Carbon Farming Optimiser

Bokhara Plains case study

Department of Primary Industries

Optimising the farm enterprise to deliver multiple benefits (Production, Carbon and improved resource condition)

"Bokhara Plains" case study

Context

Enabling primary producers to participate in carbon markets may have multiple benefits, for farmers and to NSW. Carbon farming can provide additional farm income, greater farm enterprise resilience, create regional jobs and economic opportunities, and increase biodiversity delivering multiple co-benefits to regional NSW. Evaluating opportunities for farmers to participate in on-farm climate change abatement activities, maintain or increase production and improve the resource base is a major focus of the "Accessing Carbon Markets" project under the NSW DPI Climate Change Research Strategy. Here, we describe one component of the larger project which seeks to determine the feasibility of a Carbon Farming Optimisation (CFO) tool to determine the combination of potential activities a farm enterprise could undertake to achieve maximum economic returns and deliver multiple benefits (carbon sequestration, production and environmental).

Information is lacking that allows farmers to make well-informed decisions about the economic consequences entering carbon markets or identifying the potential for non-market abatement activities. These activities include on-farm emissions reduction or sequestration and have the potential to benefit the farm enterprise by improving landscape condition and increasing agricultural production. Understanding the economic and environmental trade-offs and synergies associated with a change in land management (*e.g.* changing grazing strategy) or land-use (*e.g.* reforesting grasslands) to incorporate carbon farming and access carbon markets as well as abatement activities not currently supported by the carbon markets is the focus of this case study.

This case study is one of three on-farm studies which aim to identify cost effective abatement opportunities with multiple benefits (production and environmental). Each study is undertaken in different landscapes/enterprises as a proof-of-concept for the development of an on-farm tool allowing farmers to optimise the farm enterprise for carbon, environment and production. Farmers will not only be able to optimise land management/use for abatement activities but understand where trade-offs between agricultural production, biodiversity and resource condition occur, helping to support the sustainable use of natural resources. Where environmental co-benefits are verified, additional value could be realised through markets that provide a financial incentive to provide environmental services (*e.g.* biodiversity), adding to returns from carbon trading.

The case study is structured into three sections: A description of the enterprise and farmer aspirations for land use change; examination of multiple environmental co-benefits indicators; and the implementation of the Carbon Farming Optimisation.

Enterprise description

"Bokhara Plains" is 9,200 ha property of native pasture approximately 35 km north of Brewarrina in Western NSW owned and run by Graham and Cathy Finlayson. There have been several, past scientific studies[1-3] and case studies[4] documenting the landscape regeneration resulting from Graham and Cathy's Holistic Management which commenced in 2001. Graham and Kathy have also participated in a 10-year West-2000 Plus Enterprise-based Conservation program that incentivised the maintenance and increased retention of ground cover [5-7]. A photo showing the high biomass pastures that would retain ground cover is below (Figure 1).

Figure 1 View of paddocks of "*Bokhara Plains"* showing the level of biomass used to ensure groundcover is retained.

Historically, the property was used to run a Merino enterprise and when the property was purchased, the owners engaged in an improvement process by investing in fencing and watering points to establish a fast-rotation, 'holistic' grazing system with the expectation of increased productivity (pasture-based) and soil organic carbon (SOC) stocks. To date the property has traded cattle and occasionally sheep as well as agisting paddocks to other producers. A figure of the property with paddock boundaries is shown in **Figure 2**.

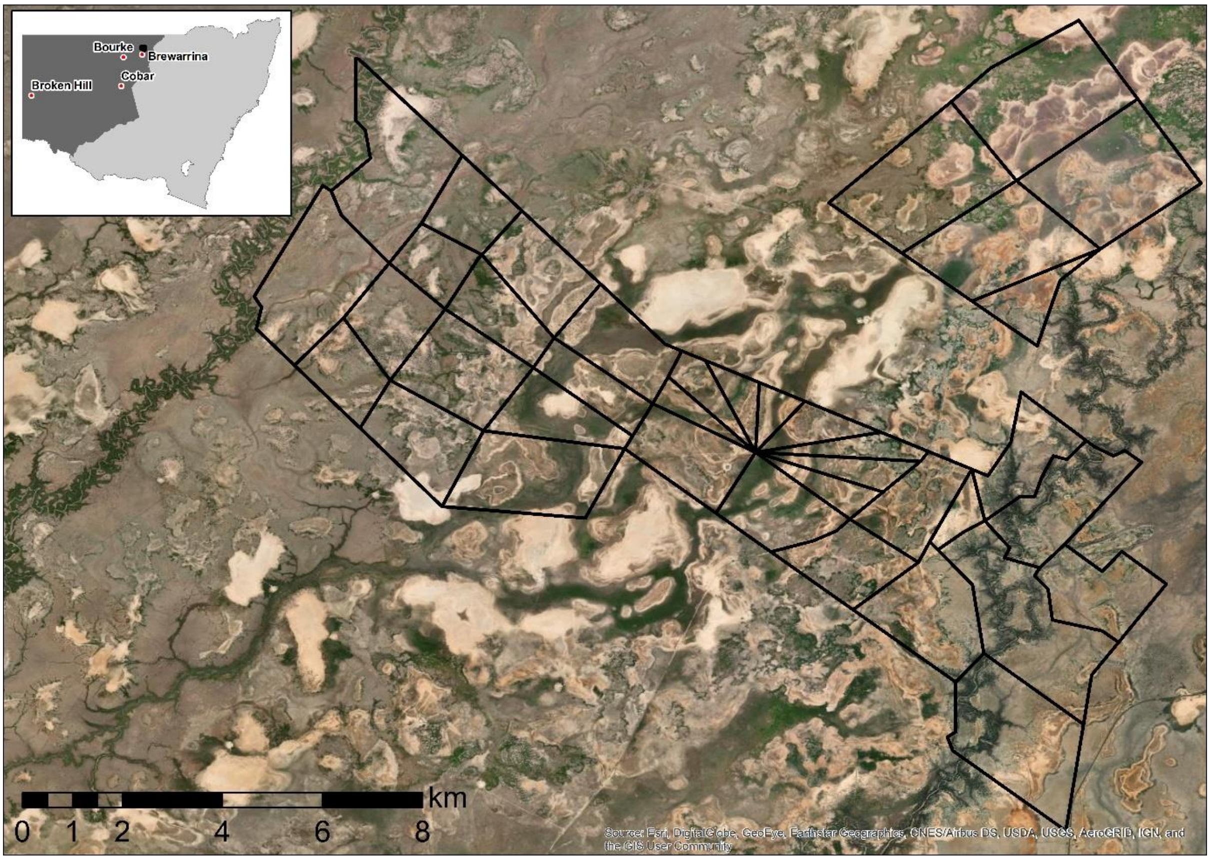
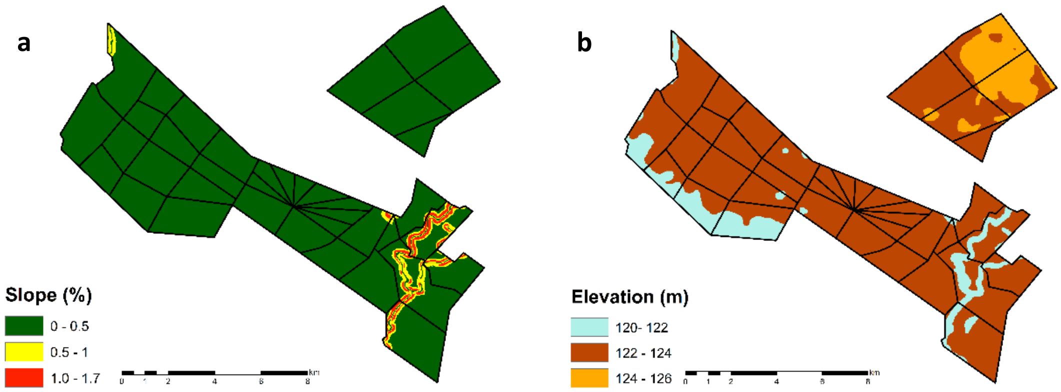


Figure 2. Approximate location of *"Bokhara Plains"* in NSW with property boundaries and paddocks shown by solid black lines.

Landscape characteristics

Most of *"Bokhara Plains"* is characterised by the Wongal Land system, with some smaller areas being Upper Darling and Long Meadow land. The majority of the property is flat with a small amount of land, Upper Darling, having a moderate slope, 1.0-1.7% slope. This area is also covered in sparse woody and woody vegetation Figure 3.



