CARBON NEUTRAL COTTON FARMS

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Our Fibre. Our Focus. Our Future

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Summary

The Australian Cotton Industry is developing a carbon (C) footprint calculator for cotton farms. The calculator determines C sequestration and emissions associated with agricultural production (irrigated and dryland crops and grazing enterprises), as well as the net primary productivity (NPP) and C sequestered by native vegetation. NPP is defined as the net flux of carbon from the atmosphere into green plants per unit time (Distributed Active Archive Center, 2014). A case study illustrating the C footprint of a cotton farm near Wee Waa has been developed and is reported here. The calculator will demonstrate how growers can be carbon neutral, or even better, generate carbon credits. In addition, carbon conscious consumers need reassurance that the system used to grow the product is environmentally sustainable (Maraseni et al. 2010).

Introduction

Agricultural production inevitably leads to carbon dioxide (CO2) and other greenhouse gas (e.g. nitrous oxide, methane) emissions to the atmosphere (ABS, 2014). These emissions are generated by clearing and cultivating land, fertilizer applications, use of diesel and other fossil fuels to power machinery, transportation of the final product and livestock grazing. These production-related emissions can be managed to some extent, and while some C sequestration occurs within cropping areas (Department of Agriculture, 2014), a holistic view of the farm, incorporating native vegetation, is required to properly reflect a farm's overall C balance. As shown in this case study, taking a holistic approach, demonstrates that it is possible to achieve a C neutral, or even better, a C positive (i.e. through the creation of C credits) enterprise.

No matter which government is in power or the price of C on world markets, it is likely that there will be a C tax or emissions trading scheme in some form in the future, and agriculture will be affected, for example a tax on inputs such as fertiliser or energy inputs (Parliament of Australia, 2014). Hence, growers should be well-informed about the sources and sinks of C on their farms. In addition, C-neutral enterprises appeal to conscious consumers and may therefore provide a product differentiation point. While most growers will not get rich by generating C credits through the Carbon Farming Initiative (CFI), the majority can minimise their ecological footprint by running C neutral enterprises.

We have been working to develop C accounting calculators to help growers manage their farms so that they can become C neutral. These tools will allow growers to make decisions about their land management, to achieve C neutrality and avoid paying C pollution taxes. The additional ecosystem service benefits for cotton growers who manage for C neutrality are huge, and include erosion mitigation, biodiversity conservation, natural pest control and filtration of pollutants that might otherwise enter waterways (Smith 2010; Reid et al. 2003).

Methods

A case study farm was chosen near Wee Waa in the Namoi Valley in northern NSW Map 1). Farm production on the Kahl family holding 'Redbank' consists of irrigated cropping and livestock grazing (merino sheep and beef cattle). Native vegetation on 'Redbank' varied from native pastures, to mature and regenerating river red gum forest (Table 1). The soil type across the majority of the cropping and riparian areas of the farm is dominated by a heavy grey-black vertosol, while the grazing components of the property are dominated by sodic, deeply gilgaied brigalow soils that aren't desirable for cropping.

A literature review determined net primary productivity (NPP) of vegetation types commonly encountered on 'Redbank' (Table 1). The age of the vegetation (e.g. young or old tree regeneration, mature or old growth trees), density of trees (e.g. scattered trees, woodland or forest) and management history (e.g. thinning, grazing or burning) were taken into account when selecting relevant rates of NPP on 'Redbank'. We assumed C sequestration was equal to half of the NPP (Dwyer et al. 2009; Gifford 2000; Horner et al 2010). Where direct measurements of NPP could not be found for some vegetation communities, but the age of the vegetation was known, C storage was divided by the age of the vegetation to give average NPP over time.

