

MORE PROFIT FROM NITROGEN



Long-term costs and benefits of best practice Nitrogen Use Efficiency (NUE): *market access and environmental considerations for increased profit*

About the research

The More Profit from Nitrogen Program (MPfN Program) was a five-year partnership (2016-2021) between the Australian cotton, dairy, sugar and horticulture industries. It was conducted to bring about increased farm profitability and reduced environmental impact by increasing NUE, thereby, reducing the amount of applied nitrogen (N) required to produce each unit of product. Eleven research projects were delivered by nine organisations, involving forty-two field sites across Australia.

The MPfN Program has delivered knowledge, technologies and decision support resources that can significantly increase NUE, reducing environmental impact whilst increasing the long-term sustainability and profitability of Australian farming businesses.

Purpose and background

There are challenges associated with the adoption of improved NUE as Urea, the N source most commonly used in Australian agriculture, is considered relatively cheap “insurance”, and annual costs associated with use above recommended guidelines are perceived as having a negligible impact upon business profit. This case study investigates potential options for promoting longer-term benefits of adopting more sustainable N best management practices (N BMPs), to increase uptake of certain MPfN Program recommended NUE strategies for each industry, and the likely legacy this may have upon operator environmental and business sustainability.

Ideally, incentives such as nutrient trading, credit schemes and premium payments (or a combination of these) need to be considered to ensure producers are not financially disadvantaged when transitioning to more sustainable N BMP (Antille and Moody, 2021). Furthermore, looking beyond initial adoption, long-term N BMP implementation has potential to provide additional farm business value through reducing greenhouse gas (GHG) emissions and improving environmental condition such as soil carbon levels.

The study presents modelled outcomes of implementing N BMPs identified in the MPfN Program and applied in the Australian cotton, dairy, sugar and horticulture industries over twenty-five years. Economic benefits can be achieved through input savings from sample baseline scenarios, as well as improved productivity and market premiums for sustainable products, emissions and pollution reduction, and carbon sequestration. This is an area of economic consideration that current private sector and government activity suggests will drive markets and influence the value of credits schemes (current and planned) and premiums paid for more sustainable products.

KEY MESSAGES

- Responsible use of N fertiliser can have implications for global agricultural goods trade and market access.
- Among case study commodities, initiatives to differentiate products via certification are growing, to recognise and capture market premiums from consumer-led demand for sustainable practices.
- A proposed one per cent product premium is applied from N Best Management Practice (N BMP) use in this study. When assuming a \$10k (initial) and \$5k (ongoing) audit cost on a scenario farm for each industry, adopting a theoretical N BMP certification showed significant economic returns and immediate payback, particularly in high-value (per ha) crops.





On-farm sustainability standards and global trade

Global action on climate change is increasing, from governments to voluntary corporate action, with many large companies having publicly committed to emissions and decarbonisation strategies (Science Based Targets, 2021). These parties are also striving to achieve greater transparency around the climate impact of their products throughout supply chains, including those in agriculture (Unilever, 2020). Additionally, there are clear signals that environmental impacts are being considered in global trade (World Trade Organisation, 2021) and action will be taken upon laggard countries, such as carbon border quotas on carbon intensive goods into Europe and the US.

The product environmental footprint methods being developed under the EC Europa (2021) *Single Market for Green Products Initiative* of the European Commission (2018) (EC) aim to measure environmental performance, including nitrous oxide and N fertiliser application. The European Union (EU) has expressed plans to introduce a carbon tariff system no later than 2023. The EC plans to table a carbon border adjustment mechanism proposal for selected sectors in 2021.

As an export-oriented country, Australian agri-food industries are sensitive to changes in policy and market regimes, particularly Asia, North America and Europe. Achievement of sustainability standards may become a requirement for access into large agri-food markets in the near future (McRobert and Gregg, 2021). An example is the Australian Oilseeds Foundation (2021) initiative to develop Sustainable Grain Australia, the sustainability certification of Australian grain, oilseeds and pulses under the International Sustainability and Carbon Certification (ISCC) scheme. The ISCC is a voluntary scheme used in the canola, used cooking oil and tallow industries of Australia where oils and fat products are intended for biofuels. Biofuels produced in the EU must use inputs certified as sustainable. ISCC is also used in the production of Australian sorghum destined for ethanol production. Participating farms of this scheme are required to provide a fertiliser plan with rates, proof of agronomic advice and how the cropping rotation is used to break pest/disease cycles and improve soil N.