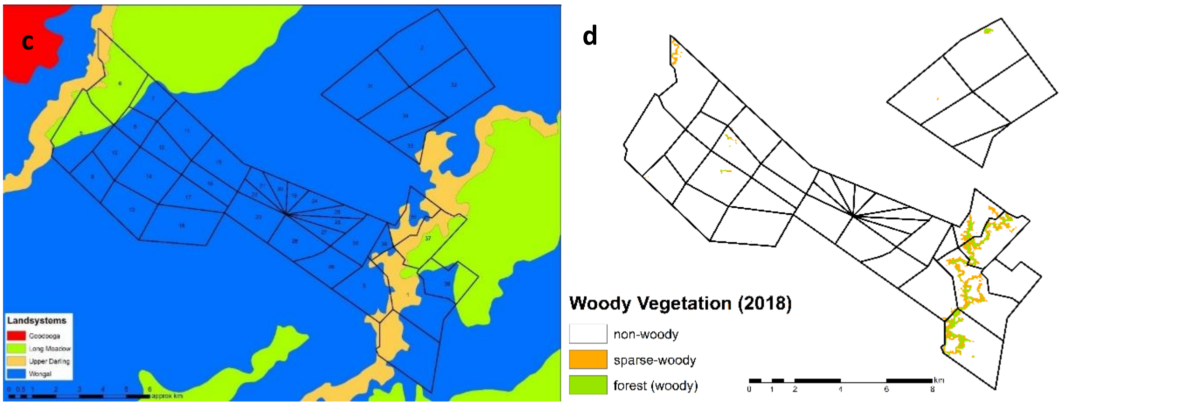


Figure 3 *"Bokhara Plains"* boundaries showing a) slope (%)[8], b) elevation [8], c) Landsystems [9], d) woody vegetation cover [10]

The clay content of soils (Figure 3) shows that the majority of the property has soils with a clay content of 30 – 45 % for the top 5 cm of the soil and that some areas have a very heavy clay topsoil with a clay content of up to 55 %. As would be expected the clay content of soils generally increases with depth, however some areas appear to have soils that are uniform throughout the profile with heavy clays in both the 0 – 5 and 5 – 15 cm layers. These soils would have a relatively high water-holding capacity and would store water for extended periods after floods occur.

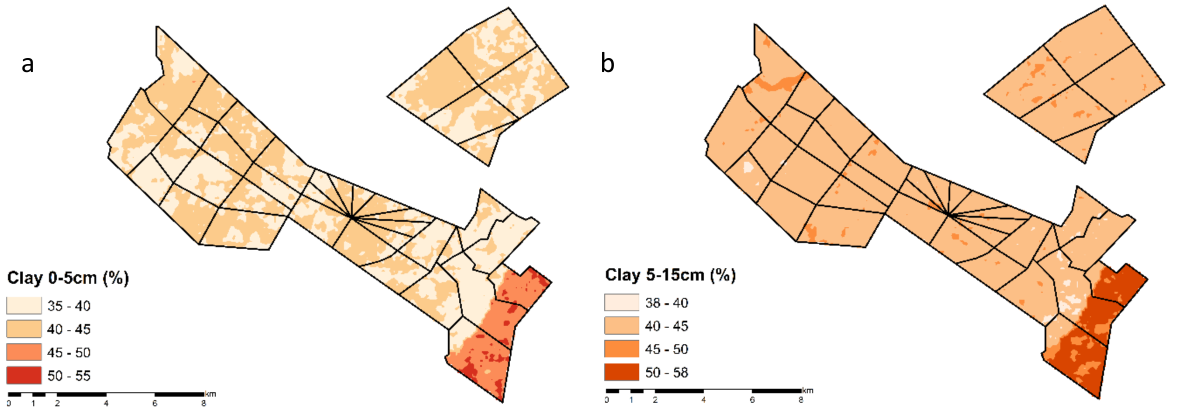


Figure 3 *"Bokhara Plains"* boundaries showing % clay in soil for a) 0 – 5 cm and b) 5 – 15 cm [11]

Riverine clay soils in low rainfall areas are usually neutral to alkaline in pH because in these environments the Ca in the soil precipitates and forms calcium carbonate. Further, the low productivity of these areas means that N exports are very low so soil acidification associated with nitrification will also be relatively low. Further, the use of fertilisers that increase soil acidity are not regularly used in semi-arid rangelands. Data in (Figure 4) suggests that the soil pH across *"Bokhara Plains"* ranges from 6.5-7.8 in the top 0 -5 cm and that the pH does not increase greatly as depth increases (Figure 4).

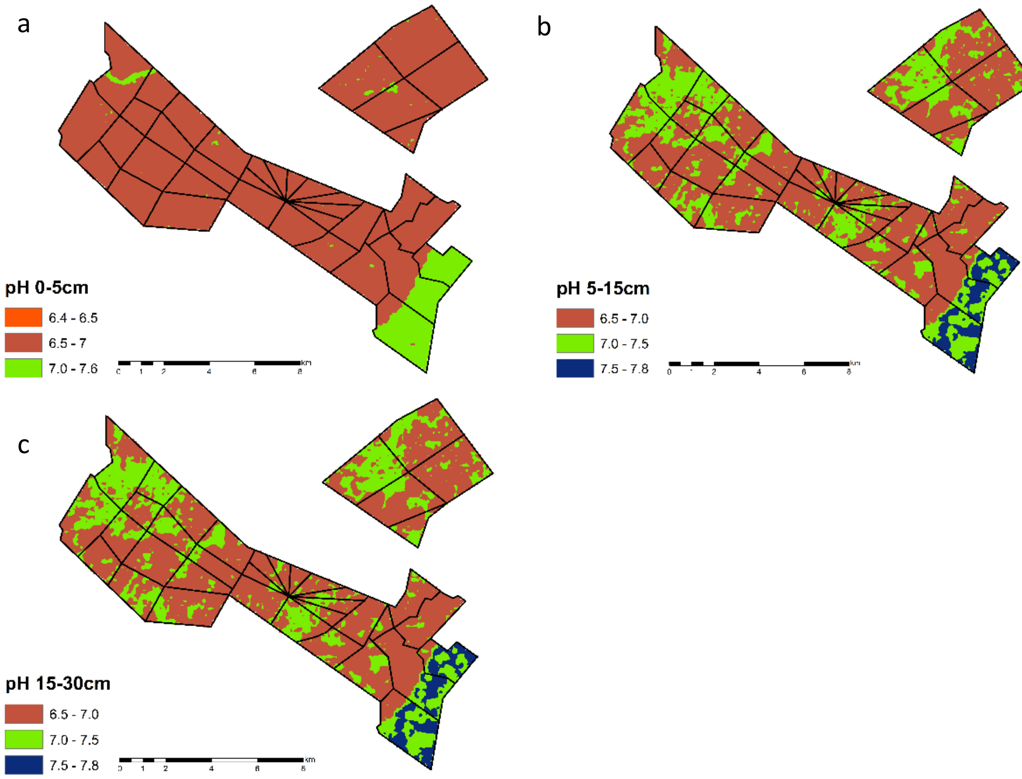


Figure 4 *"Bokhara Plains"* boundaries showing soil pH for a) 0 – 5 cm and b) 5 – 15 cm and c) 15 – 30 cm. [11]

Environmental indicators

Dust emissions

Error! Reference source not found. shows the annual amount of sediment moved by water (horizontal sediment flux - Qh) and soil moved by air as a dust emission (vertical dust flux - F) measured over a 16-year time period (2000-2016)[12]. It suggests that up to 100 t of soil per ha (or soil to a depth of 7 mm) were moved each year due to water erosion whereas 0.012 t of soil per ha was moved lost to wind erosion per ha each year.

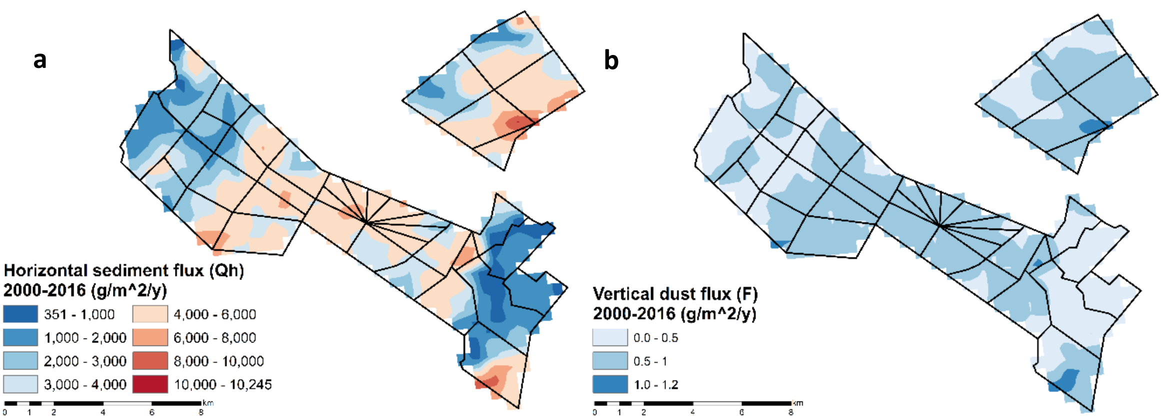


Figure 5 *"Bokhara Plains"* boundaries showing a) horizontal sediment flux b) vertical dust flux over a 16 year period (2000-2016).

