BLUE CARBON PROJECT
"DUCK CREEK RESEARCH STATION"
FARM BUSINESS ANALYSIS

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Project Details:

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List of Abbreviations:

AH	**Animal Health**
ADG	**Average Daily Gain**
AWS	**Automatic Weather Station**
BRD	**Bovine Respiratory Disease**
CWT	**Carcass Weight**
DPI	**Department of Primary Industries**
EYCI	**Eastern Young Cattle Indicator**
FTE	**Full Time Employee**
GM	**Gross Margin**
ha	**Hectare**
hd	**Head**
kg	**Kilogram**
KPI	**Key Performance Indicator**
LW	**Liveweight**
MLA	**Meat Livestock Australia**
NDF	**Neutral Detergent Fibre**
NSW	**New South Wales**
WRL	**Water Research Laboratory**
WT	**Weight**

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Scope:

Rumesearch Pty Ltd was engaged to generate an economic evaluation of the NSW DPI property “Duck Creek Research Station” on the basis of its use as a commercial beef grazing property, a research grazing property and in light of an increase in sea level over time.

"The Point Paddock" is being assessed for its suitability as a blue carbon project using the tidal restoration method, subject to successful registration with the Clean Energy Regulator. An extension of this analysis is to demonstrate the cost of a reduction in grazing area to the business. This data can then be used by DPI to help inform decision making regarding the suitability of registering The Point Paddock as a blue carbon project under the Emissions Reduction Fund with the Clean Energy Regulator.

The analysis is restricted to current business operation and does not seek to evaluate all potential uses of land to potentially increase economic returns (for example, cropping, horticulture etc.).

Outcomes from this analysis maybe used within extension services to compare the relative return for grazing land versus a conversion to carbon credit sequestration. A variable that is difficult to control overtime is the variation in both input costs and the price of cattle per kg. However, the cattle price is somewhat controlled by the trading nature of the operation.

Executive Summary:

The commercial business for the Duck Creek Research Station property run as a steer backgrounding operation turning over cattle approximately every six months demonstrates that the property is relatively profitable at $1,223 / ha. When not required for research operations it is advisable that the property is conducted in this manner with a focus on the KPI’s given in Table 4 to ensure the calculated level of profit is achieved.

As shown in Table 1, conducting agricultural research on the property severely restricts the profitability of the enterprise, however, the scope of this analysis does not allow for evaluation of other benefits to the organization. Research work is more intensive and requires greater flexibility, severely restricting the amount of animals that can be produced on the property.

As The Point Paddock will be resumed for the Blue Carbon project the reduction in productivity and profitability was performed (Table 1). The reduction of approximately 8% of the grazing land has approximately 14 % reduction in profitability due to the effect of fixed costs.

Increases in sea level height and the commensurate reduction in drainage was modelled on productivity and profitability of the commercial business plan. The reduction in profitability was profound, with the largest drop in the first 30 years and a small, but still significant drop in profitability when projected out to 2100. The initial increase in sea level has a dramatic effect on the land class, with much of the highly productive well drained land becoming land susceptible to waterlogging and periods of little to no production.

Table 1 - Summary of production model for Gross Margin (GM) calculations

	Commercial GM	Commercial GM minus The Point Paddock	Research GM	Research GM minus The Point Paddock	Commercial GM 2050	Commercial GM 2100	Duck Creek Research Station Costs - no Agriculture
$ Total	$171,250	$147,064	$89,878	$68,924	$24,204	-$30,201	-$172,430
$ / Ha	$1,223	$1,050	$642	$492	$173	-$216	-$1,232

Finally, it is important to demonstrate the cost of no agricultural activity at all. Even the projections of sea level rises in 2100 still did not mean running backgrounding beef cattle on Duck Creek Research Station was economically futile. The commercial GM for 2100 showed an effective offset of fixed costs of approximately $1,000 / ha. The cost of managing Duck Creek Research Station in a non-agricultural state is not insignificant and was demonstrated to be approximately $1232 / ha. While it is noted this number is not directly applicable to The Point Paddock due to site specific reasons it is perhaps a more accurate number of what many sites may cost to manage if they are put into a non-agricultural state.

In summary, the cessation of grazing The Point Paddock would cost a commercial beef operation approximately $24,186 / year in lost profit. However, as research is undertaken at the Duck Creek Research Station, the loss is proportionately less at $20,954.

1. Commercial Business Plan:

1.1 Description of business and activities:

The property “Duck Creek Research Station” is a beef backgrounding (or growing) property located on North Coast of NSW, near Ballina. The property is a good example of highly productive, arable flood plain grazing. It utilizes a combination of sub-tropical pastures and rye grass over sowing for winter production.

The existing property managed by NSW DPI is approximately 190.8 ha (based on Valuer General data). Almost 19 ha of existing mangrove areas already occur at the site. Mangrove trees persist throughout the property where protected from cattle. Other areas are utilized for riparian zones, roads, housing and storage. This leaves an approximate area of 140 ha of effective pasture for animal production.

Over the years the business has fluctuated between commercial and research grazing operations. The property has adequate facilities for conducting research (secure fencing, laneways and efficient yards). However, research requires considerably more flexibility and management than a commercial cattle operation. This means that less animals can be run under research conditions.

The property contains highly fertile soils and a very high rainfall of approximately 1864.7 mm (Ballina Airport AWS) with a moderate summer/autumn dominance (wettest March and driest September). However, when this is combined with a reduction in evaporation during winter there is on average more than adequate moisture for winter grass species (typically annual rye grass *Lolium perenne*) to be over-sown into summer grass dominant pastures (Setaria, *Setariasetaria sphacelate*, Kikuyu *Pennisetum clandestinum,* Blue Couch, *Cynodon dactylon*).