Current trends

Markets and consumers are seeking increased action from industries to address GHG emissions. N fertiliser can significantly contribute to product carbon footprints when used above optimal use efficiency rates for plant uptake and reduced loss to the environment.

Recognition of the positive contribution agriculture and the land sector can have in mitigating national emissions is well established. There are increasing options, both payments for ecosystems services (government-led) and premium labels for sustainably-produced goods (market-led) (McRobert and Gregg, 2021). The range of standards, certification and assurance schemes on offer, to provide producers with incentive to transparently report upon performance measures when adopting soil carbon and regenerate landscape practices, is also gaining momentum.

As individual industries such as meat and livestock move towards carbon-neutral production (Meat and Livestock Australia, 2021), reducing emissions of nitrous oxide also become more important in other industries, such as dairy. Marketing of carbon-neutral products frames the term “More Profit from Nitrogen” differently, making a reduction of the GHG footprint of a farming system also an economically interesting option (Rowlings et al., 2021).

All agricultural industries of the MPfN Program have established industry-wide sustainability strategies that include climate change goals and emissions reductions targets. More broadly, work is underway to develop an overarching meta sustainability framework for Australian agriculture (McRobert and Gregg, 2021).

“At the recent Global Food Forum in Sydney, delegates heard agribusiness leaders assert sustainability is now mainstream for the agri-food industry”
Australian Farm Institute (2021).

To access the EU, participating farms of the International Sustainability and Carbon Certification (ISCC) scheme are required to provide a fertiliser plan with rates, proof of agronomic advice and how the cropping rotation is used to break pest/disease cycles and improve soil N.



A review of sustainability supply chain initiatives for MPfN Program case study industries

A review of relevant sustainability initiatives available, or developing for sugar, cotton, dairy and horticulture, was undertaken to increase understanding of both the price premiums that can be achieved and non-compliance price penalties. Table 1 presents a summary of those considered in the study.

Table 1. Examples of reviewed current agricultural sustainability market initiatives with potential for premium (or discounts) available to Australian sugar, cotton, dairy and horticulture industries. Does not include premiums for certified organic production, which generally do not allow use of synthetic nitrogen.

Industry & initiatives	Summary points	Source
Sugar: Bonsucro, ProTerra and VIVE programs	International sustainability standards. Smartcane BMP is recognised by Bonsucro as having full alignment and CANEGROWERS is strengthening alignment of Smartcane with Bonsucro, ProTerra and Vive.	(SmartCane BMP, 2021) (Bonsucro, 2021); (Proterra, 2021)
Sugar: Coca-Cola Amatil (CCA)	Under purchasing contracts running to 2021, CCA purchases will be a mix of Smartcane BMP and Bonsucro certified sugar. Implementing Smartcane BMP could benefit growers by between A\$25-220/ha/year.	(Lucio, 2019)
Sugar, horticulture: Great Barrier Reef water quality compliance	Smartcane BMP accreditation is formally recognised as an alternate pathway to compliance under the Queensland Government's Great Barrier Reef regulations in relation to water quality.	Queensland Government, 2021)
Dairy: Fonterra supply chain incentive	As part of Fonterra New Zealand's broader sustainability plan, a co-operative <i>Difference Payment</i> of up to 10c/kg of milk solids can be secured if the farm meets on-farm sustainability and value targets.	(Fonterra, 2020); (ISO, 2021)
Dairy: Coles supply chain initiative	Investment in on-farm sustainability initiatives, as a part of new direct sourcing agreements for Coles Brand fresh white milk. Transparent contracts that include a minimum farmgate price until June 2023.	(Coles Group, 2020)
Cotton: Better Cotton Initiative global sustainability standard	Since 2014, many Australian cotton growers have been able to negotiate a premium for their Better Cotton Claim Units, ranging from \$3-\$8/bale (in 2014/15). Over 2019/20 season, some growers negotiated a small premium for <i>myBMP</i> /Better Cotton, but generally, this was harder to achieve than in previous seasons due to increasing global supply. In the program's early days, BCI premiums were at one time reaching 30%-40% (in the global market) but declined over time.	(<i>myBMP</i> , 2021) (Better Cotton Initiative, 2021); (McConnel, 2021) (Cotton Australia, 2020) (Brown et al., 2015)
Cotton: Good Earth Cotton	Traceable, sustainably-produced, carbon positive cotton. Premium's and grower certification unknown.	(Good Earth Cotton, 2021)
Cotton: Oritain technology, Country Road partnership	Oritain assures provenance. Used in Country Road's Biodiversity Project Australian Grown Cotton Heritage Sweat campaign	(Oritain, 2021) (Auscott, 2021) (Country Road, 2021)
Cotton: insurance incentive	A premium discount offered by Achmea for its All-in-One Farm Pack to eligible cotton farmers who are certified through the <i>myBMP</i> program	(Achmea, 2021)
Horticulture	Carbon Friendly produce – achieving carbon neutrality or carbon positive status and the generation of carbon inset credits (CiC) which can be on-sold through the value chain (1 CiC is 1 kg CO ₂ e)	(Carbon Friendly, 2021)
Sugar, horticulture	Reef Credits rewards abatement of pollution (including nitrogen) at the edge of the Great Barrier Reef system. In 2020, HSBC purchased (at \$36.40 per credit) the first tranche of reef credits. One reef credit is equivalent to one kg N, or 538 kilograms of sediment avoided.	(Eco-markets Australia, 2021)