Soil organic carbon

SOC is an important indicator of soil condition and increasing SOC stocks can sequester carbon from atmosphere providing climate change mitigation. Three datasets were available to assess SOC stocks for *"Bokhara Plains"* (Figure 6). The range of SOC stocks for *"Bokhara Plains"* differed for each dataset with the dataset developed using multiple linear regression ranging from 20 – 37 t SOC ha^{-1}, the dataset developed by this project using random forests ranging from 13 – 36 and a previous dataset ranging from 9 – 43 t SOC ha^{-1}. Work was also done by this project to estimate SOC stock increases under increases in vegetation management (i.e. by increasing vegetation cover by 10%) and suggested that in some parts of the landscape SOC stocks could be increased by 9 t SOC ha^{-1}. Direct measurement of soil organic carbon sequestration had been previously undertaken for the case study property[1] indicating carbon stocks of 13.65 t ha^{-1}

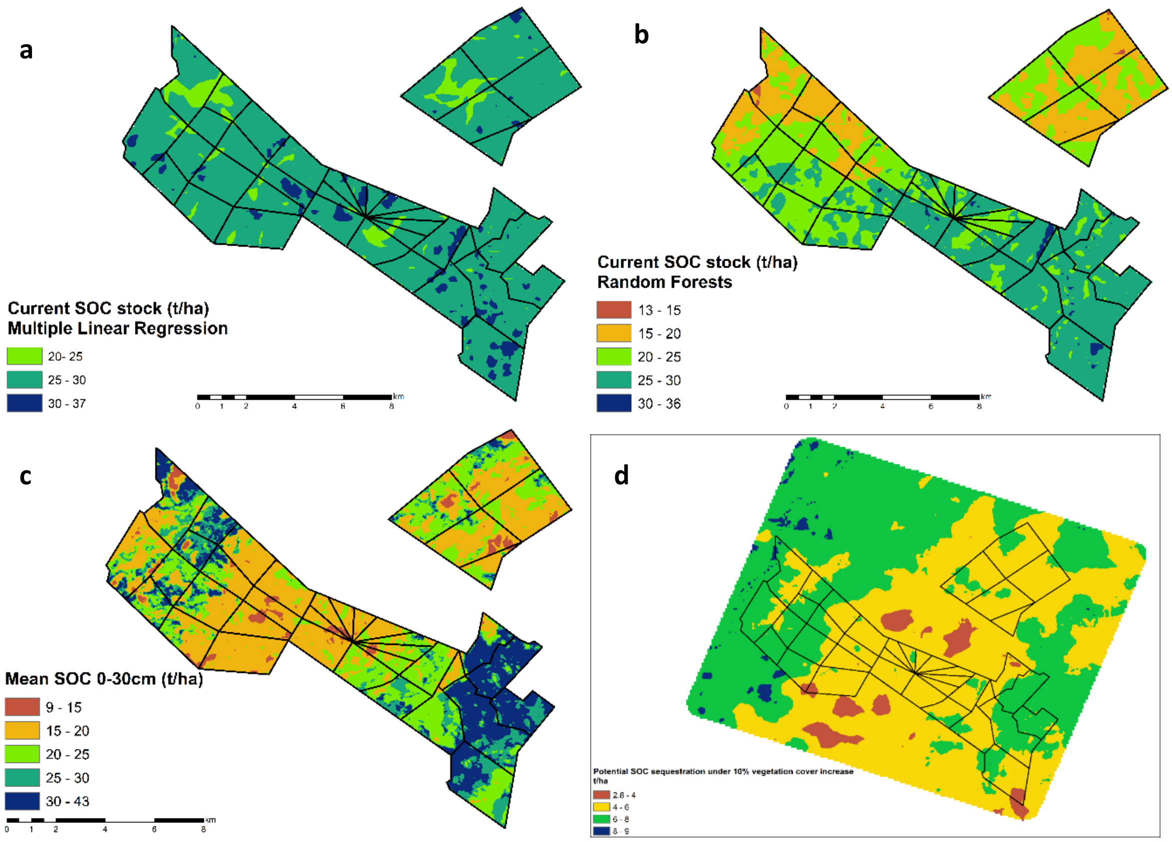


Figure 6 Current soil organic carbon stock (0 – 30 cm) modelled using different methods a) Multiple linear regression, b) random forests, c) random forests with finer resolution and d) predicted SOC stock increases (0 – 30 cm) for *"Bokhara Plains"* when vegetation cover increases by 10% as derived from spatial data developed as part of this project using multiple linear regression.

Ground cover

Ground cover thresholds to reduce wind (50%) and water (70%) erosion have been well established[13,14] but total vegetation cover (woody and ground cover) has been proposed as a more effective indicator of exposure to wind erosion[13]. Over time, ground cover has been accepted as a proxy for the provision of ecosystem services such as soil conservation. The importance of retaining ground cover is embedded into natural resource planning for western NSW through catchment targets to retain 50% ground cover.

We examined the use of two ground cover products, Sentinel fractional cover images and Landsat fractional cover images which primarily differ in their resolution and time period. For example, Landsat fractional cover images (the source data for groundcover estimates in products such as FarmMap4D and VegMachine) provides seasonal fractional ground cover at a 30m resolution at 3-monthly intervals based on the Landsat images. These seasonal images are available from 1988 onwards. The Sentinel fractional cover images were retrieved from Digital Earth Australia and are available from November 2017 to November 2019 with 2-3 images per month.

Ground cover "clumpiness"

Vegetation patch dynamics is a major factor influenced by grazing[15]. Patches of vegetation control water flow through the landscape with increased vegetation retaining water[16] and concentrating nutrients[17] while reducing run-off and erosion. The spatial arrangement and temporal dynamics of cover has been linked to landscape condition[18]. The use of spatial variance analysis to characterise the 'clumpiness' of patches into a clumpiness index has been proposed by those authors to access changes in the spatial heterogeneity. The clumpiness indicator reflects landscape spatial heterogeneity and may provide additional information as a co-benefit indicator than ground cover alone, because it indicates the relative size of the patch of bare ground with larger patches being potentially more susceptible to erosion. High levels of clumpiness indicate that there are relatively large patches of bare ground between clumps of vegetation. "Range" is used to indicate clumpiness with the range representing the distance at which the pattern of patches and vegetation in a landscape become homogenous. For example, a range of 100 m means that any two or more transects of 1000 m long that are placed across the area of interest will have similar proportions of bare ground to vegetation. This means that the greater the range, the greater the variability in the landscape (*i.e.* patches of bare ground are bigger).

Sentinel-2 factional cover images (10m resolution) were obtained from November 2017 to November 2019. Fractional cover consists of four bands; Band 1, bare ground, rock, disturbed, Band 2, photosynthetic vegetation, Band 3, non-photosynthetic vegetation and Band 4, model fitting error. Monthly mean bare ground (Band 1) was processed from 2-3 images per month. The mean bare ground was used in this study as the amount of bare ground relates to exposure to wind erosion.

Paddock comparisons

To assess the potential for clumpiness to be used as a co-benefit indicator, the clumpiness of Paddocks 18, 23 and 31 (Figure 7) were assessed over time (2017 to 2019). These paddocks were selected, because the paddocks have a different management history with Paddock 18 and 23 having holistic grazing implemented from 1999 onwards, whereas paddock 31 which had only recently been acquired had a long history of set stocking. Paddock 18 and 23 have also had water ponding and scarifying work being done. Further, paddock 18, 23 and 31 differ slightly in terms of different landforms as demonstrated by the spatial data (above) and radiometric survey (Figure 8).

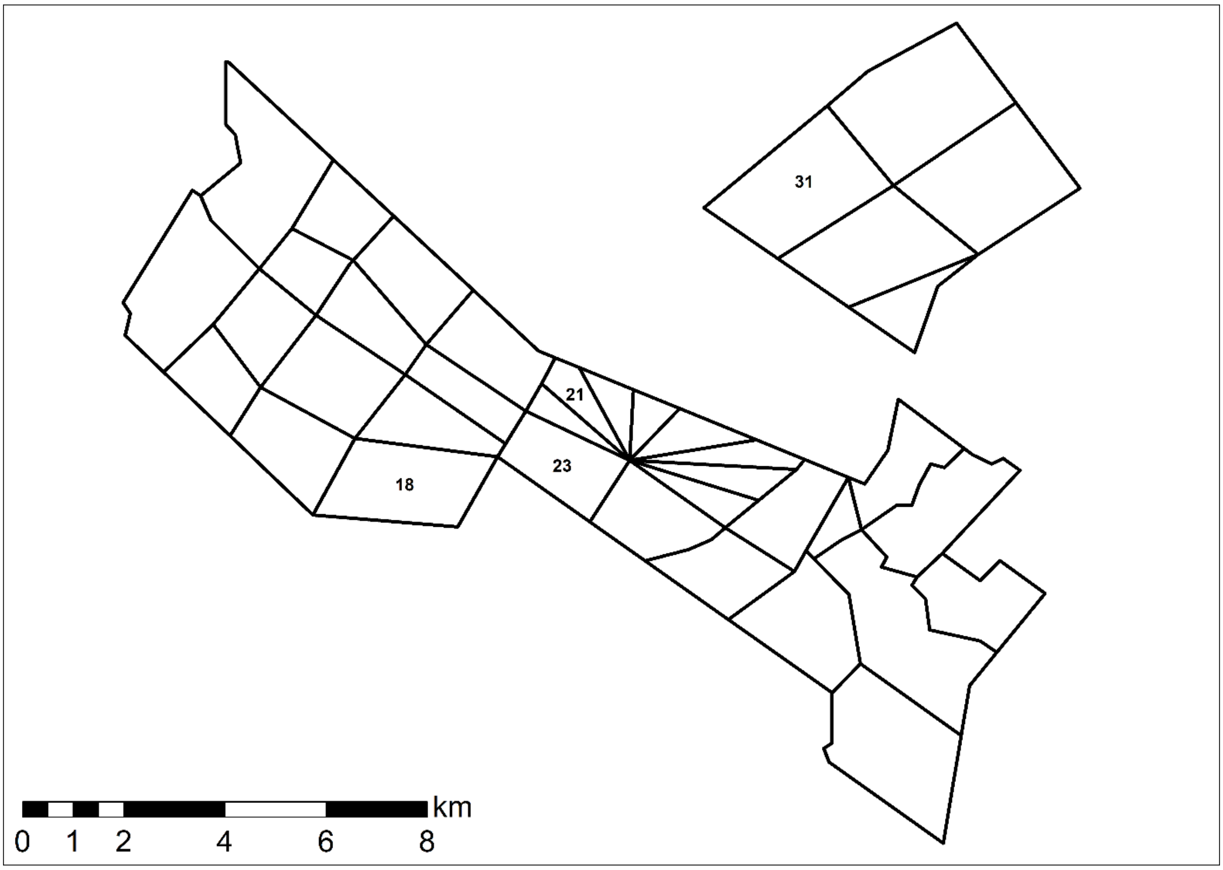


Figure 7 Bokhara Plains property showing the location of paddocks 18, 23, 21 and 31 which were used for the Ground cover analysis.

