THE IMPACT OF AN AUSTRALIAN EMISSION TRADING SCHEME AND THE USE OF AGRICHAR ON THE SUGARCANE INDUSTRY

Cameron Thomas

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Abstract

The Australian government's proposed Carbon Pollution Reduction Scheme (CPRS) is likely to have a significant impact on the price of farm inputs (diesel, fertiliser, water and electricity). Furthermore, offsets (reduction or removal of greenhouse gas emissions that counterbalances emissions elsewhere in the economy) are a potential area of expansion under the scheme with particular interest in the agricultural sector.

Agrichar is one of the new technologies and farming practices being investigated to counteract CPRS-imposed costs. Its two claimed benefits which relate both to the profitability of cane growers as well as to climate change are: the reduction in fertiliser application; and the carbon which agrichar can store in the soil for hundreds to thousands of years.

This study drew on the Farm Economics Analysis Tool (FEAT) developed by the Queensland Department of Primary Industries and Fisheries specifically for the sugarcane industry. An analysis was conducted for a typical sugarcane farming enterprise in the Herbert Region of North Queensland. The scenarios included in the analysis recognised the change in input prices due to an emissions trading scheme, the change in farm practices when agrichar is included in operations and the potential to trade in offsets from that additional carbon stored by the use of agrichar.

The sugarcane grower was found to benefit from the inclusion of agrichar into the operations. Agrichar is seen as a potential and viable option for sugarcane growers and should be considered as an alternative under the emissions trading scheme to minimise the impact of the rise in input costs. Further scientific and policy development could see the possibility for stored carbon to be traded in the offsets market, providing additional, although minor, cash flow to the grower.

Key words: CPRS, sugarcane profitability, carbon offsets, agricultural adaptation

Disclaimer

The authors are responsible for any errors. Opinions expressed are theirs alone and do not necessarily represent the policy of the Queensland Department of Primary Industries and Fisheries

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Introduction

An emission trading scheme is seen as the most efficient way, under the Kyoto Protocol and also recognised by the Australian Government, to reduce greenhouse gas emissions, being based on a cap and trade system. The Garnaut Climate Change Review examines "the impacts, challenges and opportunities of climate change for Australia" (Garnaut, 2008). The latest report released by the Government at the time of the study was the Green Paper (July, 2008) which outlines the possible Carbon Pollution Reduction Scheme (CPRS) which will commence in 2010. The White Paper has recently been released with minor changes from the Green Paper. Agriculture has been excluded, with this to be reviewed in 2015. As indicated in the White Paper, the Government commits to a medium-term national target to reduce Australia's greenhouse gas emissions by between 5% and 15% below 2000 levels by end 2020.

Under an emission trading scheme, offsets can be used to reach the target levels of emissions. Offset credits can be purchased from a carbon sequestration programme when a firms pollution is above their designated cap at the end of the period. These credits can be purchased to offset emissions. There are strict regulations related to offsets and currently only forests which comply with the Kyoto Protocol can be included in the offset market.

This report examines the impact of an emission trading scheme on the Australian sugarcane industry. The sugarcane industry is one of Australia's largest and most important rural industries (Canegrowers, 2008). The industry has the capacity to produce more than 4.75 million tonnes of sugar annually. Depending on prices, the industry generates direct revenue of around $1.5 billion to $2 billion. Under a carbon reduction scheme, sugar growers' costs will increase, due to an increase in the price of inputs.

However, a new product which is used instead of fertiliser and has long term benefits may possibly be available on the commercial market. This is known as 'biochar' or 'agrichar'.

The objectives of this study are:

1. to overview the emission trading scheme and its potential impacts and especially the potential impacts on the sugar industry
2. to outline the agrichar technology and investigate its impacts on input use as well as the possibility of using it in the trading of offsets
3. to examine the profitability of agrichar in sugarcane farming

The above objectives were examined through developing four scenarios which were then used to conduct an economic analysis.

The full costs and benefits of the inclusion of agrichar in farming practices are in experimental stages. The advice in this study is based on the current state of knowledge, however the approach used will enable this study to be updated once more technical and policy information becomes available. The assumption is made that agrichar will be recognised under the CPRS to trade in the domestic offset market. The impacts of emissions trading scheme on the cost of inputs are only estimates of what may happen.

Background

An emission trading scheme means it is no longer free to pollute. Firms will need to purchase permits to emit greenhouse gases, increasing their costs. Particular attention is focussed on the impact on farmers and on the change in input prices.

As stated in the CPRS Green Paper (Department of Climate Change, 2008), the CPRS will cover energy intensive industries. This is classified as industries that emit 25,000 tonnes of carbon dioxide equivalents each year. The CPRS Green Paper, outlines in Box 1.8 (Department of Climate Change 2008, p77) how an emissions trading scheme will change relative prices. The scheme will increase the cost of activities that cause greenhouse gas emissions.