Analysis of farm level economic benefits

Aim

To review and assess the theoretical environmental and economic benefits, as well as associated additional costs, of implementing N BMPs on farm under a farming enterprise audit certification that pays a 1% product premium. This study builds upon the MPfN Program recommendations of Antille and Moody (2021) who examined a methodology for determining the Most Economic Rate of Nitrogen (MERN) and its subsequent influence on improved adoption of N BMP.

Method

An investment analysis was used to evaluate the longer-term economic benefit, as well as associated costs, of on-farm N BMP adoption in the context of participating in a certification scheme, across the four MPfN Program industries of cotton, sugar, dairy and horticulture (cherry and mango tree crops).

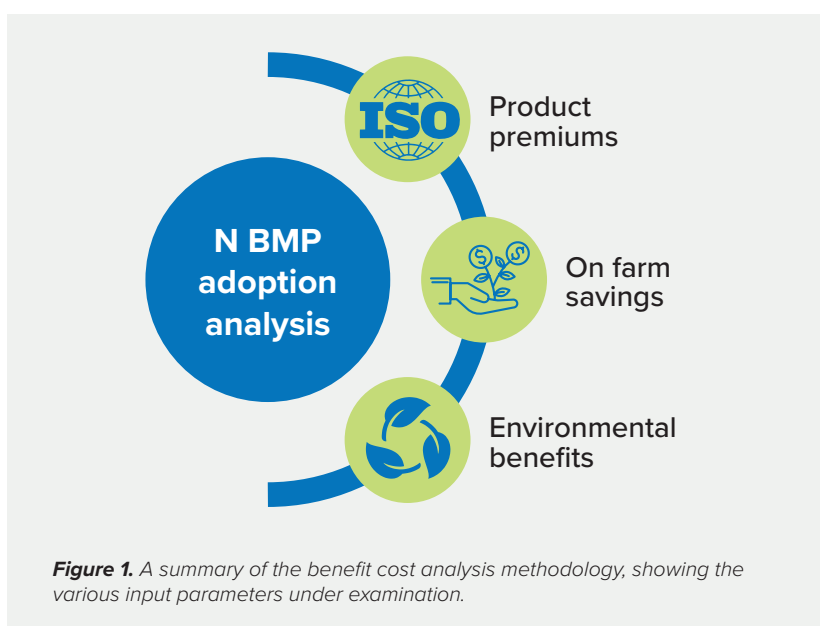
The decision on whether a farming enterprise should consider investing in N BMP recommendations, identified through the MPfN Program research findings, can be informed by applying performance metrics that compare new or updated N BMPs with a business-as-usual scenarios. For example, a positive net present value (NPV), Internal Rate of Return (IRR) can demonstrate a viable investment or benefit resulting from participation in a sustainability focused certification scheme (Malcolm et al., 2005).

The assessment required a stepped process, outlined in detail below.

A change in GHG emissions, as a result of investing in N BMPs, were used to calculate social costs and benefits (Sinden and Thampapillai, 1995). Social-cost is the cost to society resulting from an event, an activity or a change in policy (khan, 2016). This section provides an overview of the analyses to evaluate the trade-offs relating to the adoption of N BMPs at the farm level for MPfN Program industries. The overall benefit-cost analysis is divided into three sections:

- (1) Product premiums and audit costs;
- (2) On-farm N use savings; and
- (3) GHG modelling.