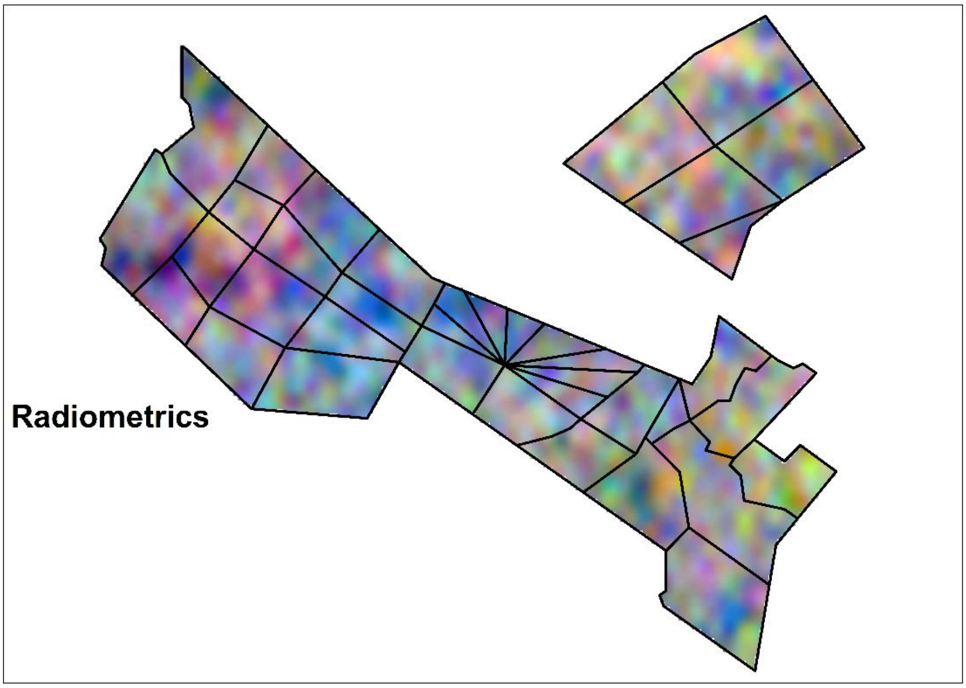
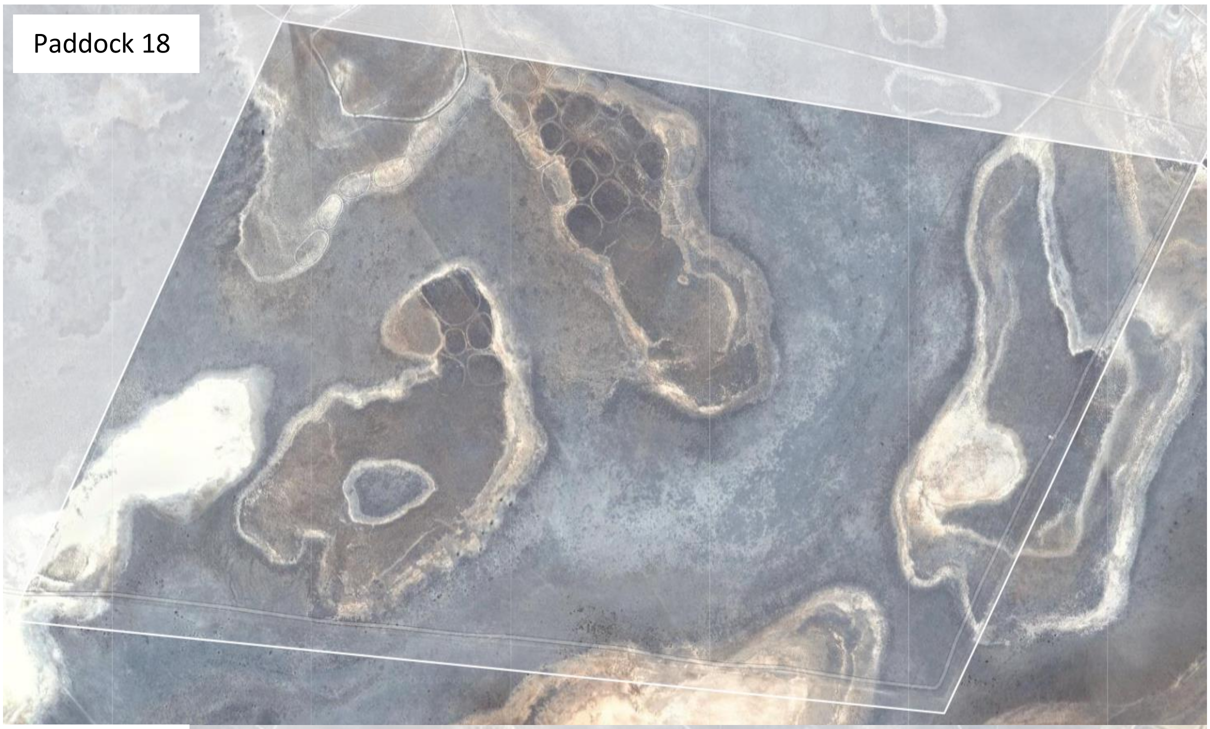


Figure 8 Radiometric signatures for *“Bokhara Plains”*.


Paddock 18

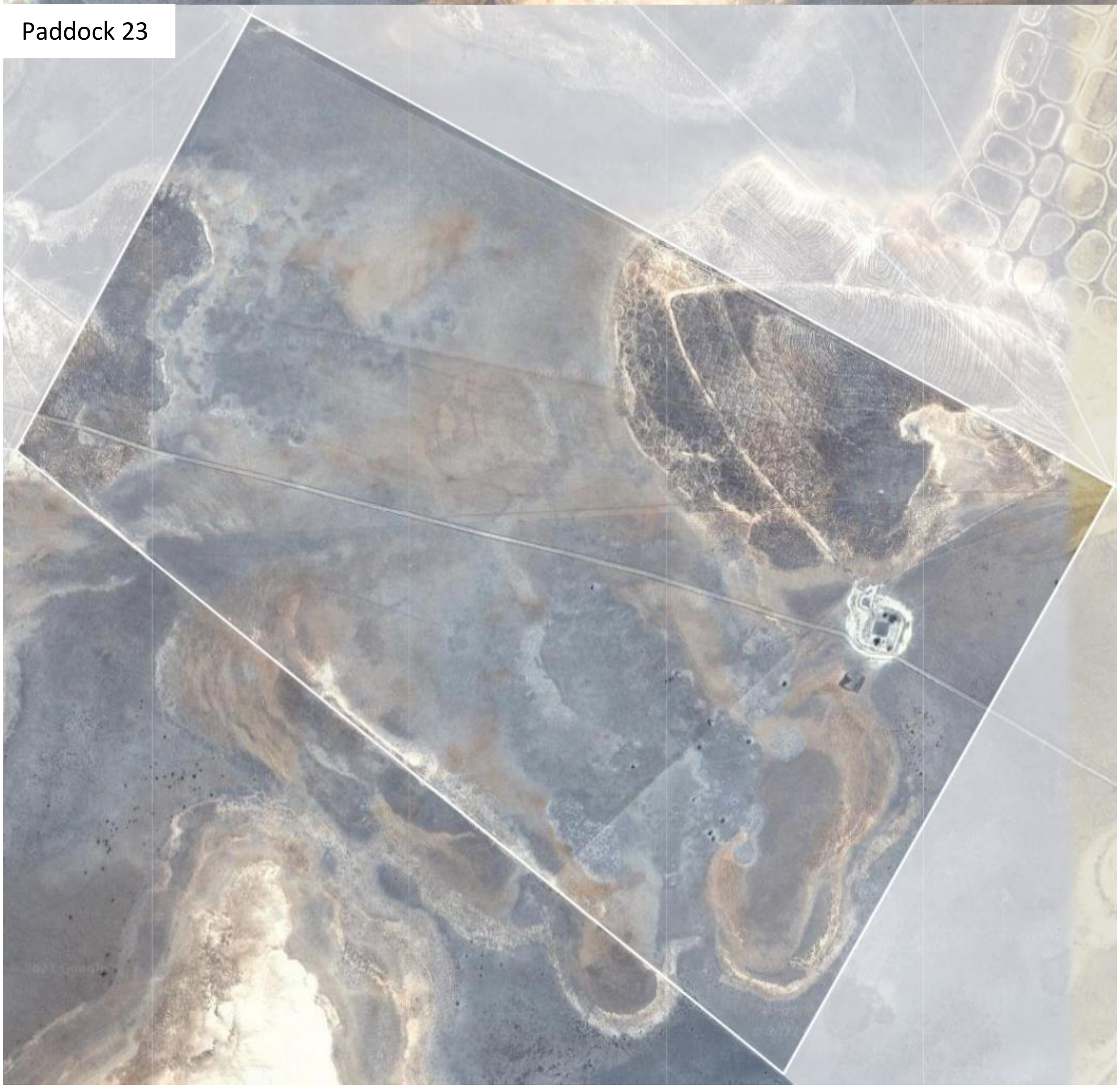

Paddock 23

Figure 9 Images extracted from VegMachine, showing the paddocks 18 and 23 with waterponding and scarifying to regenerate claypans.