As a commercial operation the business is able to grow young beef animals from weaning weights (~265 kg.LW) to feedlot entry weight (~465 kg.LW) in approximately 6 months. With two intakes of cattle during the year. Under scientific conditions only one rotation of animals due to the flexibility required when conducting research work.

Pasture management consists of forage conservation in Autumn, sowing and mulching of annual rye grass in tropical grass in late autumn. Fertilisation of annual rye grass throughout winter and spring and mulching/slashing of tropical grasses as required to maintain quality during summer. As well as the usual weed management, drain maintenance and occasionally resowing of summer pastures if damaged by flooding or overgrazing.

Livestock management consists of rotating through pastures to maintain optimum grass quality. Pest management, including application of anthelmintics for intestinal worms (predominately *Haemonchus* and *Cooperia*), application of fly repellant ear tags for the control of Buffalo fly (*Haematobia irritans exigua*). Plus, the usual animal husbandry practices required for large numbers of young animals (respiratory disease, infections and injuries). Regular weighing of livestock is required to ensure market specifications are reached accurately and no overweight cattle are produced.

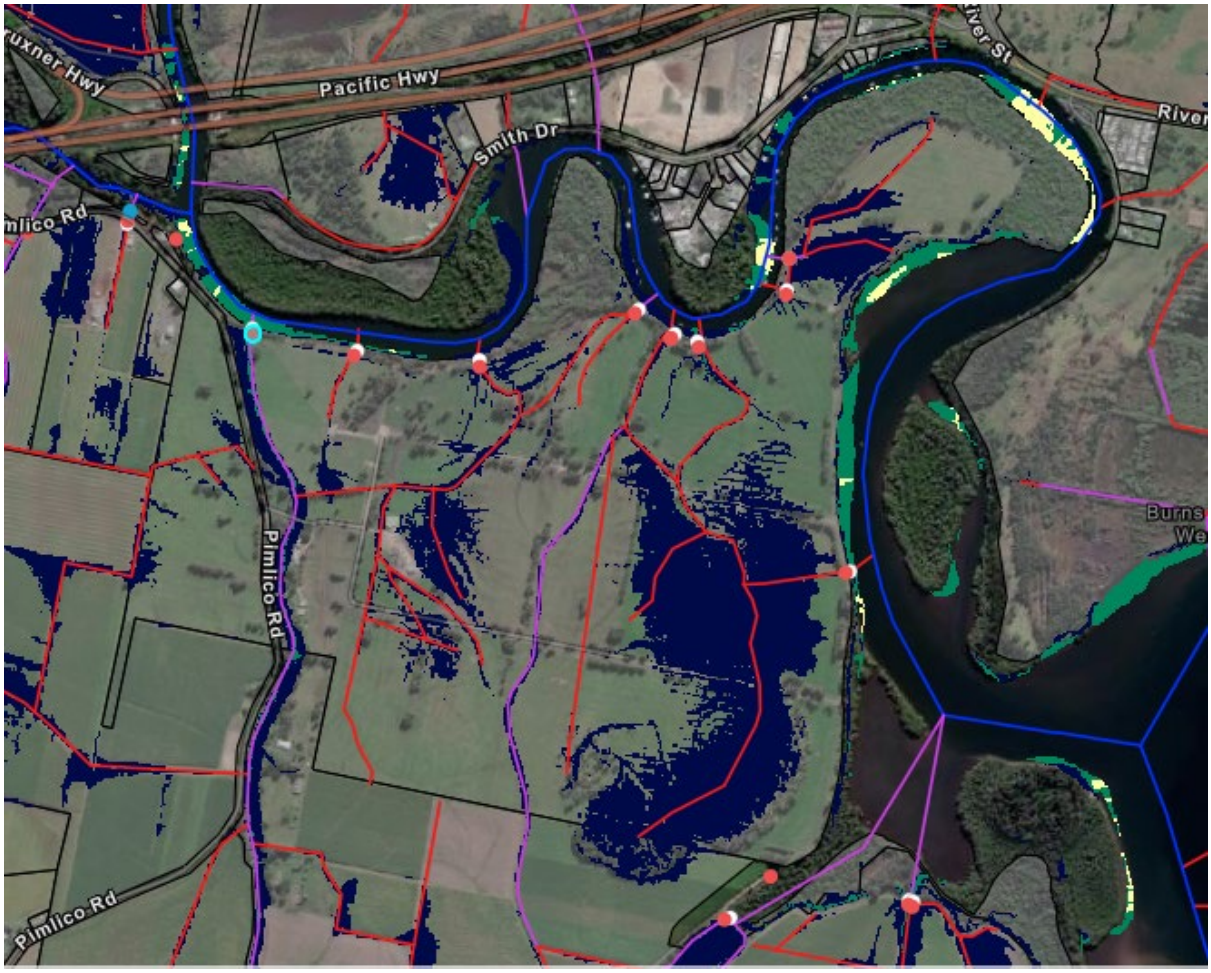

Figure 1 Present day (2020) areas at Duck Creek Research Station susceptible to poor drainage (adapted by NSW WRL from Figure 8-34 in Harrison et al. 2023).

Figure 1 was used to assess the proportions of Duck Creek Research Station that were classified into 3 land classes;

1) High – well drained, only subject to inundation during a levee breach flood event. Rarely saturated. Grows kikuyu and *Setaria* as well as optimum yields of annual rye grass.
2) Medium – well drained, but susceptible to water logging when flood gates are impacted by high estuary levels. Can be due to local rain, riverine flooding or a combination of both. Moderate levels of water logging are reflected by lower yields of grass and subsequently lower kg of weight gain.
3) Low – poorly drained. Due to either soil quality (heavier clay, proximity to drains, elevation or distance to flood gate), often may grow couch instead of kikuyu or *Setaria*. Is more susceptible to losses of annual rye grass due to water logging and is reflected in growth rates and lower weight gains. (dark blue in Fig. 1).