Figure 1 (on the right) shows the components of the investment analysis framework



Approaches to measuring changes in farm practice

The main task for farm business management is to analyse the options for change to increase the productivity and profitability of the business. This process, identified by Malcolm et al. (2005) involves:

- (1) Identifying innovations;
- (2) Imagining alternative futures; and
- (3) Judging alternative futures against criteria of feasibility, likelihood and contribution to achieving goals.

Discounted Cash Flow (DCF) analysis involves budgeting all expected flows of both economic and social benefits provided, and the costs incurred, when they are expected to occur, then adjusting these to present day values (Sinden and Thampapillai, 1995). DCF can be used at the whole farm level or enterprise level. In the case of analysing N BMP use, the primary focus was on investment analysis at the enterprise gross margin level, using the DCF method, over an assumed 25-year period and a discount rate of 5 per cent (Rural R&D Corporations, 2018). Benefits and costs are calculated and reported as NPV, IRR or Benefit-Cost Ratio (BCR).

A DCF (rather than a partial budget) was used to account for setting-up the program certification system over the long-term and account for likely changes in environmental policy and market prices.



Representative farm analysis and assumptions

Cotton analysis used a change in N application rate to a MERN calculation, using a sample of industry N use data. The current average N application rate is an average derived from data collected over the most recent five-year period, as published in the Cotton Grower Practice Surveys (CRDC, 2016-2020). The rotation from the average farmed area consists of a cotton-wheat rotation with 50% of the farmed area planted to cotton annually. Yields and lint prices were drawn from the latest cotton industry gross margins (Powell and Welsh, 2019). The emissions calculation is based on the non-linear equation with the difference between 300 kg N/ha and 230 kg N/ha (MERN) applied.

Sugarcane N use assumptions vary in production systems including irrigated, semi-irrigated and rainfed systems - each with differing yields and N fertiliser response. The case study focus was a change from *business as usual* to Smart Cane Best Management Practice (SmartCane BMP, 2021), and MERN framework from MPfN Program research. Sugarcane prices and yield assumptions were derived from the DAF (2021) Farm Economic Analysis Tool (FEAT). Assumptions also included a fallow/cane rotation every seven years at which point sugarcane is not grown and output throughout the DCF time series is adjusted accordingly. The non-linear Emissions Factor (EF) curve was used to calculate a 40 kg N/ha reduction from the sample rate of 200 kg N/ha.

Dairy farming occurs across both temperate and tropical locations, each with unique combinations of pastures and N use. The farm production data is underpinned by DAF (2020) annual benchmarking analysis. The avoided N use is broadly aligned with MPfN Program (2021) case study findings (Revell, 2021b). EF assumes medium intensity irrigation on pastures with applied N fertiliser.

Cherry EF was derived from temperate deciduous cropping research. Gross margin assumptions relate to an established 10 ha Tasmanian irrigated system (Tasmanian Government, 2021).

Mango MPfN Program related production figures were used to assume a 10 kg N/ha reduction on a 43 ha Northern Territory irrigated system.

The study product premium of 1%, and audit cost assumptions, were standardised across five enterprises. A summary of inputs into the DCF and associated references are shown in Table 2.

Table 2. Model assumptions into the discounted cashflow analysis: Avoided N, Emissions Factors, Avoided N₂O, Average Farm Size, Enterprise Gross Revenue (\$/ha) and reference source.

	Avoided N (kg/ha)	Emissions Factor	Avoided N ₂ O (kg/ha)	Average size farm (ha)	Enterprise gross revenue (\$/ha)	References
Cotton	70	1.9%	1.6	495	\$6,240	Antille and Moody (2021), CRDC (2016-2020), Strong (2021), Grace et al. (2016)
Sugar	40	1.99%	0.76	56	\$3,900	QDAF (2021), Connolly et al. (2018), QFF (2021), Grace et al. (2017)
Dairy	50	0.49%	0.25	75	\$18,186	de Klein et al. (2017), Rowlings et al. (2021), Murphy et al. (2020), Revell (2021b)
Cherries	29	0.15%	0.15	10	\$156,250	Tasmanian Government (2021), Pandeya et al. (2020), Swarts et al. (2016), Revell (2021a)
Mangoes	10	1.6%	0.16	43	\$14,892	Huang et al. (2012), Rowlings et al. (2013), Gu et al. (2019), Dirou (2004), Australian Mangoes (2021)

Emissions factors increase exponentially above a certain N rate. A reduction from over application can lead to substantial emissions abatement, reduce variable costs and lead to higher profits.