The average irrigated cropping enterprise at 'Redbank' works on a four year rotation consisting of cotton, wheat, mung beans, fallow, cotton, fallow, maize and fallow, before starting again with cotton. The grazing enterprise utilises all non-cropping land on a rotational basis and is stocked in accordance with seasonal dry matter production, where 1000 DSE is regarded by the owner as an average production baseline. Yield estimates and crop inputs were modelled on the NSW Department of Trade and Investment gross margin budgets (NSW DPI, 2012). Emissions of farming practices in irrigated cropping have been calculated using the Cotton Carbon Management Tool (Visser et al. 2014). The Australian Farm Institute's FarmGas calculator provided data for the 1000 dry sheep equivalent (DSE) livestock component (AFI, 2014).

Results and Discussion

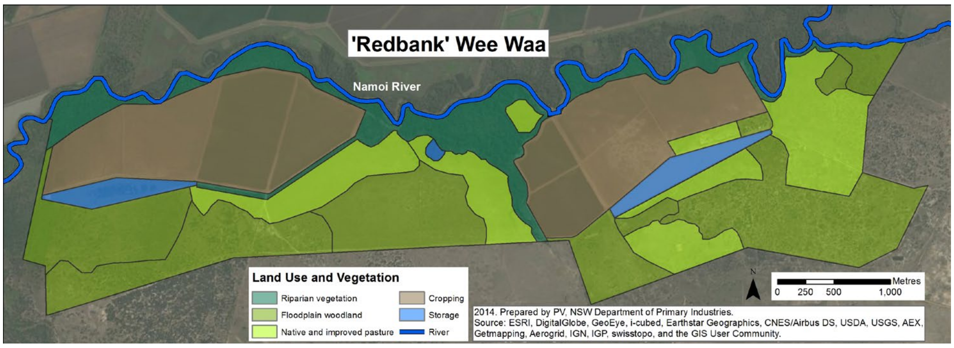
Figure 1 illustrates the environmental footprint of each component in the four year crop rotation and grazing enterprise at 'Redbank.' Cotton production, both irrigated and dryland, produced the highest C emissions of the components within the rotation. Corn and wheat produced approximately half the emissions of cotton, while mung beans, fallow and livestock grazing produced significantly lower emissions than cotton or wheat crops.

On a per hectare basis, cropping had the highest C emissions footprint with 2742 kg CO2 (e) annually (Figure 2). Livestock grazing was the other source of emissions, with 280 kg CO2 (e) annually. The three native vegetation categories represented

TABLE 1 Areas of native vegetation on 'Redbank,' their management and potential C-sequestration rate based on net primary productivity (NPP).

Vegetation type	Farm area (ha)	Management/ land use/ structure	C-seq. rate (t C ha^{-1} yr^{-1})	Total C seq. (t yr^{-1})	Total C seq. (t yr^{-1} CO_2(e)
River red gum riparian forest	153.5	Old-growth, mature and regenerating trees, some tree thinning	2.07[1]	317.8	1165.0
Coolibah woodland	6.6	Old-growth, mature and regenerating trees	0.50[2]	3.3	12.1
Regenerating brigalow	114.5	Pockets of dense regeneration	0.65[3]	74.4	272.9
Mature and regenerating poplar box and brigalow	332	Multiple-stemmed poplar box with mature, open brigalow	0.60[4]	199.2	730.5
Tropical pasture	53	Bambatsi panic, Rhodes grass	0.40[5]	21.2	77.7
Native grasslands	179.5	Mix of perennial grasses	0.27[6]	48.5	177.7
Total Farm Veg	839.1			664.4	2436.2
Average ha^{-1}				0.8	2.9

1. Robertson et al. 2001; 2. Burrows et al. 2002; 3. Chandler et al. 2007; 4. Moore et al. 2007; 5. Lodge and Johnson 2010; 6. Garnaut 2008.



MAP 1 Land Use and native vegetation categories represented on 'Redbank' Wee Waa.