The implementation of an emissions trading scheme will result in a rise in fuel prices. Emission abatement costs, reflected in increased prices of fuel, electricity and energy dependent farm inputs (e.g. fertiliser, electricity, fuel), will reduce farm competitiveness, lowering the value of export sales and increasing import pressure in domestic markets. This will particularly be the case in those sectors – grains, horticulture, beef, sugar and cotton – that are facing increasing competition from Eastern Europe, Asia and South America (Keogh, 2008).

Four agricultural inputs have been identified as changing in price under the emissions trading scheme. These are diesel, water, electricity and fertiliser. Queensland Farmers Federation provided estimated increases which are outlined in the table below and used in Scenarios 2, 3 and 4 of the economic analysis (see Table 1).

Table 1. QFF estimates carbon price impact on farm inputs

Input	At $20/tonne	At $40/tonne	At $60/tonne
Electricity ($ per MW/hr)	$20	$40	$60
Fuel Diesel (cents/litre)	6 cents	12 cents	18 cents
Fertiliser (urea) ($ per tonne)	$52.60	$105.20	$157.80
Water ($ per ML)	$2.90	$5.80	$8.70

(Source: Perry, 2008)

The sugarcane industry is important to Australia's economy, with the majority of production occurring in Queensland. Over the years, the industry has been actively pursuing changes in farming systems, the key change being from burning to a process of GCTB. The industry is subject to many environmental constraints, mainly in respect to the degradation of the Great Barrier Reef, due to its proximity to the reef and land use conflicts. Growers are constantly in the spotlight for excessive use of nitrogen fertilisers which enter the surrounding water systems, flowing into the Great Barrier Reef, harming the ecosystem. Recently a new farming input, agrichar, has been developed, offering another way towards sustainable operations with a reduced impact on the environment. With growers adopting new types farm management, their image could be improved in the sense that they are 'doing their bit' for the environment.

Agrichar (Figure 1) is produced by a process called pyrolysis (the chemical decomposition of organic material by burning in the absence of oxygen). "Instead of 'slash and burn' farming techniques that release carbon dioxide into the atmosphere, 'slash and char' would put carbon dioxide back into the ground" (Dover, 2007). Agrichar contains a stabilised form of carbon that has the potential to generate a sustainable increase in soil carbon. Agrichar captures atmospheric carbon and stores it safely in the soil, providing additional greenhouse gas mitigation along the way.

Figure 1. Sample of Agrichar

(Source: www.m-easy.co.jp/03/biochar.html, 2008)

In Figure 2 it can be seen that when char is added to yellow clay soil of limited biological activity, it is transformed to some of the richest soils.

Figure 2. Change in soil characteristics from agrichar

(Source: Lehmann, 2007)

Benefits of agrichar include:

- Agrichar can play a vital role in climate stabilisation through sequestering carbon and reducing greenhouse gas emissions from agricultural soils.
- Downie (2007) statement, “agrichar provides further mitigation of greenhouse gas emissions through the reduction in nitrous oxide emissions from the soil”.
- According to Best Energies, agrichar improves soil capacity for: nutrient retention (reducing ongoing fertiliser inputs), moisture retention, increasing and holding carbon levels (sequestered from the atmosphere), active earthworms and useful microbes and balancing pH in some soils.
- Experiments have demonstrated that agrichar improves soil health, increases crop yields, decreases fertiliser requirements and therefore enhances agricultural sustainability.

Downie and Van Zwieten outlined the use of agrichar in Benjamin, 2008.

- Agrichar is believed to remain in the soil for hundreds and even thousands of years.
- Application of 20 tonnes per hectare will raise organic carbon level of the soil by 0.7% to 1%.
- Generally farmers would use one application of 10 to 20 tonnes per hectare of agrichar and this one application would have a long term benefit in the soils.
- Nitrogen fertiliser reduction can be 100% if using manure based biochars and possibly 50% if using wood based biochars (Lukas Van Zwieten, pers. comm.).

Agrichar in the context of trading carbon sequestration offsets

An added challenge for the design of an emission trading scheme will be finding ways to recognise the sequestration of carbon in soils and vegetation, or the incorporation of carbon into the soil through processes such as agrichar (Keogh, 2008). This process provides real opportunities for both lower emission reduction costs and increased farm productivity, but will require careful development of the emission trading scheme rules to ensure that appropriate incentives are created.

The Kyoto permanence principle is a key element in the international carbon market model. It requires that credits created through avoided emissions and sequestration credits used to offset emissions are permanent (Article 3 of Kyoto Protocol). Permanence is defined as greater than 100 years. “There is opportunity for agricultural soils to sequester huge amounts of carbon as biochar, which is a permanent, low risk sink” (Best Energies, 2008). Agrichar would be considered a long term sink for the purpose of reduction in emissions. Once agrichar is incorporated into the soil, it is difficult to imagine any incident or change in practice that would cause a sudden loss of stored carbon. This addresses the issue of permanence under the Kyoto Protocol. Gus Sharpe (Carbon Innovation Pty Ltd) believes agrichar lasts for thousands of years, increasing the possibility for including soil carbon in the forthcoming emissions trading scheme scheduled for 2010.