On-farm optimisation

Carbon farming opportunities

To demonstrate the application of the CFO in this case study, it was assumed that *"Bokhara Plains"* was still being run set-stocked and that the Finlayson's were yet to implement a land management change (*i.e.* convert to holistic management). It was also assumed that converting to holistic management would sequester SOC (discussed below). Three activities could be selected by the CFO to optimise returns – organic beef, steer trading or agistment.

The cattle trading enterprise purchased steers at 200 kg and sold at 400 kg. Steers were assumed to have an average daily liveweight gain of 0.7 kg which meant they were held for 8.5 months and then sold. Steers were purchased from regional saleyards at an average distance of 440 km and sold either through saleyards or direct to processors. At the end of the sixth year, the property was capable of carrying, on average, 710 steers. An agistment enterprise assumed the same stocking rate and income was derived on a per head basis.

At the end of the sixth year the property was able to carry 400 cows in the organic cattle breeding enterprise. Joining occurred twice a year (spring and autumn) after which joined cows/heifers were scanned for pregnancy. Dry cows/heifers were culled and this gave a 100% calving rate. Cow/heifer mortality was assumed to be 2%.

Data sources and assumptions for carbon farming optimiser

Data

Enterprise data, described in sections below was used in the CFO and given in appendix A.

Available operating and capital costs

Capital costs associated with the changes were for fencing and stock watering points and costs were obtained from the landholder. Capital available for improvements (including fencing for areas converted to human-induced regeneration). It was assumed that $50 000 was available for operating and capital expenses each year.

Stocking rate and pasture availability

Optimisation of *"Bokhara Plains"* assumed that pasture availability increased linearly from the implementation of management changes to the end of the sixth-year post-implementation. Pasture availability at implementation was estimated by calculating the feed requirements of the previous enterprise (*i.e.* a 400-head self-replacing Merino ewe enterprise) whereas pasture availability at year 6 was estimated from data provided by landholder (*i.e.* a 400 head organic cattle breeding enterprise). Pasture availability assumed that one 60 kg Merino ewe required on average 13.7 MJ ME day^{-1} and one 450 kg cow required 126 MJ ME day^{-1}. An alternative management option was to trade steers and the number of steers that could be traded was determined by the estimated feed availability with an assumed energy requirement of one steer on average of 70 MJ ME day^{-1}.

Gross margins

Gross margins for steer trading, cattle agistment and organic cattle breeding were developed from the estimated returns and variable costs for each enterprise. The purchase and sale price of the livestock were estimated by the landholder as were the daily liveweight gains, distance to saleyards.

Commissions, industry levies, transport costs and saleyard fees, where relevant, represented current industry values.

The cost of animal health products were taken from NSW DPI livestock gross margins [19].

Gross margins for holistically managed pastures also included the costs of sampling the farm to estimate SOC sequestration for the purposes of attaining credits. It was assumed that sampling was undertaken at the end of the 7-year period and the cost of the sampling was apportioned evenly over that period on an annual basis. It was assumed that 300 cores were taken and the cost of sampling and processing a core was $12.

GHG emissions

Greenhouse gas emissions associated with the production of cattle were calculated using the B-GAF [20]. For cattle trading, it was assumed that 4 cohorts of cattle were on the property at any one time and the average weight of animals in each age class were used for GHG emissions calculations. For cattle breeding, there were 2 cohorts of young cattle and the average weight of animals in each age class were used for GHG emissions calculations. ME and protein of pasture in B-GAF were used so that a daily liveweight gain of 0.7 kg was achievable and were 65 Mj and 11%, respectively.

GHG emissions included were enteric methane and N_2O from manure and urine deposition, consistent with the NIR.

Soil organic carbon

It was assumed over that SOC increased over the seven year period after pasture management was changed from set stocking to holistic. Crediting for SOC sequestration was consistent with the 'Measurement of Soil Carbon Sequestration in Agricultural Systems Method[21]. Credits were provided for 75% of C sequestered and sequestration was adjusted to account for increases in emissions when the number of animals increased as a result of management changes.

To estimate SOC increases we used measured data from a field study recognising that measured data will not always be available to a farmer. An alternative method for SOC estimation is to use spatial data. We plotted spatial data for *"Bokhara Plains"* for layers of current SOC stocks and predicted SOC stock changes which have been developed as part of the larger Accessing Carbon Markets Project and compared against measured data and compared this data to measure data from Orgill, et al. [1].

Labour

Labour was constrained to 6 500 hours per annum as an approximation of three full-time workers being available. Labour hire was not assumed to be available.

Additional indicators

Additional indicators of co-benefits were assessed for inclusion in the optimisation modelling with the intention of including income from credits associated with providing co-benefits. These indicators were soil loss and biodiversity.

Results

Soil organic carbon

Predicted SOC stocks for *"Bokhara Plains"* derived from spatial layers (Figure 6) were not indicative of SOC stocks as assessed by field sampling. Field sampling Orgill, et al. [1] showed that SOC stocks at *"Bokhara Plains"* ranged from 12 – 14 t SOC ha^{-1} where as the spatial layer developed using multiple linear regression suggest that SOC stocks range from 20 – 37 t SOC ha^{-1}. In contrast, spatial layers developed using random forests suggest a range of between 11 – 26 t SOC ha^{-1}. Spatial layers developed to estimate SOC stock increases associated with a 10% increase in vegetation also overestimated potential increases. The spatial layers developed as part of this project suggest that in some areas of *"Bokhara Plains"* it would be possible to increase SOC stocks by up to 9 t SOC ha^{-1}. It should be noted that reaching maximum SOC stocks occurs over long-time frames (e.g. decades) after an initial rapid increase and the values provided in the spatial data may represent changes over these long time frames, longer than is applicable for trading SOC sequestered due to land management under the ERF.

Clumpiness

Clumpiness, as derived from variograms, in the holistically grazed paddocks, 18 and 23, which also had waterponding and scarifying work done, was generally lower, though more variable, than in paddock 31 (set stocking) and suggests that implementing holistic grazing as well as land regeneration practices has provided the co-benefit of reducing bare ground and creating a more homogenous landscape (*i.e.* smaller patches of bare ground) (Figure 10).This was despite paddock 18 and 23 generally having more bare ground as assessed by Sentinel-2 images (Figure 11). Fractional data from Landsat imagery (Figure 12) confirmed that bare ground was generally greater in holistically grazed paddocks including 18, 21, 23. This difference was evident from 1988, prior to any interventions being made by the current owners. These paddocks on the Bokhara Plains property were characterised by large clay scalds visible on the above images extracted from VegMachine. Interventions by the Finlayson's including waterponding and scarifying the clay scalds which allowed rainfall to penetrate the soil surface rather than run-off, which has resulted together with rotational grazing, in regeneration of perennial species. However, it is also likely that the difference in bare ground between paddocks is the result of inherent biological factors as opposed to management. However, changing management appears to have reduced bare ground relative to the set stocked paddock as demonstrated by a reduction occurring in areas where rotational grazing alone or rotational grazing and waterponding have been implemented (Table 1). However, it is unlikely that changing management has influenced the proportion of green vegetation.

Table 1 Bare ground and proportion of dry matter that is green for paddocks 18, 21 and 23 prior to and after management changes were implemented.