An audit of the property to compare the actual grass species with the NSW Water Research Laboratory sea level rise drainage vulnerability mapping (Figure 1) was conducted with the assistance of the property manager and found that they were reasonably reflective of the pastures. However, due to the dry autumn (2023) the audit of the grass species may have underestimated the negative effects of water logging.

1.2 Gross Margin for backgrounding cattle:

A commercial gross margin for backgrounding cattle in prepared in Table 1. The exercise has used standard contracting values for pasture activities such as forage conservation, mulching, seeding and fertilizer and can be seen in Annexure 1. While this understates the profitability of the operation (as a profit is factored into the contracting business) it does simplify comparisons of operations when different levels of activities are incorporated into various operations.

The gross margin for commercially backgrounding cattle forms the base model for further comparisons within this report. The challenge with presenting this gross margin is the massive variation in cattle price over the last five-year period (2019 to 2023). The EYCI (eastern young cattle indicator) over this period has seen a greater fluctuation than any other period during its inception. Over this period the EYCI was at a low of 385 c/kg.cwt on the 12/3/2019 and a peak of 1191 c/kg.cwt on 24/01/2022, as of 15/05/2023 the EYCI has dropped to 609.28 c/kg.cwt (courtesy MLA). The prices for purchasing and selling of livestock was taken at an approximate EYCI of 700 c/kg.cwt which was reflective of prices during March and April 2023.

While a high EYCI is more likely to increase the returns for the cattle backgrounding operation it is not always the case and any increase in return is not reflective of the magnitude of the EYCI fluctuation. This is due to the association of weaner price and feeder steer price with market moves. As the EYCI increases the weaner price increases more than the feeder steer price, this means that much of the increase return in income of weight gained is lost due to selling the initial weight of the animal at a deduction (Table 2 - Example A).

Conversely as the EYCI decreases the price of weaner animal decreases to equal too and often less than the price of the feeder steer. Meaning that there is little or minimal deduction on the liveweight of the animal bought in (Table 2 - Example B).

Table 2 - A comparison of steer trading margin during periods of high and moderate cattle prices

Example	EYCI	Weaner wt	Value	Feeder wt	Value	Trading Margin
	c/kg.cwt	kg	c/kg.lw	kg	c/kg.lw	$ / hd
A	1,000	265	700	465	550	$702.5
B	600	265	400	465	380	$707.0

In terms of managing market fluctuations in cattle price the mantra for trading stock and economic analysis of the business is to compare the replacement cost of the animal instead of the starting price and finishing price of the animals. For example, the business owns 100 steers and sells them on March 15th for $2,000 / hd after purchasing them the previous October for $1,000, the business purchases 100 replacement weaners for $1,500 / hd. How much did the business make on this trade? If comparing on individual animal basis the answer is $1,000, however, a more accurate assessment is the replacement cost of $500.

The replacement cost process works very well in steady state production systems. Which is what would occur at Duck Creek Research Station if it was not for research obligations. The challenge with jumping in and out of the market means that the cost of research is higher than just the upfront costs of analysis, measurement and management.

A commercial steer trading operation of this size would typically employee one full-time employee, but not as a stand-alone operator. Duck Creek Research Station as an individual entity would be considered too small for one full time employee and it would much more likely integrated with other properties, most likely a breeding property. Many of the jobs would likely require more than one operator to be successfully undertaken (drenching, drafting, fencing). In total one full time employee (FTE) is required, and the position is budgeted as so. The provision of a full-time employee also allows for basic maintenance, security, pest control (e.g. Fire, ferals, foreigners provision).

Infrastructure maintenance is set at a total value of $500,000 with a replacement every 20 years. This is less than the current capital allocation on Duck Creek Research Station, however, more in line with a commercial property of this size. Infrastructure maintenance encompasses the replacement, repair and depreciation of fixed assets such as houses, boundary fences, roads, water infrastructure, sheds, cattle yards and associated facilities. For example, the current set of cattle yards is worth approximately $200,000 and will need replacing every 20 years, this facility has already incurred close to $100,000 in repairs and improvements within the last 5 years.

Table 3 - Gross margin for Duck Creek Research Station run as a commercial steer trading enterprise.

Variable Cost	kg	Head	$	$ / Head	Full Year $
Weaner steer purchase	265	918	4.4	1,166	1,069,825
Freight to property		918		15	13,763
AH Costs induction		918		15.3	14,038
AH Ongoing		918		18.1	16,607
AH Therapeutic	0.05	46		45	2,064
Mortality loss	0.005	5			
Morbidity loss	0.01	9			-10,698
Supplement silage	100	918	0.220	22	20,185
Supplement feed	100	918	0.500	50	45,876
Pasture costs					80,850
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE%	0.25	Sal + OnC	120,000	30,000
Stock management (Labour)	FTE%	0.75	Sal + OnC	120,000	90,000
Farm vehicles expenses					25,000
Electricity + water					12,000
Fencing/yards					11,770
Infrastructure maintenance (houses etc.)	Cap Value	500,000	Ann. Maint	10%	50,000
Fire, ferals, fences					0
Livestock selling	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight		97,502
Total cost					**$1,593,782**
	kg	**Hd**	**$/kg**	**$ / hd**	
Livestock sales	465	904	4.2	1,953.00	1,765,032
					171,250
		Total ha	**140**	**$/ha**	**$1,223**

1.3 Financial targets:

The gross margin presented in Table 2 shows a profit of $1,223 / ha. This would be considered very high for grazing properties but is reflective of the very high carrying capacity of this property. There is an approximate trading margin of $700 when the initial financial analysis was conducted in April 2023. While there are opportunities for greater trading margins (June 2023 is considerably larger) a margin of $600-700 is considered to be reflective of long-term weaner to feeder steer trade (pers coms. David Farrell, Farrel McCrohon Stock and Station agency principal).