Accountability of agrichar is more straightforward than with other soil sequestration methods. Tracing the source of carbon in soil back to a change in agricultural practice is difficult and therefore not accepted under the Kyoto Protocol. These do not exist for agrichar sequestration, there is no reason why the associated emission reductions should not be allowed into trading markets under current agreements (Lehmann, 2007). The nature of slow pyrolysis technology ensures that its benefits are measured and easily auditable for the calculation of carbon off-sets (Vyse, 2008).

Agrichar will comply with the additionality criteria as it is a new product and a change in farming practices which can be verified.

However, there is a limitation on recognising the use of agrichar in an emission trading scheme as it is still in experimental stages. Further research needs to be undertaken for issues such as:

- Best methods to incorporate into soil
- Most cost-effective application methods and rates
- What the payback periods are for various applications
- If benefits change with type of soil
- Is it truly a substitute for fertiliser
- If further applications are necessary
- How much can be produced and available in the foreseeable future
- Supplying agrichar in substantial quantities

Environmental externalities

The use of agrichar has environmental benefits. This report does not consider the indirect benefits associated with agrichar from reduced pollution of surface or ground waters. These externalities occur because of the decrease in fertiliser use due to agrichar's improved nutrient retention and moisture retention.

Methodology

A combination of personal communications and secondary resources were used to compile the data used in this study. The primary tool to conduct the economic analysis was the Farm Economic Analysis Tool (FEAT), developed by the Queensland Department of Primary Industries and Fisheries (DPI&F). It was necessary to include a risk analysis as much of the information used in this study is in experimental stages. The Excel add-in tool @RISK was used for this. A discounted cash flow was developed to evaluate the proposed changes to the farming system. Four Scenarios were developed which address the objectives of this study.

Farm Economic Analysis Tool (FEAT)

FEAT is an annual steady state model, which does not account for transitional factors, such as farmers altering farming practices once fertiliser prices prove to be too expensive. It is a whole farm economic decision model specifically designed for sugarcane growers and can be used to evaluate the economic impact of a change in farming practices (Cameron, 2008). FEAT builds on a detailed model of the farming system and farm resource use to allow impact assessment of alternative farming practices.

FEAT was used to evaluate: (1) the impact of an emissions trading scheme on the sugarcane farmer; and (2) the benefits to the grower if existing farming practices were changed to include the use of agrichar.

Risk Analysis

@RISK was used as it integrates well with the Excel-based FEAT program. Cumulative probability distributions were used to calculate expected ranges of values.

Discounted Cash Flow

A standard discounted cash flow (DCF) analysis was used to evaluate the proposed changes to the farm from incorporating agrichar into the existing farming system. The DCF analysis estimates the net present value (NPV) of the incremental net cash flow stream over twenty years. It arises directly as a result of estimating the difference in the annual cash flow pattern for the farm, with and without the proposed change.

A breakeven analysis was carried out on the price of char to find when it is unviable to change from the current practices to apply char.

Scenarios

Four scenarios were developed to run in FEAT, taking into account the issues of the emissions trading scheme, agrichar and the possible trading of carbon offsets. Bernard Milford from the Canegrowers organisation provided assistance with the development of each scenario. A concise statement of the scenarios appears in Table 2.

Table 2. Scenarios

Scenario	Background
1 Base Case	Typical dryland sugarcane farm in the Herbert Region: base case.
2 Base Case + ETS	Scenario 1, plus the alterations to the price of inputs under an emissions trading scheme.
3 Base Case + ETS + Agrichar	Scenario 2, plus the use of agrichar in the operation.
4 Base Case + ETS + Agrichar + Offsets	Scenario 3, plus the trading of additional carbon sequestered from char in the offsets market.

Scenario 1: Base Case

Scenario 1 is the base case – a typical dryland sugarcane farm in the Herbert Region. The data for the base case was provided by Mark Poggio from DPI&F in Ingham, based on information from a previous study conducted in 2007. Because this data is obtained from the 2007 study, it needs to be noted that since then, there has been a considerable increase in the price of fertiliser. In 2007 prices were DAP $700/tonne, NK $650/tonne, lime $100/tonne, and GF 501 $650/tonne compared with mid-2008 prices of DAP $1,710/tonne, NK $1,115/tonne and GF 501 $1,210/tonne. A sensitivity analysis was carried out on this.

The base case is for a 39.96 hectare dryland sugarcane farm in the Herbert, which consists of a plant crop, four ratoons and fallow. Each of the six paddocks are of equal size (6.66 hectares). The expected sugar price is $295/tonne, with expected yields as follows:

- Plant: 97.5t/ha
- First Ratoon: 91.25t/ha
- Second Ratoon: 81.88t/ha
- Third Ratoon: 76.88t/ha
- Fourth Ratoon: 71.88t/ha

The remaining scenarios impact on the price and quantity of inputs, the main one being fertiliser. The farm applies DAP, NK and lime upon planting and GF 501 on each of the ratoons. These figures are found in the "plant spring fallow" and "1st Ratoon" spreadsheets. Expected Spring Fallow fertiliser expenses are $680.07/ha, and Ratoon fertiliser expense $415.52/ha.

