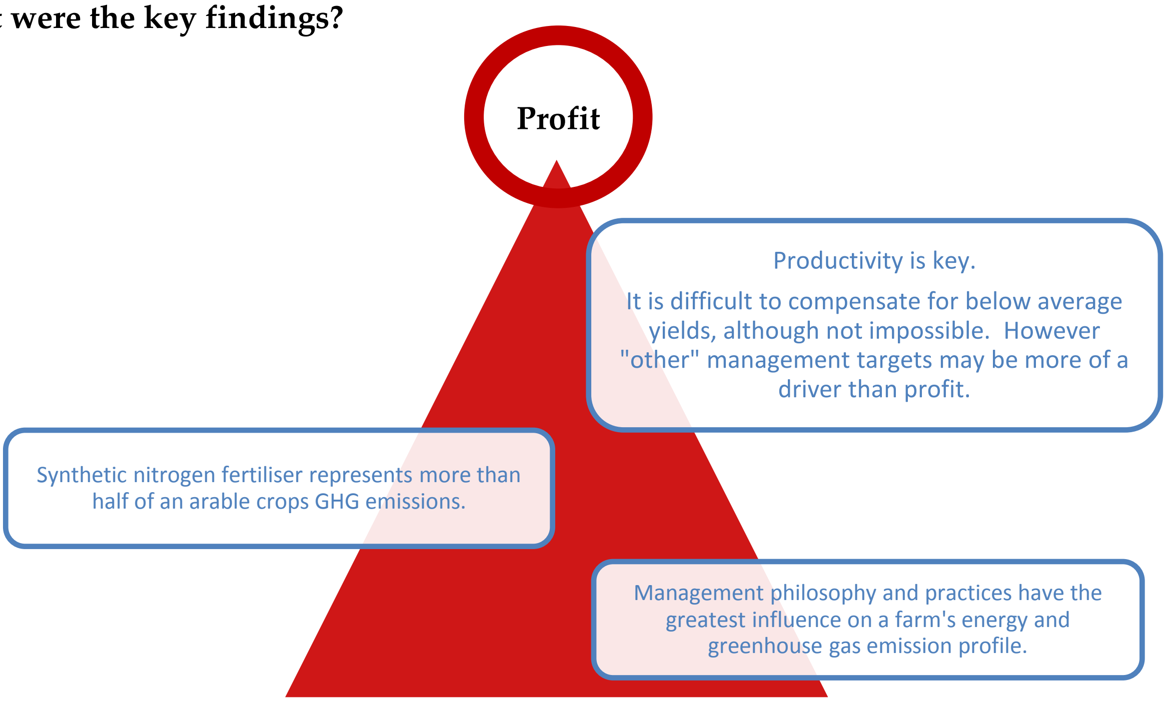
Resource Use Efficiency – Wheat & Ryegrass
Arable Carbon Footprint Project 2011

Smart farming is about using available resources efficiently, farming for profit and productivity and future-proofing your business. That means knowing what drives your business and how to manage the factors you can influence.

The Arable Carbon Footprint Project is a snapshot of one year's cropping data from 10 farms growing a mix of wheat, ryegrass seed, maize grain and maize silage crops. The project has established a resource use inventory for each crop and from these drops out the carbon footprint result. The potential of this project however is so much more than simply being able to point to a crops carbon footprint. The project has established a framework and set of first benchmarks[1] for monitoring resource use efficiency. Ultimately if the crops financial performance can be overlaid on the resource use inventory then individual growers and the industry has a very powerful tool for steering towards the goal of greater long term sustainability, both environmentally and financially.

The study identifies the resource use and carbon hotspots and with these potential areas for further efficiency and guidance for future investigation.

What were the key findings?



Carbon footprinting takes a holistic life cycle thinking approach. Reduction solutions come in many forms, but need to fit the farmers' philosophy.

[1]The small sample size of 10 and short monitoring period (1 year) means that the results offer only a preliminary glimpse into the resource inputs and carbon emissions of each crop.

Generally the highest producing farms had the lowest carbon footprint. However some low input systems, in the form of minimum tillage, nitrogen use, or dryland farms, were able to overcome lower yields to perform better per tonne than the survey average.

For arable production, fuel and electricity use ranges between 33 – 50% of total energy use. Consequently it is an area worthy of further investigation. Within the current system there are often opportunities for lowering fuel use through tractor and implement setup, but generally the biggest gains are achieved by reducing the number and type of cultivation passes. Along the continuum from full cultivation to no-tillage there is a considerable amount of learning, experimentation, and time required. What is needed to drive this is a management philosophy and set of goals.

Implementing reduced tillage requires a major shift in practices, and often involves many years of thinking and doing by trial and error.

A change in one aspect of the operation has flow on effects throughout the business. Implementing reduced tillage while having a direct effect on lowering fuel use, will also affect the soil structure, consequently the soil water holding capacity, consequently possibly irrigation and electricity or diesel use, nutrient availability, fertiliser use, agrichemical use, and ultimately production.

The lowest GHG emitting wheat farm had low nitrogen and lime use. When combined with their above average yields they also had the lowest GHG emitting wheat crop.