The Duck Creek Research Station property suffers from flooding that is greater than a 1 in 50 flood event. It is largely protected by levee banks but they will be topped in large events such as March 2022 flood event. From a commercial point of view this event will completely remove one cycle of steers. Dramatically cutting profitability. However, this is rare. More likely is continued wet weather and low-level riverine flooding that will severely impact drainage. The time of year this occurs is critical to its impact on productivity, with excess summer pasture meaning that the loss of low-lying pastures between November and April will be of little consequence. However, between May and October this will have much more serious economic implications. This could be considered to occur once every 10 years.

The Duck Creek Research Station property is less likely impacted by droughts as the mean rainfall is excessive to requirements. While they can occur, seldom do they result in lost production.

1.4 KPI generation:

To achieve the financial targets demonstrated in section 1.3 there are several key performance indicators (KPI) that are required. These are presented in Table 4.

Table 4 - KPI for meeting budgeted production targets as a commercial steer trading operation

KPI	Value	Target
Summer ADG	Kg / day	> 0.7
Winter ADG	Kg / day	> 1.2
Morbidity	% of purchased cattle	< 0.5
Mortality	% of purchased cattle	< 1
Winter pasture growth rates	Kg / day	> 38
Summer pasture quality	Neutral detergent fibre %	< 60

2. Non Agricultural Farm Management costs:

An analysis of the cost of occupying land was undertaken for use in understanding the implications of ceasing all grazing/agricultural activities on Duck Creek Research Station. The potential for generating income from carbon sequestration methods means that this is starting to be a commercial farm management structure with non-traditional income. However, there is an existing cost base associated with land that is often neglected when comparing returns from carbon projects.

2.1 Fire, ferals and fences program:

The title of this section (Fire, ferals and fences) is a small insight into the challenges of occupying land without actively managing an agricultural resource. A regular farm manager deals with the three Fs as a part of everyday business. Typically, control of all 3 is as simple as just being “present”.

Existing agricultural entities such as Duck Creek Research Station have a presence amongst the surrounding agricultural neighbourhood. An absence of agricultural activity means that there is no longer a reason for a presence that deters feral animals and weeds, is present to control a fire, maintains fences in case of breaches or just the presence alone discourages trespassers.

This essentially means that a property the size of Duck Creek Research Station requires a caretaker and that this has associated costs. Also, the property has significant physical assets with residual value (houses, sheds etc.), this will be the case when looking at most agricultural holdings. The GM in Table 5 seeks to capture the cost of occupying Duck Creek Research Station for non-agricultural activity. Perhaps this is a combination of Blue Carbon and forestry for carbon.

The area of weeds requires a little more clarification. There are many noxious weeds that require control. Cattle are an effective control agent for many of them (Bitou Bush *Chrysanthemoides monilifera* is a prime example). The removal of cattle will mean a likely invasion of weeds that will require a control program. These costs have been incorporated into the Fire, ferals and fences section.

Table 5 – Gross margin for occupying Duck Creek Research Station without Agriculture.

Variable cost	kg	Head	$	$/Head	Without Livestock
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE%	0.25	Sal + OnC	120,000	21,250
Farm vehicles expenses					25,000
Electricity + water					4,000
Fencing/yards					4,680
Infrastructure maintenance (houses etc.)	Cap Value	500,000	Ann. Maint	10%	50,000
Fire, ferals, fences					42,500
Total cost					**172,430**
No Livestock sales					0
					-172,430
		Total ha	**140**	**$/ha**	**-$1,232**

All other fixed costs (e.g. rates, insurance etc.) have been kept the same as in previous GMs. The cost of occupying the land is approximately $1,232 / ha. This number could be used as a guide to the cost of ceasing agricultural operations on a given portion of land. In the case of The Point Paddock, the number is excessive as The Point Paddock does not have any neighbors that it will affect. It only requires minimal boundary fencing (approximately 125 m). Furthermore, the Blue Carbon methodology where it is effectively implemented will likely take care of the weed burden on the majority of the land.

3. The effect of the loss of The Point Paddock on the Duck Creek Research Station business plan:

3.1 Effect on productivity:

The loss of available land for a grazing entity increases the cost pressure on fixed costs such as assets, labour and working capital. To analyse the effect of converting The Point Paddock from grazing to blue carbon a scaled gross margin was conducted which demonstrated the effect of reducing cattle turnover with the only saving the reduction in hectares of pasture managed.

As land available for growing grass decreases the amount of animals that the property can run decreases. This cannot be offset profitably by purchasing in feed or increasing the grass growth on existing land as it is already modelled to be producing at its most effective rate.

The land in The Point Paddock is considered less productive due to its proportion of high, moderate and low being more skewed to low than the average of the property. Furthermore, The Point Paddock is only protected by a low-level levee system and not the main levee system which is maintained by local government. As such The Point Paddock was assigned a much lower level of productivity than the average of the remaining land at Duck Creek Research Station.

The productivity model was adjusted by land class with a commensurate reduction in stock numbers.

3.2 Effect on overall profitability of commercial business:

A revised GM for Duck Creek Research Station was conducted with the absence of The Point Paddock (Table 6). All direct costs associated with livestock were reduced *pro rata*. Pasture costs were reduced in respect to the hectares no longer being used in The Point Paddock (12 ha). All other costs are fixed in reflection of whether The Point Paddock is or isn't available for grazing.