The price of fuel which the business incurs is 90c/L after rebate. This figure is found in the "machinery" sheet of the FEAT model.

Scenario 2: Base Case + ETS

Scenario 2 considers farm operations under the emission trading scheme. As farmers are price takers and inputs are inelastic (mainly in the short run), there will be a reduction in profit due to the increase in the price of inputs. Perry (2008) estimated the change in farm inputs for the price of carbon traded in the market (see Table 1).

It is assumed that carbon will be traded in the market at $20 per tonne of CO_2 equivalent. As the farm used in the study is a dryland system, the relevant increases in costs under the emissions trading scheme for this study are diesel of 6c/L and fertiliser $52.60/tonne. Since electricity is only used for domestic purposes, its cost is not accounted for in this model.

The price of fuel needs to be changed in the "machinery" sheet of FEAT, increasing from 90c/L to 96c/L. Fertiliser costs are $713.76/ha for Spring Fallow and $448.85/ha for Ratoon.

Scenario 3: Base Case + ETS + Agrichar

Scenario 3 builds upon Scenario 2, with the inclusion of agrichar into the farming operations. The agrichar is applied when planting, therefore takes six years before the entire farm is applied with agrichar. Fertiliser still needs to be applied to the remaining ratoons each year. This process is outlined in the farm plan matrix (Figure 3). Once all six fields have been applied with agrichar, no fertiliser needs to be applied again. Farmers apply one application of agrichar which would have a long-term benefit in their soils (Van Zwieten in Benjamin, 2008).

Field / Year	1	2	3	4	5	6
1	P char	R1	R2	R3	R4	F
2	R1 char	R2	R3	R4	F	P char
3	R2 char	R3	R4	F	P char	R1 char
4	R3 char	R4	F	P char	R1 char	R2 char
5	R4 char	F	P char	R1 char	R2 char	R3 char
6	F char	P char	R1 char	R2 char	R3 char	R4 char
7	P char	R1 char	R2 char	R3 char	R4 char	F char

LEGEND

P =plant R1 = ratoon 1	**APPLY CHAR**
R2 = ratoon 2R3 = ratoon 3	**APPLY FERTILISER**
R4 = ratoon 4 F = fallow	**CHAR ALREADY APPLIED FROM PREVIOUS YEAR**

Figure 3. Farm Plan Matrix

The following data represent the use of agrichar in farming systems:

- Application rate = 20t/ha (Downie in Benjamin, 2008)
- Cost of char = $50 - $200 per tonne (Van Zwieten in Benjamin, 2008)
- Fertiliser reduction can be 100% if using manure based biochars and possibly 50% if using wood based biochars (Van Zwieten, pers. comm.)
- Application cost = $40/ha (Mark Poggio & Rod Strahan, pers. comm.)

Due to the large range of the estimated price of char in the commercial market, an expected value was calculated using @RISK. The expected char price used was $122.50/tonne.

Scenario 4: Base Case + ETS + Agrichar + Offsets

Scenario 4 takes into account the second characteristic of char – its potential to sequester and store carbon. Agrichar meets the criteria outlined for offsets under the Kyoto Protocol. These criteria are additionality, measurability and permanence. If recognised under the national emission trading scheme, growers who adopt char into their system could possibly trade the '*additional*' carbon sequestered from changing practices, providing additional cash flow.

The following assumptions were made:

- At a rate of 20t/ha of agrichar, soil carbon will increase by 1% (Downie in Benjamin, 2008)
- Average of 28.6t/ha soil carbon in the Herbert Region (Bernard Schroeder, pers. comm.)
- Expected carbon price = $27.50/tonne (calculated using @RISK)
- Can only trade additional carbon sequestered (i.e. 1% of 28.6t/ha)

To comply with the Kyoto Protocol and CPRS, growers can only trade the additional carbon sequestered by converting to the use of agrichar. The calculations are shown below.

28.6t/ha of soil carbon

1% additional soil carbon from agrichar = 28.6 x 0.01 = 0.286t/ha

As only apply agrichar on planting
Year 1: 0.286 x 6.66 = 1.9047 tonnes of additional soil carbon (plant)
27.5 x 1.9047 = 52.38
Can trade 1.9047 tonnes of carbon each year at a price of $27.50/tonne

Therefore, carbon offsets = $52.38 (cash flow)

Year 6: total farm under char
0.286 x 39.96 = 11.42856 tonnes of additional soil carbon
27.5 x 11.42856 = 314.29
Once entire farm applied with agrichar, can trade 11.42856 tonnes of soil carbon at a price of $27.50/tonne. Carbon offsets = $314.29

Table 3 outlines the additional cash flow of the carbon offsets each year. It is assumed that offsets will be able to be traded each year.