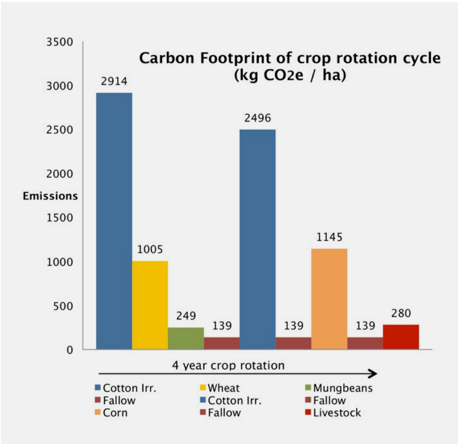


FIGURE 1 Greenhouse gas emissions from four year irrigated cropping rotation and livestock grazing native rangelands on 'Redbank'.

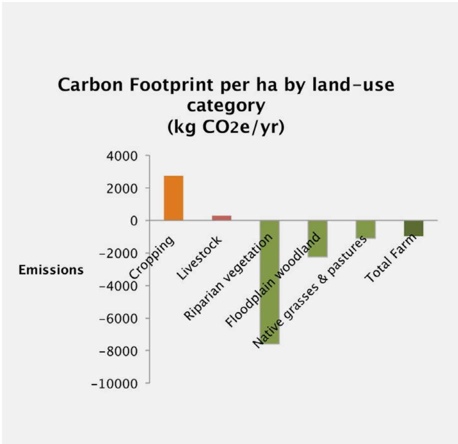


FIGURE 2 Annual greenhouse gas emissions by land use category (kg CO2e/ha) on 'Redbank'.

at 'Redbank' sequestered C, with riparian vegetation being the most valuable compared to floodplain woodlands and grasslands. Overall, when multiplied out according to the proportions of different land uses on 'Redbank,' the farm is C positive, i.e. it is sequestering more C annually (1185 kg CO2e/ha) than it is emitting.

Carbon sequestration by native vegetation is variable, and depends on a variety of factors, both environmental and human induced, including: the species present and ecosystem structure (trees, shrubs, grasses, the proportions of each and competition for resources), management (e.g. grazing, burning, removal of logs), season (drought vs floods), site quality (fertility, soil type, moisture availability) and history (ringbarking or tree removal, or untouched). Riparian vegetation is the most productive on farm (Naiman et al. 2005), and therefore the most valuable for C sequestration. Woody vegetation is more valuable than grasslands in terms of C sequestration, as trees live longer and are less vulnerable to the impacts of drought, grazing and other management factors. Soils under woody vegetation are generally more C-rich due to large litter inputs and the high C:N ratio of woody litter, which decomposes slower than grass-derived litter (Swift 1979).

Younger trees have faster growth and C sequestration rates than old-growth or mature trees, and this is why revegetation and assisted regeneration are included as approved methodologies for carbon offset projects under the CFI. However, old-growth trees store more C, both in the trees themselves and in the underlying soil, than young trees. Due to the CFI regulatory 'additionality' test, the only approved activity relating to remnant woodland/forest vegetation is the protection of remnant vegetation that was previously approved for clearing (Australian Government, 2014). However, a recent paper showed the value of native vegetation (particularly river red gum woodlands) on cotton farms as a significant C sink, and put forward a case for recognition of this fact in future policy developments (Smith and Reid 2013). In addition, many recent high impact papers have shown that old-growth remnant vegetation does sequester C, and should therefore be considered in C accounting tools (Luyssaert et al. 2008). Hence, we should not write off the value of remnant vegetation yet.

No gas flux data, e.g. respiration by plants and C released to the atmosphere during decomposition, were found for native vegetation communities relevant to this study, and data on C sequestration rates in soils under native vegetation was largely unavailable. However, this study is intended to be a conversation starter, and highlights the need for further research in this area.

Conclusion

Depending on relative land-use proportions, carbon emissions from cotton farms can be offset by native vegetation, potentially allowing cotton farmers to achieve carbon neutrality and in turn, provide an environmentally sustainable product to the global market.

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