The revised GM demonstrated a reduction in margin from $171,250 down to $147,064.

Table 6 – Duck Creek Research Station gross margin without The Point Paddock

Variable cost	kg	head	$	$ / Head	Full Year
Weaner steer purchase	265	860	4.4	1,166	1,002,691
Freight to property		860		15	12,899
AH Costs induction		860		15.3	13,157
AH Ongoing		860		18.1	15,565
AH Therapeutic	0.05	43		45	1,935
Mortality loss	0.005	4			
Morbidity loss	0.01	9			-10,027
Supplement silage	100	860	0.220	22	18,919
Supplement feed	100	860	0.500	50	42,997
Pasture Costs					73,920
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE %	0.25	Sal + OnC	120000	30,000
Stock management (Labour)	FTE %	0.75	Sal + OnC	120000	90,000
Farm vehicles expenses					25,000
Electricity + water					12,000
Fencing/yards					11,770
Infrastructure maintenance (houses etc.)	Cap Value	500 000	Ann. Maint	10 %	50,000
Fire, ferals, fences					0
Livestock selling	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight		91,383
Total cost					**1,507,209**
	kg	**Hd**	**$ / kg**	**$ / hd**	
Livestock sales	465	847	4.2	1,953.00	1,654,273
					147,064
		Total ha	**140**	**$ / ha**	**$1,050**

4. Research Business Plan:

The variations in potential research programs on a property such as Duck Creek Research Station mean that generating a specific research business plan is unreasonable. However, there are several implications that can be easily ascertained and have been structured into the research gross margin (Table 7).

While Duck Creek Research Station is suitable for running beef breeders or preparing heifers for joining and calving, it is most accurate to compare Duck Creek Research Station on the basis of backgrounding cattle. The main difference between a commercial backgrounding operation and a research backgrounding operation are as follows;

- Flexibility, research programs typically need flexibility for start dates, finish dates, changes, specific pasture covers etc.
- Labour, research programs typically require more measurements, sample generation and analysis, specific treatments and monitoring.
- Security, the requirements for separating replicates is much more onerous than a commercial program.

The result is that the research business plan differs from the commercial business plan in two key ways;

1) There can only be one rotation of feeder steers for the year. This is because there needs to be flexibility around start dates, guaranteed pasture covers etc. also it is beneficial to have the property free of animals so there is improve biosecurity.
2) Labour requirements will double to two FTE plus an allowance for research consumables, testing etc.

To compensate for the above a research fee of $2 / hd / day is required. This does not fully compensate for the loss of turnoff of commercial cattle. However, there are other potential income streams that have not been included such as the harvest of pasture silage for sale or the potential to grow crops such as Soybeans, which would not interfere with the research priorities.

4.1 Effect on overall profitability of commercial business:

Table 7 – Duck Creek Research Station research gross margin

Variable cost	kg	head	$	$ / Head	Full Yr
Weaner steer purchase	265	459	4.4	1,166	534,912
Freight to property		459		15	6,881
AH Costs induction		459		15.3	7,019
AH Ongoing		459		18.1	8,304
AH Therapeutic	0.05	23		45	1,032
Mortality loss	0.005	2			
Morbidity loss	0.01	5			-5,349
Supplement silage	100	459	0.220	22	10,093
Supplement feed	100	459	0.500	50	22,938
Pasture costs					80,850
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE %	0.25	Sal + OnC	120,000	30,000
Stock management (Labour)	FTE %	0.75	Sal + OnC	120,000	90,000
Research expense (Labour)	FTE %	1	Sal + OnC	120,000	120,000
Research expense (Materials)	Sampling, Reporting, Office equipment	Sampling, Reporting, Office equipment	Sampling, Reporting, Office equipment	Sampling, Reporting, Office equipment	30,000
Farm vehicles expenses					25,000
Electricity + water					12,000
Fencing/yards					11,770
Infrastructure maintenance (houses etc.)	Cap Value	500,000	Ann. Maint	10%	50,000
Fire, ferals, fences					0
Livestock selling	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight		53,021
Total cost					**1,113,471**
	kg	**Hd**	**$ / kg**	**$ / hd**	
Livestock sales	515	452	4.2	2,163	977,410
Research income ($2 / hd.day)	2	452		904	225,939
					89,878
		Total ha	**140**	**$ / ha**	**$642**

5. Forward projection for sea level rises:

5.1 Impact of reduced drainage on productivity:

This economic evaluation was tasked with evaluating the productivity of the Duck Creek Research Station property in regards to forecast increased in the height of low tide with the subsequent impact this would have on drainage.

The Australian Bureau of Meteorology reports: 'Global mean sea level rise is accelerating. Tide gauge and satellite altimetry observations show that the rate of global mean sea level rise increased from 1.5 ± 0.2 cm per decade (1901–2000) to 3.5 ± 0.4 cm per decade (1993–2021). The dominant cause of global mean sea level rise since 1970 is anthropogenic climate change. http://www.bom.gov.au/state-of-the-climate/oceans.shtml

Recent work undertaken by the University of New South Wales Water Research Lab (Rayner et al, 2023) has collected information about NSW coastal floodplains to help landowners, local councils and the Government make decisions and adapt for climate change. The reports for each estuary can be found in the 'more information' of the Marine Estate Management Strategy project page https://www.marine.nsw.gov.au/projects/coastal-floodplain-study

Two future heights (+ 16 cm near future: 2050, and + 67 cm far future: 2100) were evaluated via gross margin analysis taking into account reduced productivity as the incidence of water logging increased. Figure 1 in section 1.1 demonstrates the amount of land considered at risk of reduced productivity due to water logging at present. After an inspection of the property this was calculated as 15 % of the 140 ha of pasture being considered class 3. With 60% being considered class 2 and 25 % class 1.