Table 3. Carbon credits/offsets[1]

Year	1	2	3	4	5	6
Cash flow from offset	$52	$105	$157	$210	$262	$314

The main assumption for Scenario 4 is that the additional carbon sequestered by agrichar will be able to be traded in the offsets market. This may not be the case under the proposed emissions trading scheme due to commence in 2010. Further policy and science needs to be developed if soil carbon is to be included in the offsets market in future years.

Results

The FEAT model was used to run each of the Scenarios. Table 4 presents key results from the FEAT modelling of the various scenarios. The table outlines total income, variable costs, gross margin and farm business profit. The main farm financial criterion used to compare the results is farm business profit. Farm business profit is the return to the business after variable costs and fixed costs are allocated.

Table 4. Summary of Scenario results

Scenario	Total Income	Variable Costs	Gross Margin	Farm Business Profit [a]
1 Base Case	$70,477	$43,266	$27,211	- $64,939
2 Base Case + ETS	$70,477	$44,466	$26,011	- $66,139
3 (year 1) Base Case + ETS + Agrichar	$70,477	$56,295	$14,181	- $77,969
3 (year 7-20) Base Case + ETS + Agrichar	$70,477	$27,755	$47,222	- $49,428
4 (year 1) Base Case + ETS + Agrichar + Offsets	$70,477	$56,295	$14,181	- $77,916
4 (year 7-20) Base Case + ETS + Agrichar + Offsets	$70,477	$27,755	$47,222	- $49,114

[a] Farm business profit is equal to gross margin minus total fixed cost. In all scenarios total fixed cost is equal to $92,150. In Scenario 1 for example, farm business profit = $27,211 - $92,150 = -$64,939.

[1] Due to the FEAT program, titles were unable to be changed. Carbon offsets are included as a cash flow under the title 'contract work' in the "profit" spreadsheet.

Each of the scenarios has a total farm income of $70,477 and a total fixed cost of $92,150. This is based on the assumption of the same income stream and the same fixed costs for each scenario. Note that total fixed cost is far greater than total income, indicating that the typical cane farm is not viable under the price assumptions used in this study.

The changes in gross margin between each Scenario is due to the change in variable costs (gross margin = total income – variable costs). In the base case (Scenario 1), variable costs equal $43,266, increasing to $44,466 in Scenario 2. This is due to the increase in input prices (fertiliser and diesel) under the emissions trading scheme. Scenario 3 (year 1) and Scenario 4 (year1) have significantly higher variable costs due to the introduction of agrichar into the farming system. In year 1, char is applied at planting with the four ratoons having fertiliser applied. Scenario 3 (year 7-20) and Scenario 4 (year 7-20) have significantly lower variable costs of $27,555 when compared to the other Scenarios. This is because once year 7 is reached, no agrichar or fertiliser is applied as discussed previously.

Figure 4 displays a graph of the risk analysis of each of the scenarios modelled in FEAT using the @RISK program. The graph indicates the cumulative probability of attaining particular levels of farm business profit under each of the scenarios. This graph can be interpreted in the following way. At point A, there is an 80% probability the farm business profit under Scenario 2 will be less than -$61,873, with a 20% probability that farm business profit will be greater than this.