Paddock number	Management and intervention (if applicable)	Variable	Pre-management change	Post-management change
18	Rotational grazing	bare ground (%)	66.1	61.9
23	Rotational grazing with waterponding and scarifying	bare ground (%)	69.9	61.5
31	Set stocking	bare ground (%)	51.9	51.6
18	Rotational grazing	green (%)	12.2	11.9
23	Rotational grazing with waterponding and scarifying	green (%)	10.2	11.5
31	Set stocking	green (%)	14.5	13.9

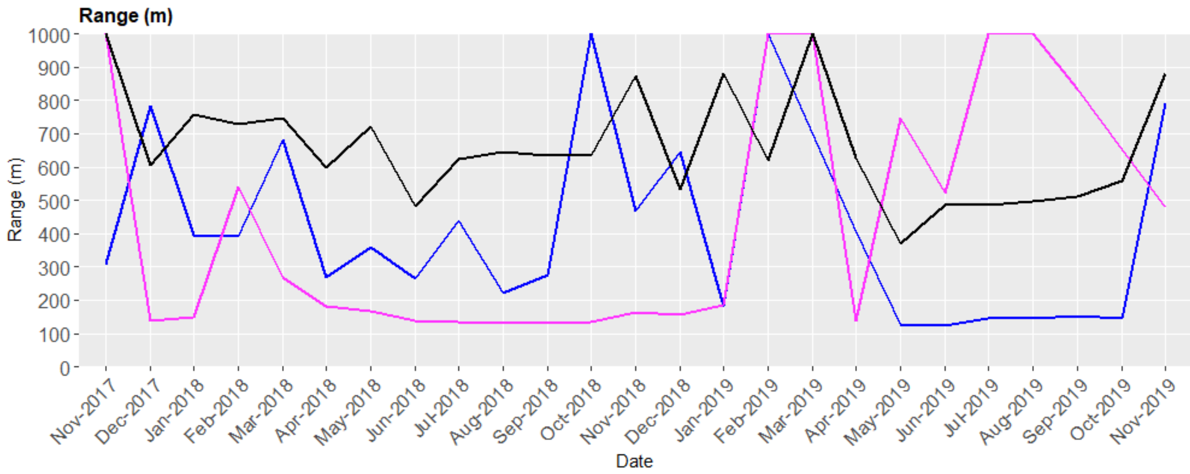


Figure 10 Average range of clumpiness (m) for paddocks 18 (blue), 23 (pink) and 31(black) on a monthly basis over a two-year period. Note that the maximum detectable range is 1000 m. Data based on Sentinel-2 fractional cover images at 10m resolution.

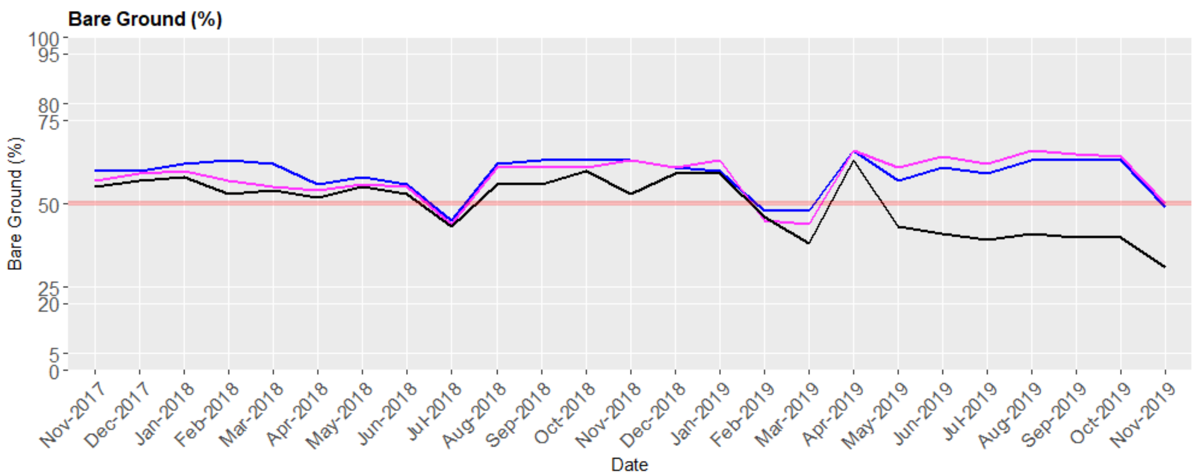


Figure 11 Average monthly bare ground (%) for paddocks 18 (blue), 23 (pink) and 31(black) over a two-year period extracted from Sentinel-2 fractional cover images at 10m resolution.

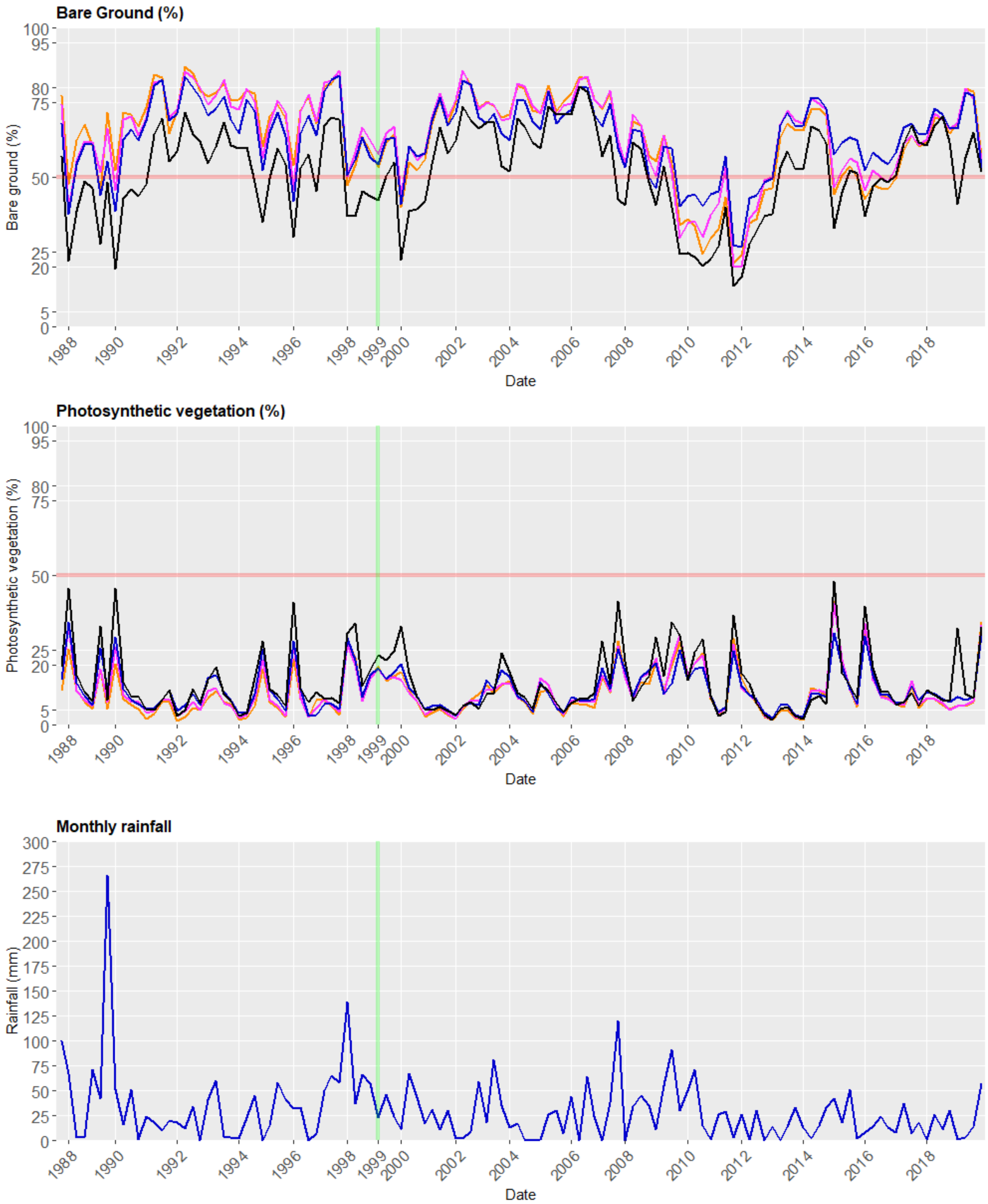


Figure 12 Seasonal fractional cover extracted from Landsat fractional cover images at 30m resolution for paddocks 18 (blue) , 21 (orange), 23 (pink) and 31 (black) on a quarterly basis over a 32-year time period, **a)** bare ground, b) photosynthetic vegetation c) monthly rainfall. Vertical line represents the implementation of holistic management in paddock 18, 21 and 23.

Carbon Farming Optimisation

The baseline run assumed that no income was derived from SOC sequestration and assumed an increase in carrying capacity when converting to holistic pastures. The CFO suggested that the greatest economic returns would occur by converting approximately 1000 ha of pasture to holistic management and steadily converting from an agistment enterprise to an organic breeder enterprise results in the greatest income (Figure 13). The conversion to holistic pastures and organic breeders is limited to the operating and capital available each and the CFO directs operating and capital to converting holistic pastures in the first instance after which operating and capital is directed to buying in breeders for organic weaner production. Only 1000 ha is converted to holistic grazing because the costs of conversion are not offset by the productivity gains.