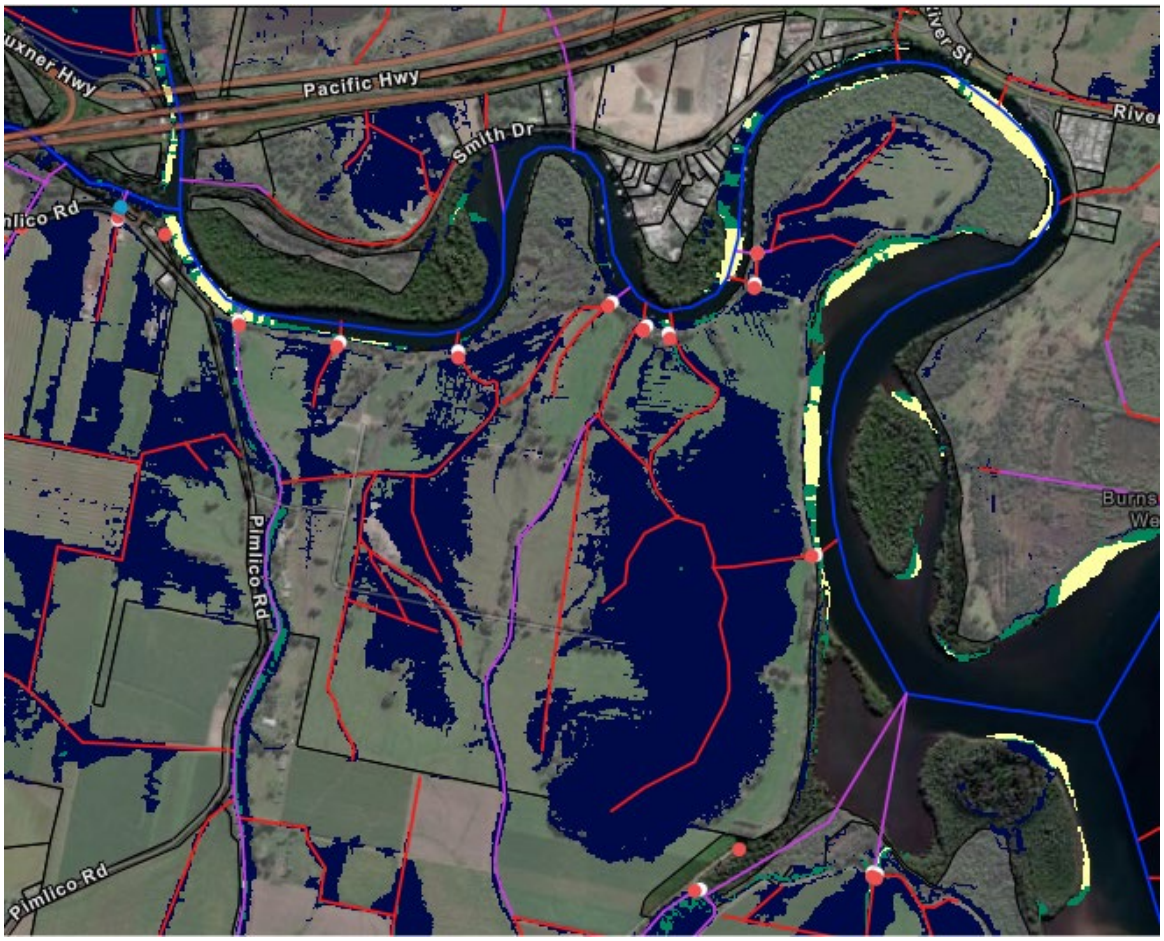

Figure 2 - Near future (2050) areas at Duck Creek Research Station susceptible to poor drainage (adapted by NSW WRL from Figure 8-34 in Harrison et al, 2023)

An estimation of the change of land class presented in Figure 2 had Land class 3 increasing from 15 % in 2020 to 67 % in 2050. The changes in land class for all 3 time periods (2020, 2050 and 2100) are detailed in Table 8. Figure 3 demonstrates the increase in water logging in 2100.

Waterlogging is most likely from late summer to early winter and severely reduces the ability to over-sow rye grass. The greatest determinant of productivity at Duck Creek Research Station is the amount of rye grass produced. That is because it has a much lower Neutral Detergent Fibre (NDF) than the tropical grasses, this factor significantly improves growth rates. An increase in water logging results in late plants or no planting of annual rye grass on affected land.

Ultimately, poor drainage will result in species growing that are unsuitable for even low rates of cattle production.