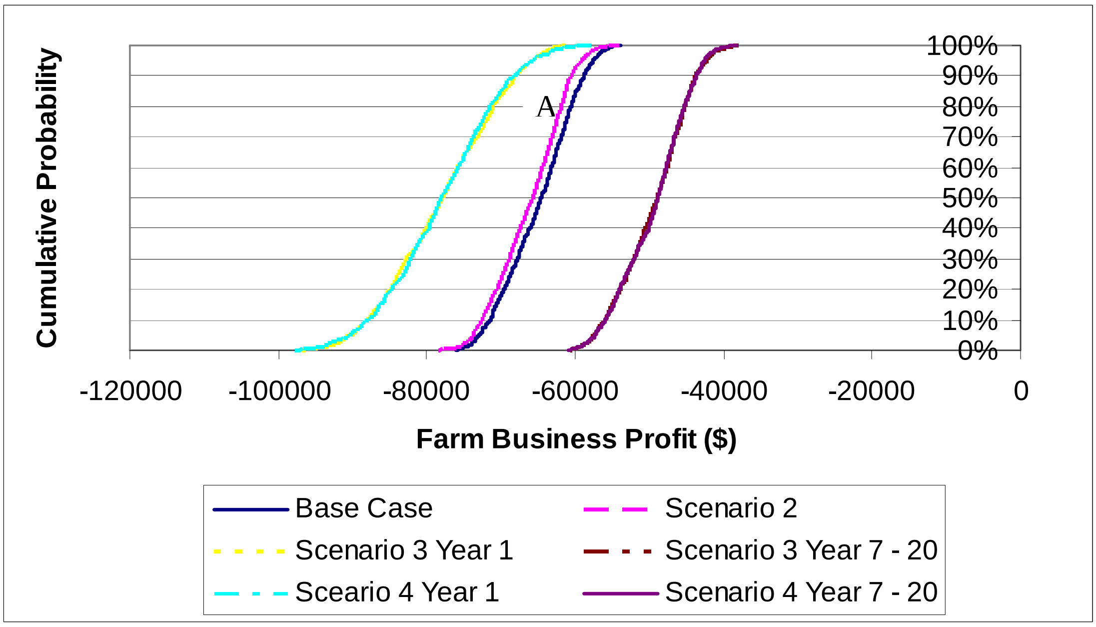

Figure 4. Probability distribution of farm business profit

Scenario 3 (year 7-20) and Scenario 4 (year 7-20) are seen as the better options when the decisions is based on the farm business profit. The farm business profit for Scenario 3 (year 7-20) is - $49,428 and - $49,114 for Scenario 4 (year 7-20). This compares to the base case where a farm business profit of - $64,939 was achieved. The difference between the farm business profits of Scenario 3 (year 7-20) and Scenario 4 (year 7-20) is due to the additional cash flow from the trading of carbon offsets. The reason why both of these scenarios provide a smaller loss is due to the fact no fertiliser or agrichar is needed to be applied. Refer to the farm management matrix (Figure 3) for further explanation. Thus while the cost agrichar reduces farm business profit in year 1, its impact in reducing fertiliser usage is felt in years 7 to 20.

Because the benefits and costs of agrichar occur in different periods, a net present value of the stream of costs and benefits using discounting analysis needs to undertaken to determine the relative merits of using agrichar.

The DCF was developed through the use of FEAT. The DCF analysis was used to evaluate the benefits of changing from existing farming practices (Scenario 2 – base case, plus emission trading scheme) to operations which include the use of agrichar (Scenario 3). These two scenarios were chosen to be used in the DCF as both include the price change of inputs under the emission trading scheme (fertiliser and diesel). Also Scenario 3 was chosen over Scenario 4, as currently the carbon sequestered by agrichar is not recognised to be traded in offsets. The cash flow from the offsets is very minimal and would not have much impact on results. The criterion measured is the net present value (NPV). The NPV represents the current value of the investment over a twenty year period using a discount rate of 8%.

This is a partial budgeting model, only changing the fertiliser variable (i.e. NPV only changes by total fertiliser costs). The change in farm business profit equals the change in total fertiliser costs. (Changing farming practices to include agrichar in operations (Scenario 3 minus Scenario 2)).

Figure 5 displays the total farm income ($70,477) which is constant throughout out all scenarios, and also the total farm costs of Scenario 2 and Scenario 3. This figure only displays year 1 to 7, as beyond this, costs remain the same. It is seen that until year 5, the total costs of continuing operations under current conditions (Scenario 2, GCTB) are less than that of using agrichar. However, from year 5 onwards, the total costs are less under Scenario 3. This is where the value of agrichar is evident. The benefits of change (both undiscounted and discounted) are seen in Figure 6.

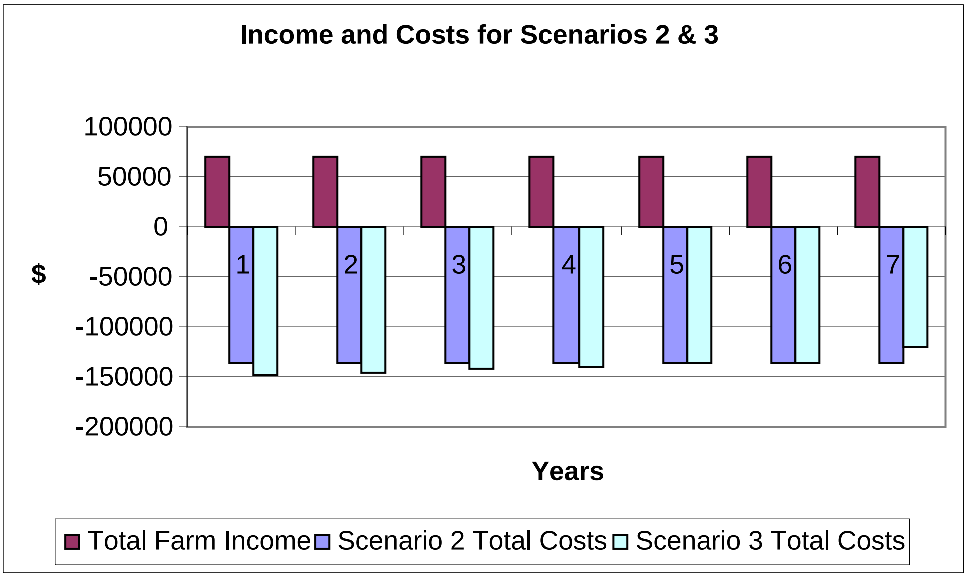

Figure 5. Total Farm Income and Total Farm Costs for Scenarios 2 and 3 over a 7 year period