Nitrogen is an energy and carbon intensive input. By virtue of the fact that nitrogen accounts for around 45% of resource inputs and 60% of GHG emissions it continually shone through as an opportunity for further investigation. The lowest resource use and GHG emitting wheat crop per tonne was mainly attributed to their low nitrogen use at 10.0 kgN/t (100 kgN/ha) compared to the average of 23.4 kgN/t. Some of this was achieved due to soil type and previously building soil fertility. The fertiliser management was based around years of experience, backed up by soil testing and fertiliser advice.

It is realised that not all farms can achieve lower input levels, even with the best management possible, due to inherent climatic and soil condition constraints. Even so, monitoring inputs provides an opportunity to consider and track changes. Armed with the resource use inventory and some preliminary benchmarks it is hoped that this resource will aid decision making by providing another tool to answer "what is the next step in driving this farm forward?" or determining what this farms next most limiting crop production factor is.

Dryland and Irrigated Wheat Production

Amongst the six wheat growers surveyed four irrigated their crops. We can compare yield and nitrogen usage between the irrigated and dryland groups as shown in the following table.

Table 1 Impact of irrigation and nitrogen use on wheat crop yields

	Yield(t/ha)	**N use (kg/ha)**	**N use (kgN/t grain)**
Dryland	Average = 8.1	Average = 187	Average = 24.0
	Range = 6.5 – 9.7	Range = 184 - 190	Range = 19.6 – 28.3
Irrigated	Average = 9.0	Average = 193	Average = 23.2
	Range = 5.4 – 10.5	Range = 100 - 240	Range = 10.0 – 43.3

There is wide variability in these numbers due to management decisions. There are many factors influencing yield; identifying the limiting factor or factors will provide the opportunity to explore ways to overcome the limitation and improve yields. As can happen some of the low yields in the irrigated crops were below the dryland group due to adverse spring weather conditions causing crop failure in parts dropping the overall yield. Irrigation assists a grower to manage weather induced soil drying limiting crop growth, however it means increased capital expenditure, increased labour inputs to manage it and often increased inputs to maximise the new yield goal. In the table above, we see the average nitrogen use is higher amongst irrigated crops than dryland crops in terms of kgN/ha, but is lower per tonne of grain produced suggesting that the extra nitrogen has resulted in higher production. The range of nitrogen usage amongst the irrigated crops is much wider suggesting that possibly there are irrigated crops that have not utilised all the nitrogen applied and there is some available for the next crop, or it has been lost from the system. We have not distinguished between milling and feed wheat and this will be clouding the nitrogen and yield story; this needs to be explored in future studies. There are possibly also opportunities to investigate nitrogen use and irrigation correlations to optimise yield in a given environment.

Other factors influence these results:

- crop rotations such as wheat following a legume, does not require as high nitrogen inputs
- soil type - a sandy soil is likely to need regular irrigation applications whereas a loam soil may have sufficient water holding capacity and regular rainfall for irrigation to not be cost effective to install
- Previous history – building soil fertility and organic matter levels improves water holding capacity and may allow reduced fertiliser inputs
- Reduced tillage measures can improve the water holding capacity of soil

Further investigation over a number of years (to remove seasonal impacts), with a larger group of farmers is required to fully understand all the interactions and drivers influencing yield and inputs.

Ryegrass Seed Production

Determining ryegrass seed production inputs and resultant GHG emissions proved to be challenging as many of the inputs carried over into grass production for livestock grazing. The allocation principle was used to account for this, but does require further work to have clear rules for allocation of inputs and also having sufficiently detailed input records to make the appropriate allocation. As a first investigation the analysis revealed similarities to the wheat results.

The lowest input ryegrass crop, both in terms of inputs per hectare and per tonne of grass seed, was a dryland farm producing an above average seed yield[2]. Their low GHG emissions were driven by very low electricity and nitrogen inputs and slightly above average diesel usage. By comparison, the highest GHG emissions per hectare were due to high water use so consequently high electricity along with high nitrogen inputs (>50% above average). Due to this crop producing the equal highest yield (along with two other growers) GHG emissions per tonne were the second highest recorded, slightly bettering a farm that had the lowest yields that year.

Generally the irrigated ryegrass seed crops had more resources put into them, which were reflected in above average seed yields. By comparison, the dryland crops had lower inputs (fuel and nitrogen) per hectare, but yields were variable. Certainly differences in climate and soil types between regions; and previous cropping practices have played a significant role in these decisions.

What is the most sustainable and profitable wheat or ryegrass seed crop and what are the limiting factors?

Until financial data can be overlaid on the resource inputs, and several years production studied, we cannot determine actual profitability; however this question is food for thought.

Growers participating in this project realised the value of accurate data. It is very easy to under or over estimate resource usage when you have general rather than crop specific records. For instance, tracking fuel use by crop grown, allows you to monitor this input with accuracy and benchmark usage. The detailed survey questionnaire prompted growers to think about all business inputs and ask “are we using them efficiently? How can we track them to ensure we are using them efficiently?”

The first step is to develop a resource use inventory, which can be used to benchmark and track progress. Overlaying a crops financial performance on top of the resource use inventory would then super charge this powerful tool.

[2] Allocation of inputs between livestock and ryegrass seed production may be clouded by allocation rules and data limitations.