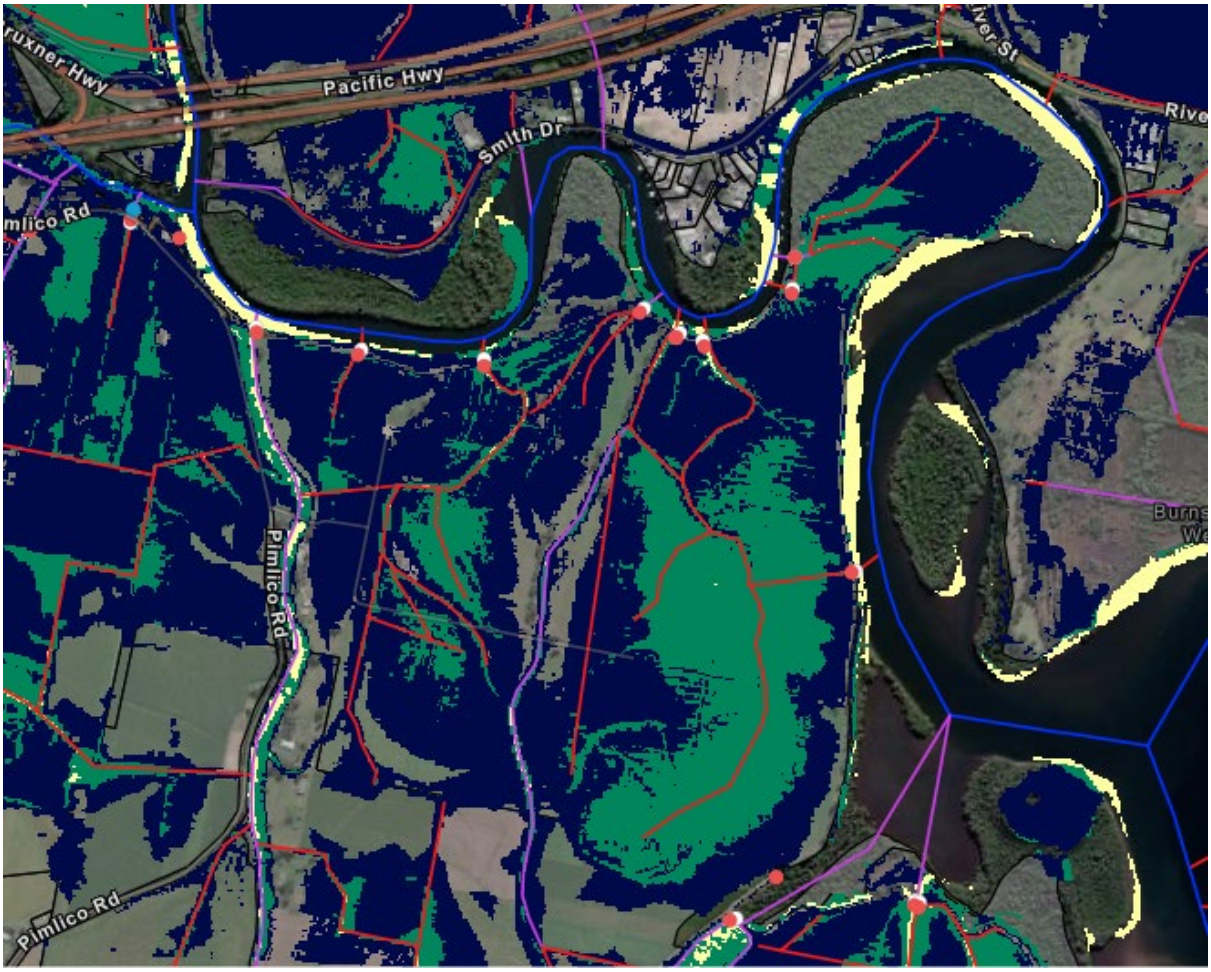

Figure 3 – Far future (2100) areas at Duck Creek Research Station susceptible to poor drainage (adapted by NSW WRL from Figure 8-34 in Harrison et al, 2023)

The assessment of 2100 suggests that 15 % of the land will become unusable for grazing in a regular manner. Perhaps there will be opportunities during dry times but this is too hard to quantify.

Table 8 - Distribution of land class as sea level rises

Land Class	2020	2050	2100
1) High	25 %	12 %	0 %
2) Moderate	60 %	11.5 %	25 %
3) Low	15 %	67.5 %	60 %
Non-usable	0 %	9 %	15 %

Table 9 – Gross Margin Calculation for Duck Creek Research Station with predicted sea level rise in 2050

Variable cost	kg	head	$	$ / Head	Full Year
Weaner steer purchase	265	632	4.4	1166	736,391
Freight to property		632		15	9,473
AH Costs induction		632		15.3	9,663
AH Ongoing		632		18.1	11,431
AH Therapeutic	0.05	32		45	1,421
Mortality loss	0.005	3			
Morbidity loss	0.01	6			-7,364
Supplement silage	100	632	0.220	22	13,894
Supplement feed	100	632	0.500	50	31,578
Pasture costs					73,342.5
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE %	0.25	Sal + OnC	120000	30,000
Stock management (Labour)	FTE %	0.75	Sal + OnC	120000	90,000
Farm vehicles expenses					25,000
Electricity + water					12,000
Fencing/yards					11,770
Infrastructure maintenance (houses etc.)	Cap Value	500,000	Ann. Maint	10%	50,000
Fire, ferals, fences					0
Livestock selling	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight		67,113
Total cost					**1,190,712**
	kg	**Hd**	**$ / kg**	**$ / hd**	
Livestock sales	465	622	4.2	1,953.00	1,214,921
					24,209
		Total ha	**140**	**$/ha**	**$173**

5.2 Impact of reduced drainage on profitability:

The projected sea level rise between 2020 and 2050 resulted in significant reduction in GM/ha from $1223/ha down to $173/ha. The primary driver for this is the large reduction in stocking rate as a consequence of lower grass production per hectare and poorer grass quality per hectare (the proportion of summer dominant water-logging resistant grass increases at the detriment of annual rye grass).

Costs associated with lower livestock numbers decreases, as do pasture costs, as there is less land available for pasture management (Table 10). Fixed costs and labour costs effectively stay the same, meaning that there is a large drop in profit margin.

Table 10 – Arable hectares by land class

Land Class ha	2020	2050	2100
1) High	35	17	0
2) Moderate	84	16	35
3) Low	21	94	84
Non-usable	0	13	21
Total Arable ha	140	127	119

A further projection of an increase in sea level out to 2100 shows a further dramatic drop in profitability. This is based on a further reduction in total arable land and a complete absence of the highly productive high land. This makes the site extremely vulnerable to waterlogging at all times.

