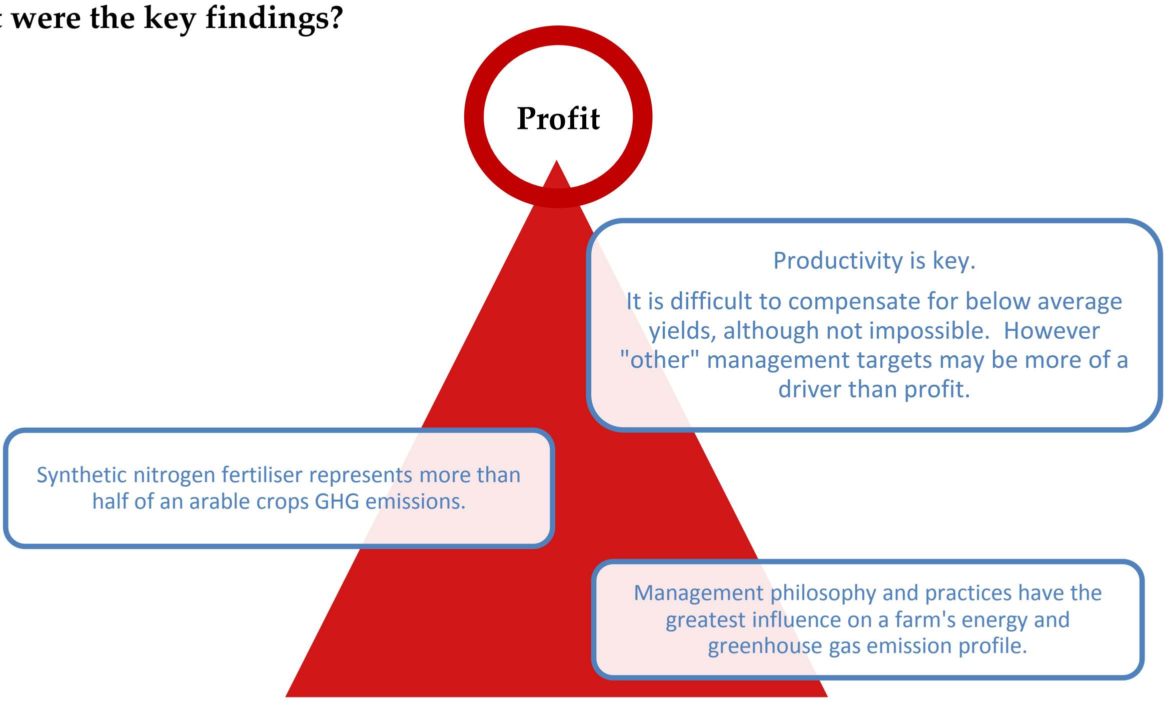
Resource Use Efficiency - Maize
Arable Carbon Footprint Project 2011

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 (14 – 20% of GHG emissions). 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. For the lowest input (per ha) maize silage crop the farm had a focus on minimum tillage. Consequently their fuel use was 25% less than the survey average. Even with a lower yield, energy use per tonne was still 10% less than the average maize silage crop. Implementing reduced tillage requires a major shift in practices, and in this case has involved 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.

Nitrogen is an energy and carbon intensive input. By virtue of the fact that nitrogen accounts for 35 - 45% of resource inputs and between 50 – 60% of GHG emissions it continually shone through as an opportunity for further investigation. The lowest resource use and GHG emitting maize silage crop per hectare was mainly attributed to their low fuel and nitrogen use at 90 kgN/ha compared to the average of 150 kgN/ha. The fertiliser management was based around years of experience, backed up by AmaizeN and fertiliser advice. While yields were below the surveyed average, GHG emissions were still 12% below the average per tonne of maize silage. The lowest GHG emitting maize silage and maize grains crops per tonne were mainly attributed to their higher than average yields, being 21.0 and 13.6 t/ha respectively.

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 Maize Silage Production

Amongst the six maize silage growers surveyed half 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 maize silage crop yields

	Yield(t/ha)	**N use (kg/ha)**	**N use (kgN/t silage)**
Dryland	Average = 19	Average = 130	Average = 6.8
	Range = 15 – 22	Range = 90 - 155	Range = 6.3 – 7.1
Irrigated	Average = 17	Average = 170	Average = 10.8
	Range = 13 - 21	Range = 105 - 240	Range = 5.0 – 15.0

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. Surprisingly, average yields are higher in the dryland production group than in the irrigated group. Irrigation assists a grower manage through periods of low rainfall, however it means increased capital expenditure, increased labour inputs to manage it and often increased inputs to maximise the higher yield goal. In the table above, we see the average nitrogen use is higher amongst irrigated crops than dryland crops, both in terms of kgN/ha and kgN/t silage. This would suggest that possibly the irrigated crop has not utilised all the nitrogen applied to the silage and there is some available for the next crop, or it is leached out of the system. There are opportunities to investigate nitrogen use and irrigation correlations to optimise yield in a given environment.

Other factors influence these results:

- crop rotations such as maize silage following pasture, does not require as high nitrogen inputs
- soil type - a sandy soil is likely to need regular irrigation applications whereas a loam soil type 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 irrigation and fertiliser inputs
- Reduced tillage can improve a soil's water holding capacity

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, inputs and profit.

Maize Grain

The survey group was very small; however it did show a range of management philosophies. The irrigated maize grain crops had more resources put into them, which were reflected in above average grain yields. By comparison, the dryland crop had lower inputs (fuel and nitrogen) and had lower yields. Certainly differences in climate and soil types between regions and previous cropping practices have played a significant role in these decisions.

However, this still raises the question - What is the most sustainable and profitable 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 it 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.