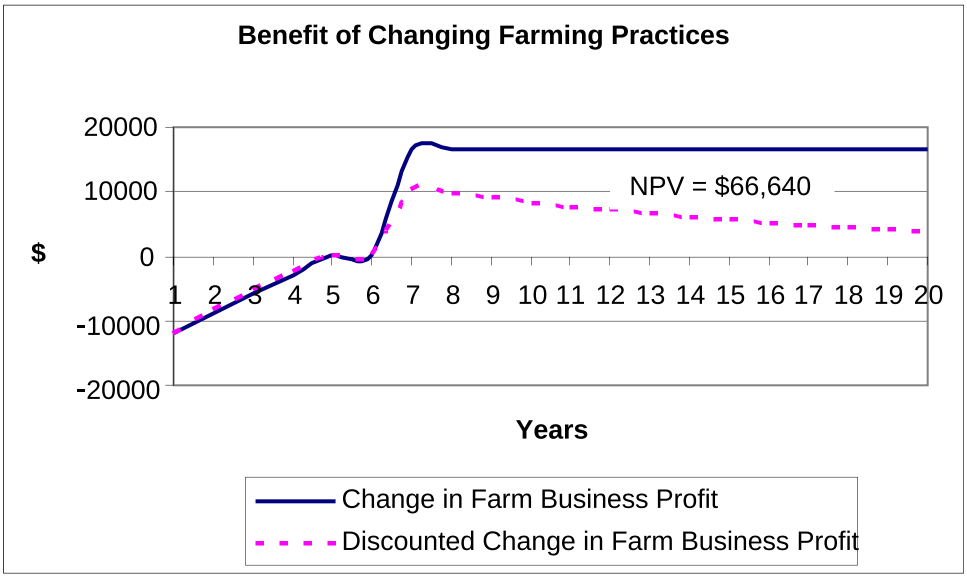

Figure 6. Change in farm business profit due to the change in farming systems

Over the twenty year period, the benefit of changing to the use of agrichar is $66,640. The benefits are not seen until year 5 due to the applications of agrichar and fertiliser. The benefit is due to the decrease use of fertiliser and agrichar to a point where none is applied. The figures of year 5 and 6 are the same as no fertiliser is applied to fallow, only agrichar. Table 5 outlines the changes in fertiliser and agrichar costs over the years (refer to the farm plan matrix in Figure 3).

Table 5. Total fertiliser costs when agrichar is used

Year		1	2	3	4	5	6
Scenario 3		Plant	Ratoon1	Ratoon2	Ratoon3	Ratoon4	Fallow
		6.66	6.66	6.66	6.66	6.66	6.66
Char Cost	2490	16583.4	16583.4	16583.4	16583.4	16583.4	16583.4
Ratoons		4	3	2	1		
Fertiliser Cost	448.85	11957.36	8968.02	5978.68	2989.34	0	0
Total Fert Costs		28540.76	25551.42	22562.08	19572.74	16583.4	16583.4

The cost of applying agrichar is $2490/hectare (from the “plant” sheet in FEAT). As it is only applied upon planting, the area applied is 6.66 hectares. The remaining four ratoons have fertiliser applied at a cost of $448.85/hectare for each ratoon (6.66 hectares). Each year char is applied upon planting and one less ratoon is applied with fertiliser as char has already been applied to that field. This process is done until all fields are applied with agrichar and therefore there are no more costs for fertiliser or agrichar application.

This study did not place a value on the environmental externalities from changing existing operations to the inclusion of agrichar. Sugarcane farmers are criticised for damage to the Great Barrier Reef due to their use of fertilisers and run-off into water ways. With the use of agrichar, fertiliser use is reduced, providing a positive externality. Agrichar is expected to reduce emissions of nitrous oxides from soils beyond replacing fertilisers, further contributing to an improved balance of greenhouse gases. Due to lack of data, this effect could not be quantified. Hence, results shown above constitute a significant underestimate of total benefits.

Sensitivity Analysis

The discount rate used in the DCF was altered to see the affect on the NPV of changing farming practices. The results represented in Table 6.

Table 6. NPV of change with a discount rate of 5%, 8% and 10%

Discount Rate	NPV of change
5%	$101,784
8%	$66,640
10%	$49,752

At a discount rate of 5% and 10% it is still beneficial to change existing farming practices to the inclusion of agrichar.

A sensitivity analysis was conducted on the price of agrichar to determine at what price it is no longer viable to switch from existing farming systems to the inclusion of agrichar (i.e. NPV is equal to zero). The agrichar price was altered in the “cane assumptions” sheet.

Figure 7 is a graphical representation of the NPV of change with respect to the price of agrichar ($/tonne). As the price of char increases, there is less benefit gained from changing practices. It is expected that agrichar will be available in the commercial market at a price range of $50 to $200 per tonne (Van Zwieten in Benjamin, 2008). At $50/tonne the NPV of change is $144,855. At $200/tonne the NPV of change equals $15,072. For prices beyond $222.706 there is no benefit of including agrichar in farming operations.