The GM in Table 11 shows a negative gross margin. However, it is still more profitable than conducting no agricultural activity at all. One of the limitations of the analysis is that it does not allow for a switch in production systems. Under the current agronomic conditions trading steers is the most profitable grazing enterprise. However, it is likely that a breeding enterprise would be much more profitable if the property is subject to more regular waterlogging as the case would be in 2100.

Table 11 – Gross margin for Duck Creek Research Station with projected sea level height in 2100

Variable cost	kg	head	$	$ / Head	Full Year
Weaner steer purchase	265	522	4.4	1,166	608,884
Freight to property		522		15	7,833
AH Costs induction		522		15.3	7,990
AH Ongoing		522		18.1	9,452
AH Therapeutic	0.05	26		45	1,175
Mortality loss	0.005	3			
Morbidity loss	0.01	5			-6,089
Supplement silage	100	522	0.220	22	11,488
Supplement feed	100	522	0.500	50	26,110
Pasture costs					68,722.5
Rates					10,000
Insurance					15,000
Property maintenance (Labour)	FTE%	0.25	Sal + OnC	120,000	30,000
Stock management (Labour)	FTE%	0.75	Sal + OnC	120,000	90,000
Farm vehicles expenses					25,000
Electricity + water					12,000
Fencing/yards					11,770
Infrastructure maintenance (houses etc.)	Cap Value	500,000	Ann. Maint	10 %	50,000
Fire, ferals, fences					0
Livestock selling	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight	Agent, Transition Fee, Freight		55,492
Total cost					**1,034,828**
	kg	**Hd**	**$ / kg**	**$ / hd**	
Livestock sales	465	514	4.2	1,953.00	1,004,557
					-3,0271
		Total ha	**140**	**$ / ha**	**-$216**

6.0 Conclusion:

The series of financial analysis presented within this report are the outcome of pastures growth/animal growth models. This process enables the generation of future production systems under influence of projected changes in climate. In this specific case the defining factor is sea level rise.

The models demonstrate a declining profitability at Duck Creek as ocean levels continue to rise. It may be of interest that there are many grazing properties on the Macleay, Clarence and Richmond floodplains that would have drainage similar to the projected drainage in 2100. Many of the properties utilize breeder cattle to graze low quality forages and the properties are often integrated with higher land elsewhere in the valley to accommodate the inevitable flooding.

However, change in land use to accommodate the rise in sea do not negate the negative impact on the value of the land. At the moment Duck Creek is considered to be a stand-alone agricultural entity. This means that it is much more valuable than an entity that requires other land for it be run commercially. Changes in grazing patterns, as mentioned above, continue to permit traditional production systems and at a continuing devaluation as ocean levels continue to rise.

On the other hand, Blue Carbon methodologies allow for a change in land use practice that potentially show an increasing value as ocean levels increase. Changes in land use from traditional grazing to Blue Carbon methods permit an ability to capitalize on the changing climate conditions, allowing the ability to generate an income from carbon capture and eco-tourism.

This report demonstrates a significant diminishing return in traditional grazing practices as ocean levels increase at the Duck Creek site.

References

Harrison AJ, Rayner DS, Tucker TA, Lumiatti, Rahman PF, Juma D, Gilbert DM, and Glamore WC (2023) Richmond River Floodplain Prioritisation Study WRL TR 2020/05 | May 2023. University of NSW, Water Research Laboratory, NSW, Australia

Rayner DS, Harrison AJ, Tucker TA, Lumiatti, Rahman PF, Juma D, Waddington K, and Glamore WC (2023) Coastal Floodplain Prioritisation Study – Background and Methodology WRL TR 2020/32 | May 2023. University of NSW, Water Research Laboratory, NSW, Australia

Annexure 1 - Cost calculations

Table 1. 1 – Pasture cost calculator

Activity	Regularity	$ / ha	ha planted 140
Spreading seed	1	32	4,480
Mulching	1	75	10,500
Spreading urea	1	24	3,360
Spreading lime	0.33	90	4,158
Spreading DAP	1	24	3,360
Wick whipping	0.1	18	252
Input		**$/ha**	
Seed	1	105	14,700
Urea	1	81	11,340
Lime	0.5	120	8,400
DAP	1	144	20,160
Chemical	0.1	10	140
		$577.5	**$80,850**

Table 1. 2 – Asset maintenance calculations

Fencing	Distance km	Value $ / km	Replacement Cost at 5%
Boundary	5.2	18,000	4,680
Internal	6.4	12,000	3,840
Cattle yards		65,000	3,250
			$11,770

Table 1. 3 – Input cost assumptions

Contracting		$ + GST	Expected ha / h	$ / ha
Spraying broadacre	$ / ha	30		30
Spraying spot	$ / h	110		110
Direct drilling	$ / ha	120		120
Mulching	$ / h	120	1.6	75
Silage baling	$ / bale	50		
Fertiliser spreading (< 400 kg / ha)	$ / mt	120		24
Fertiliser spreading (> 500 kg / ha)	$ / mt	60		60
Fertiliser spreading (> 3mt / ha)	$ / mt	30		90
Seed spreading (< 50 kg / ha)	$ / mt	800		32
Wick whipping	$ / h	90	5	18
Pasture Inputs			**Per application Kg / ha**	**$ / dose**
Lime	$ / mt	120	1000	120
DAP	$ / mt	1200	120	144
Urea	$ / mt	900	90	81
Rye/Clover seed mix (20:1)	$ / mt	3000	35	105
Wick whip chemicals				10
Animal Health Inputs				
Induction				
5 in 1				2.3
BRD vaccination				5
Backline drench				2
Labour				5
Visual ID tag				1
				$15.3
Ongoing				
5 in 1 booster				2.3
BRD vaccination				5
Injectable long acting				5.8
Labour				5
				$18.1
Therapeutic				
Antibiotic				35
Anti-inflammatory				10
				$45