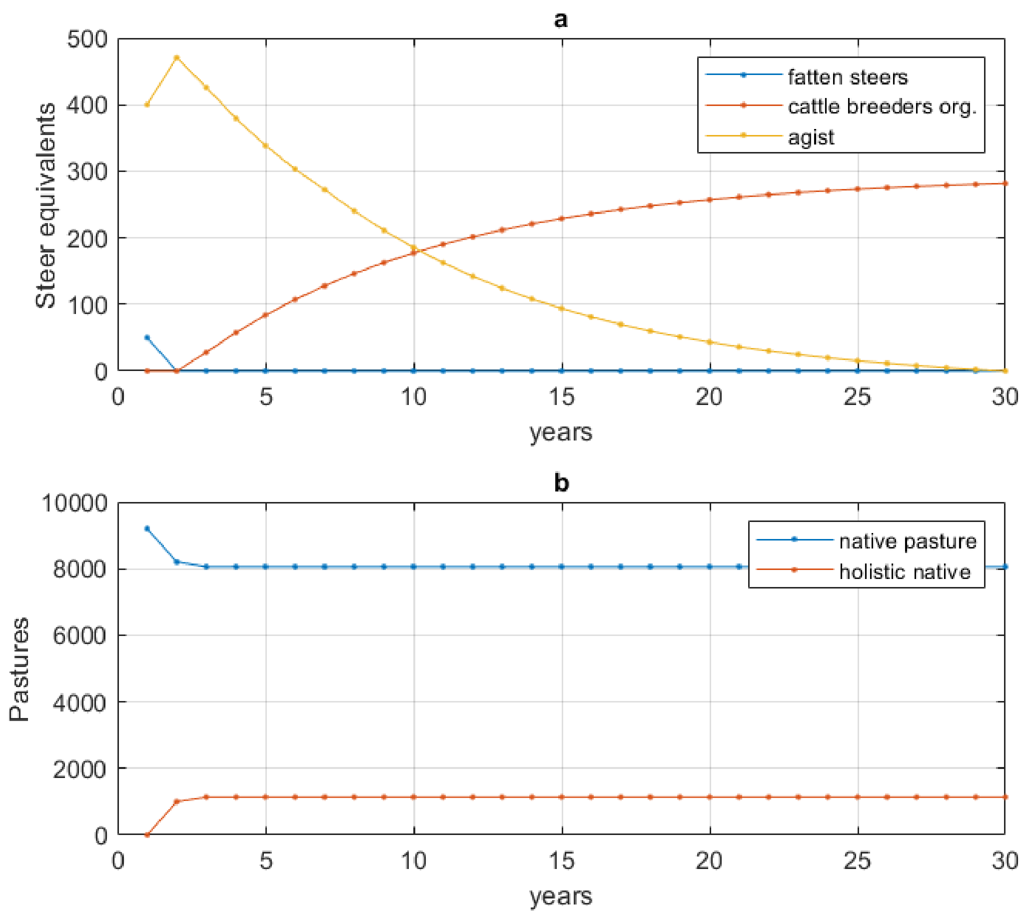


Figure 13 For years 0 – 30 of the CFO simulation a) the numbers of livestock in each class expressed as steer equivalents and b) the area of pasture under set stocking and holistic management with no participation in carbon markets.

When a C price of \$15 t C^{-1} is applied and it is assumed that under holistic grazing management 0.15 t SOC ha^{-1} $annum^{-1}$ will be sequestered, the CFO increases the area converted to holistic management to 8000 ha over a 10 year period at which point operating and capital is directed to the purchase of breeders to produce organic weaners (Figure 14).

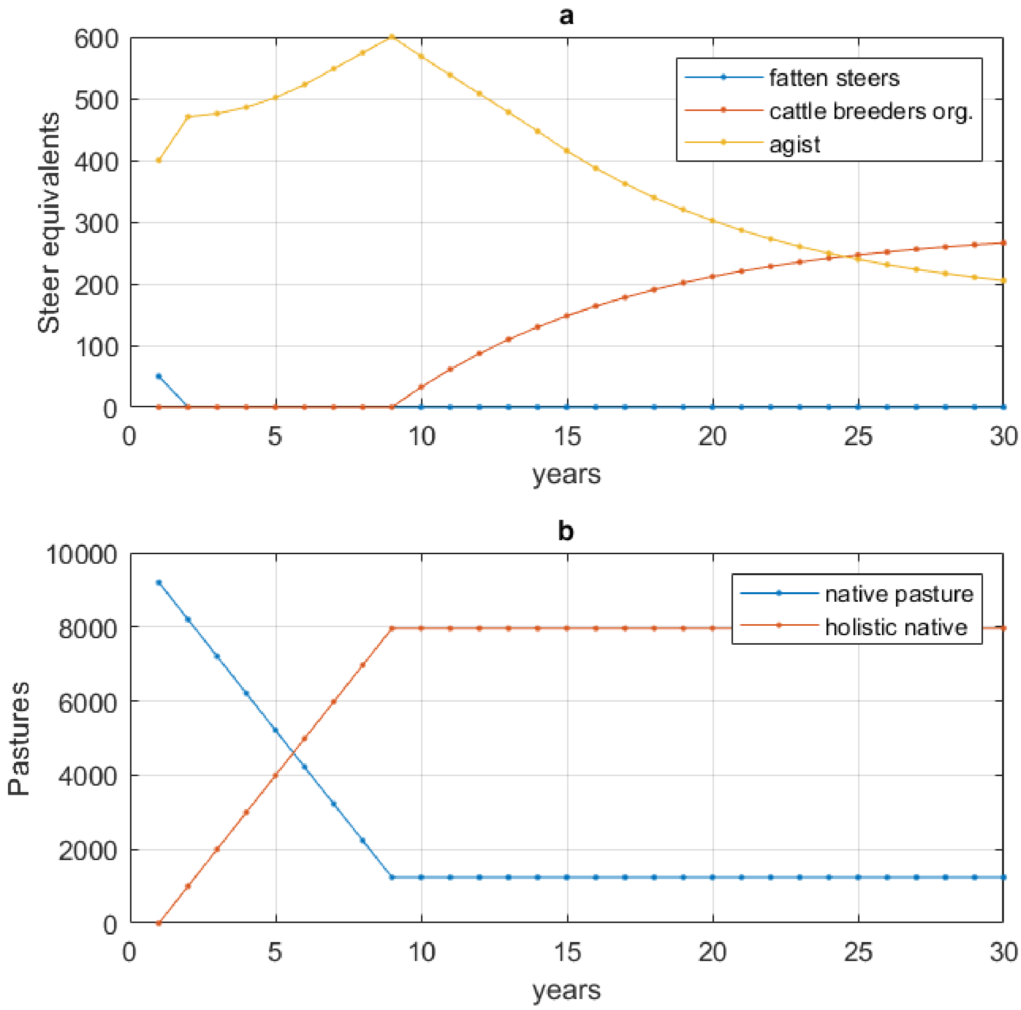


Figure 14 For years 0 – 30 of the CFO simulation a) the numbers of livestock in each class expressed as steer equivalents and b) the area of pasture under set stocking and holistic management when carbon credits earned are sold at \$15 t.

Net present value at 30 years also increased with total amount of SOC sequestered over the 7-year period after converting pastures to holistic management (Figure 15). Figure 15 also suggests that participating in an ERF measured SOC methodology would increase profitability even at a relatively low sequestration rate of 0.55 t SOC ha^{-1} but that the increase in profitability would be marginal. It is interesting to note that the increase in NPV when SOC sequestration increases from 1.1 to 2.2 t ha^{-1} is not due to an increase in the rate of conversion to holistic pasture or an increase in the rate of organic breeders but rather due to the increase in income from the C credits (data not shown).

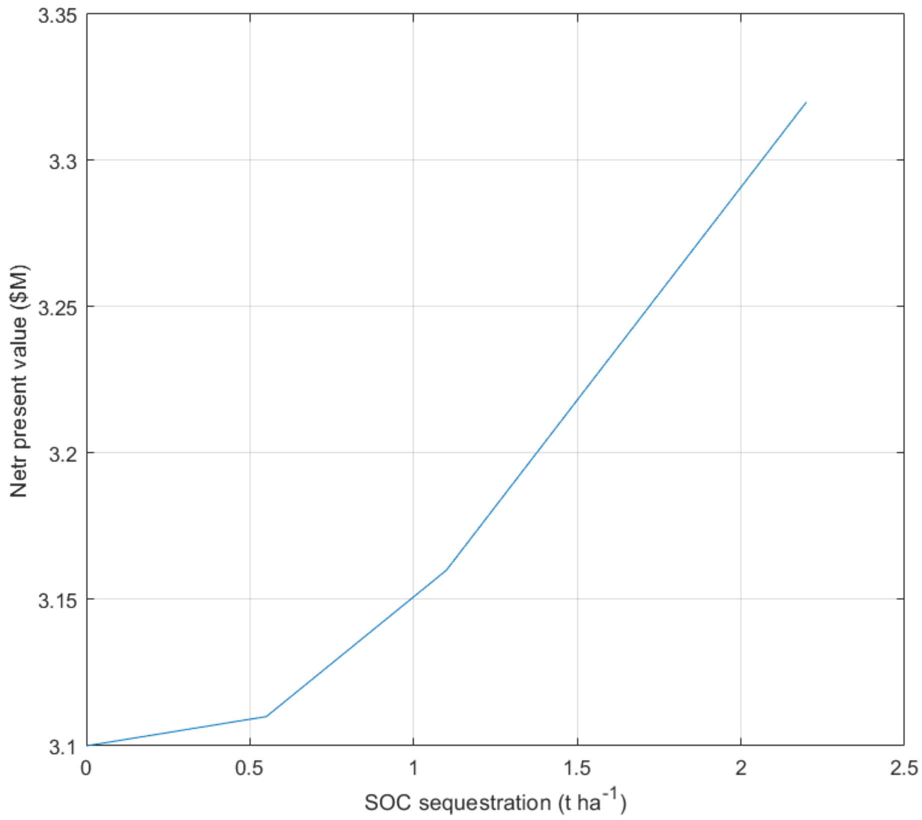


Figure 15 Net present value of *"Bokhara Plains"* enterprise at year 30 when SOC sequestration associated with conversion to holistic pastures was either 0, 0.55, 1.1, 1.65 or 2.2 t SOC ha^{-1}.