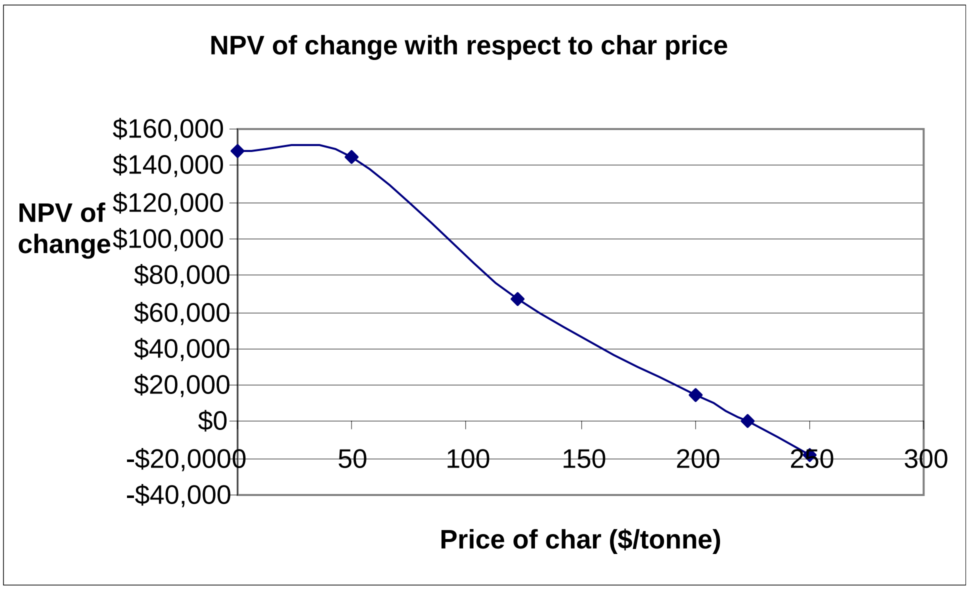

Figure 7. NPV of change with respect to agrichar price

If agrichar is sold in the market at the expected price range of $50 to $200 per tonne, then it is beneficial to change from existing operations as the NPV of change is positive.

There has been a significant increase in the price of fertiliser since 2007. This increase in fertiliser prices will have a significant impact on farm profitability. A sensitivity analysis was carried out with the current fertiliser prices inputted into the FEAT model with the remaining data held constant. The results are seen in Table 7.

Table 7. Results with use of mid-2008 fertiliser prices

Scenario	Total Income	Variable Costs	Gross Margin	Farm Business Profit
1 Base Case	$70,477	$56,370	$14,107	-$78,043
2 Base Case + ETS	$70,477	$56,473	$14,004	-$78,146
3 (year 1) Base Case + ETS + Agrichar	$70,477	$65,619	$4,857	-$87,293
3 (year 7-20) Base Case + ETS + Agrichar	$70,477	$27,755	$42,722	-$49,478
4 (year 1) Base Case + ETS + Agrichar + offsets	$70,477	$65,619	$4,857	-$87,240
4 (year 7-20) Base Case + ETS + Agrichar + Offsets	$70,477	$27,755	$42,722	-$49,114

Conclusion

This study has examined the profit impacts on a select group of famers of some aspects of the proposed CPRS due to commence in Australia in 2010. Even before the inclusion of agriculture in the scheme, there will be flow-on effects which will be felt at farm levels through the increase in price of inputs.

Each of the scenarios has a total farm income of $70,477 and a total fixed cost of $92,150. The changes in gross margin between each scenario are due to the change in variable costs. In the base case (Scenario 1), variable costs equal $43,266, increasing to $44,466 in Scenario 2. This is due to the increase in input prices (fertiliser and diesel) under the emission trading scheme. Scenario 3 (year 1) and Scenario 4 (year1) have significantly higher variable costs due to the introduction of agrichar into the farming system. In year 1, agrichar is applied at planting with the four ratoons having fertiliser applied. Scenario 3 (year 7-20) and Scenario 4 (year 7-20) have significantly lower variable costs of $27,555 when compared to the other scenarios. This is because once year 7 is reached, no agrichar or fertiliser is applied.

A DCF model was developed, which indicated that over the twenty year period there is a significant advantage in changing to the use of agrichar when the decision criterion is farm business profit. By comparing the results of Scenario 2 (existing farming practice under an emission trading scheme) to the use of agrichar (Scenario 3), it is evident that benefits can be achieved from year five onwards when there is a change in farming practices. Over the twenty year period, the benefit of changing to the use of agrichar is $66,640. The benefit is due to the decreased use of fertiliser and agrichar to a point where neither is applied.

The major limitation of this study is that both policy and science regarding an emission trading scheme and agrichar are in development stages. Further development in policy and scientific research in soil carbon inclusion into the offset market is required, as it is not currently recognised. Forestry is the only current way to trade sequestered carbon in the offset market. The major assumption in Scenario 4 is that the additional carbon sequestered by agrichar will be included under the emissions trading scheme. The relevant points as to why agrichar could be included in the offsets market were discussed, however, improved research is required for char, as currently there is some information lacking. This includes:

- Whether it really is a substitute for fertiliser
- Optimal application
- How long do benefits work for – i.e. is there a need for future applications
- Yield benefits
- If its benefits change under different soil conditions

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