Agricultural production certification audits vary, and scale is also a cost factor. For reference, known auditing costs for farm production systems include \$3,000 for myBMP cotton (Levels 1-3) (Statham, 2021), Sustainable Grain Australia (\$10,000 initial and \$4,000 annual) (Australian Oilseeds Foundation, 2021), audits for Emissions Reduction Fund (ERF) in cotton are as high as \$19,000 per landholder per annum (Welsh et al., 2015), and ERF methodology in livestock audit costs are approximately \$13,250 initial fee and \$10,000 annual fee (Cohn, 2015). In this study, assumed audit costs of certification was modelled using a \$10,000 initial fee and a \$5,000 annual fee.

The assessment considered change in emissions at the farm gate under a business-as-usual scenario compared with an N BMP certification scenario. The price of carbon of \$16/tCO₂e used was from the most recent ERF auction (Clean Energy Regulator, 2021).

Results and discussion

The results of the completed assessment are shown in Table 3, illustrating the outcomes of adopting an N BMP certification over a 25-year period. N rates (kg N/ha) were adapted to reduced levels recommended for specific research sites, or where stipulated, region or industry, from research findings of the MPfN Program. Results vary significantly across the industries.

A high-value crop such as cotton found achieving a one per cent premium for cotton lint easily outweighed BMP certification costs, as did cherries, dairy and sugar. Under the assumptions used, adoption among the five industries showed an immediate payback with significant IRR. However, a small reduction in N use (from sample rate to optimised) made little difference in the mango farm N BMP certification scenario.

Abatement cost to the consumer is calculated by dividing the premium per hectare amount by the emissions to better understand CO₂e market values and enable comparisons with other valuations. The analysis found carbon abatement results well above the average price of \$16/tCO₂e offered in the Australian Governments ERF reverse auction. The public benefit applies the ERF average price to emissions abatement calculations to examine per hectare public benefits.

Table 3. Results from the DCF analysis of a 1 per cent product premium for N BMP certification

	Payback period	Internal Rate of Return (IRR)	NPV/ha	NPV/farm	Abatement cost to consumer (ha/annum)	Public benefit: avoided CO ₂ e @ \$16/t/ha/CO ₂ e/yr
Cotton	Year 0	393%	\$1,022	\$505,747	\$187/tCO ₂ e	\$4 /ha
Sugar	Year 1	45%	\$459	\$43,385	\$448/tCO ₂ e	\$2 /ha
Dairy	Year 1	75%	\$1,124	\$84,304	\$2,283/tCO ₂ e	\$1 /ha
Cherries	Year 0	110%	\$11,406	\$114,060	\$9,801/tCO ₂ e	\$3 /ha
Mangoes	Year 5	9%	\$37	\$1,607	\$3,448/tCO ₂ e	\$0.40 /ha

An on-farm N certification scheme with a 1% market premium has the potential to change the shape of the traditional marginal response curve of N and simultaneously deliver profit to the farm enterprise.



Conclusion

Trade in global goods is becoming increasingly aware of environmentally responsible farm production as evidenced by the rise in certification schemes. Markets and consumers demand more action from industries in addressing emissions, and N fertiliser use does significantly contribute to product carbon footprints.

This study introduced a new paradigm for profitable N BMP adoption in the cotton, sugarcane, dairy and horticulture industries of the MPfN Program. A 1% product premium is achieved from N BMP use. When assuming a \$10,000 initial and \$5,000 ongoing audit cost on an average-sized farm, adopting a theoretical N BMP certification showed significant economic returns and immediate payback, particularly in high-value (per ha) crops such as cotton and cherries. When N use was more than the framework NUE, as proposed by Antille and Moody (2021), it was economic and public benefits that remained the highest. Crops using small amounts of N, such as Mangoes, found only modest economic and public benefit from improved NUE and product certification premiums.

This study provides valuable, high-level insights to industry and extension specialists who report low participation in BMP programs as well as policy officers and supply chains seeking to incentivise more sustainable production of agricultural goods.

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FURTHER INFORMATION

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