The baseline assumption was that $50 000 of operating and capital was available each year but, as discussed above, constraining capital changes the final optimisation. **Figure 16** shows how the numbers of cows purchased and the area of pasture converted to holistic are affected by the available annual operating and capital inputs. When operating and capital is constrained to $25 000 the maximum area converted to holistic management was ~ 5 700 ha, when operating and capital was increased to $50 000 approximately 8000 ha of pastures were converted to holistic and when operating and capital was increased to $75 000 then the entire property was converted to holistic grazing. Increasing operating and capital from $25 000 to $75 000 also increased the rate at which livestock run on the place were converted from agistment to breeders with operating and capital of $75 000 required to fully stock the property with breeders. Regardless of operating and capital available, the CFO prioritised the conversion of pastures to holistic management until the opportunity cost of not running breeders became greater than the economic benefit of converting pastures to holistic. Once this point was reached purchasing breeders was prioritised for available operating and capital.

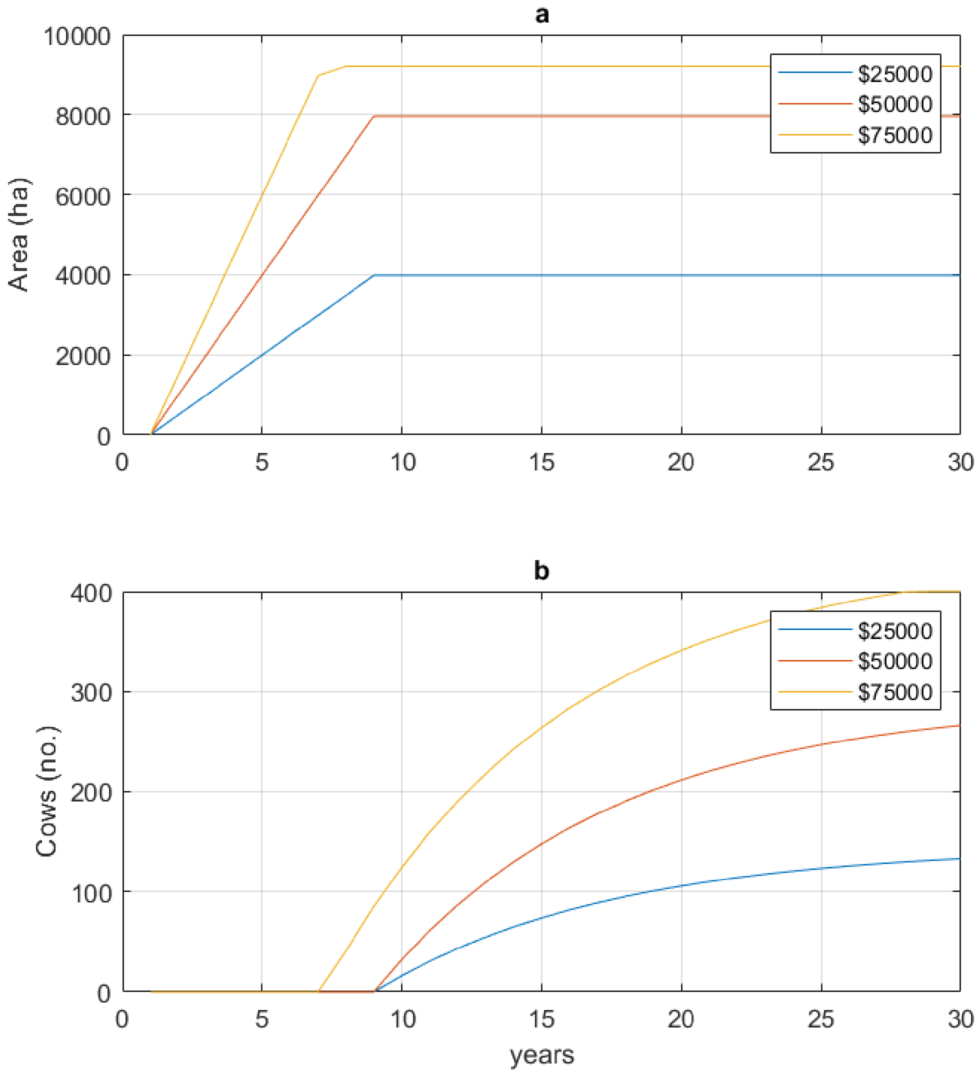


Figure 16 Area of holistic pastures (a) and number of cows (b) when operating and capital is constrained to $25 000, $50 000 or $75 000 per annum.

Conclusions

Optimisations from the CFO for *"Bokhara Plains"* demonstrate that, using the input data provided by the producer, participating in an ERF SOC sequestration methodology would be profitable at relatively low rates of sequestration when converting to holistic grazing management with a C price of $15. Any increase in C price would result in a more profitable enterprise however this would occur due to the increase in income from C credits, not from optimising the system differently. Operating and capital to implement the changes is a key constraint with between $75 000 of operating and capital required per annum to maximise profit by converting all pastures to holistic management and fully stocking the property with breeding cows to produce organic weaners. Regardless of the amount of operating and capital available, results from the CFO suggest that there is initially greater economic benefit to be gained from converting pastures to holistic after which time the operating and capital is better spent purchasing breeders.

The reduction in ground cover ‘clumpiness’ between the holistically grazed and set stocked paddocks suggests that this type of remotely sensed data could be used to assess the condition of the rangeland with the potential to provide credits, in addition to C credits, for co-benefits related to increased ‘clumpiness’. Results also suggest that short-term analysis of remotely sensed data may be misleading because assessing only short-term impacts of bare-ground (Figure 10) suggested that management interventions may have had impacts on reducing bare ground between the two paddocks, but a longer assessment suggests that there was a difference evident prior to management interventions (Figure 11).

Future iterations of the CFO will have the capacity to include a value to assess how adding income from these co-benefits affect the optimisation of *“Bokhara Plains”* to maximise income.

The SOC maps developed as part of this project may not provide a good indication of current SOC levels or the SOC sequestration potential. As such, it may be preferable to use other sources to estimate these values, particularly SOC changes.

References

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Appendix A

Additional information used in optimisation model

Agent commission	5	%
Saleyard fees	12	$/head
Levy	2	$/head
distance to sales	440	km
$/km transport	5.5	
head/load	60	
transport cost per head	40.3333333	$/head

Gross margin for organic breeder

BEEF CATTLE BREEDING GROSS MARGIN and activity details			
Date			
Description:	Cattle breeding with progeny grown and sold over hooks to org processor		
Enterprise Unit:	400	Cows	

Pasture:	ha
improved	0
native	9200

INCOME:	hd	S/hd	Total value
Steer weaners	180	1,400	252,000
Heifers	82	1,120	91,840
CFA Bull	2	2,000	4,000
CFA Cows	90	1,350	121,500
Other culls	0	-	-
Total income			469,340

VARIABLE COSTS:	hd	$/hd	Total value
Replacement bull	2	5000	10,000
Cartage to Property	2	200	400
Livestock and vet costs*	760	20	15,200
Agents commision			23,467
Livestock selling cost (cartage, levies and selling fees)	354	54.3333333	19,234
	ha	$/ha	Total value
Fodder crops	0	0	-
Hay & Grain or silage	0	0	-
Drought feeding costs.	0	0	-
Total Variable costs			68,301
GROSS MARGIN			**401,039**

per hd annum	501.30
	550

Other variables		Unit
CO2 emissions	2.46	t/hd
Labour required	7.34	hr/hd

Livestock reconciliation		unit
PTIC rate	90	%
Replacement heifers kept	98	hd
Calving (%)	100	%
Calves weaned	400	hd
Cow / heifer mortality	2	%
Year cows retained	8	years

Gross margin for agistment

BEEF CATTLE TRADING GROSS MARGIN and activity details			
Date			
Description:	Agistment		
Enterprise Unit:	710	hd	
	12	months	
Over time period			
Pasture:	0		
improved	9200		
native			
	hd/LSU	S/hd/week	Total value
INCOME:	710	5	184,600
Animals			

GROSS MARGIN		per hd	260.00

Other variables		Unit
CO2 emissions	1.18	t/hd
Labour required	4.48325359	hr/hd

Gross margin for growing cattle out

BEEF CATTLE TRADING GROSS MARGIN and activity details			
Date			
Description:	Growing out steers 240kg - 460kg in 12 months		
Enterprise Unit:	710	hd	
Purchase weight	220	kg/hd	
Target weight	400	kg/hd	
Over time period	8.5	months	assumes 0.7 kg gain day LW
Pasture:	ha		
improved	0		
native	9200		

INCOME:	hd	$/hd	Total value	
Steers	710	1,400	994,000	$3.50

VARIABLE COSTS:	hd	$/hd	Total value	
Steer Purchase	710	$880.00	624,800	$4.00
Cartage to Property	710	40.3333333	28,637	
Livestock and vet costs*	710	10	7,100	
Livestock selling cost	710	124	88,277	
	ha	$/ha	Total value	
Fodder crops (12 ha)	0	0	-	
Hay & Grain or silage	0	0	-	
Drought feeding costs.	0	0	-	
Total Variable costs			748,813	
GROSS MARGIN			346,146	

per hd annum	487.53

Other variables		Unit
CO2 emissions	1.18	t/hd
Labour required	4.13521127	hr/hd

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