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BRIDGING SCIENCE & BUSINESS

HEMP CROP INTEGRATION INTO A NEW ZEALAND DAIRY FARM BUSINESS

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Introduction

Hemp for seed fibre and hemp for cannabidiol (CBD) crops

New Zealand farmers are facing environmental headwinds in their attempt to meet new regulations with nitrogen loss, greenhouse gas (GHG) emissions and sediment loss to water ways. In light of environmental policy changes throughout New Zealand, we see the integration of hemp crops into a dairy farm pasture improvement strategy as a possible solution for farmers to reduce their environmental footprint, whilst maintaining or improving business profitability.

This document highlights the financial and environmental impact of incorporating hemp as part of a farming business strategy.

Two models are analysed, firstly, growing 10% of the effective dairy farm area in hemp for seed and fibre production, secondly; growing 10% of the effective dairy farm area with hemp for CBD production.

Base dairy farm model

A typical Otago/Southland dairy farm was used for the base model using average industry data.

The base farm is 214 ha effective area, milking 622 cows (2.8 cows/ha). The farm produced 1,162 kg MS/ha at $6.00 kgMS milk price. This generates a gross income of $7,915 per ha, operating expenses of $5,138 per ha and operating profit of $2,774 per ha.

Methodology

The tools chosen to model the impact of farm system changes on production and profit and environment were Farmax Dairy Pro® and Overseer Nutrient Budget® 6.1.1. These tools have been developed in an applied research environment to model farm system changes with a high level of accuracy.

Farmax DairyPro provides physical and financial information to compare relative data between models, whereby Overseer provides relative feedback on environmental impacts.

Key figures to model the hemp seed crop were gained from Townshend & Boleyn who conducted hemp seed trials in Ashburton, Canterbury from 2006-2008[1]. Figures used to model the CBD crop were

[1] Townshend, J. M., & Boleyn, J. M. nd. Plant density effect on oil seed yield and quality of industrial hemp cv. Fasamo in Canterbury. *Agronomy Society of New Zealand Special Publication No.13: 85-91*

gained from various websites and were based on production figures from hemp growers in the United States.

Key modelling assumptions

Hemp for seed and fibre

- Base model remains the same, except 10% of effective farm area (21.4ha) is planted in hemp (for seed & fibre) which displaces 42 milking cows i.e. reduce cow numbers from 622 to 580;
- Relative proportions of feed (pasture and supplement) offered per animal remains the same;
- Hemp seed yield of 900 kg/ha at $4.55 per kg seed[1];
- Fibre yield of 2t/ha at $500 per tonne[1];
- Hemp hurd yield of 4t/ha at $200 per tonne[1];
- 38 kg/ha seed at $8/kg will produce approximately 190 plants/m2[1];
- Crop sown on 10th of October and harvested on 6th March (based on Ashburton trials)[1].

Hemp for CBD production

- Base model remains the same, except 10% of effective farm area (21.4ha) is planted in hemp (for CBD) which displaces 42 milking cows i.e. reduce cow numbers from 622 to 580;
- Stocking rate of 3,700 clones/ha[2];
- Purchase price - $7.55 NZ per clone[3];
- Planting cost of $2,000/ha (similar to Manuka);
- $1 NZ = $0.67US;
- Hemp flower biomass per plant approximately 0.45 kg[2];
- 20% plant loss between planting and harvest;
- CBD content of flowers average 10%[4];
- CBD biomass sold at $133/kg ($6 NZ per % CBD content/lb)[5];
- Hemp hurd yield of 1.5t/ha at $200 per tonne[1];
- Additional $60,000 pa. for crop labour and harvest[4].

Hemp cannot be modelled in Overseer, therefore a barley crop was used instead. It is important to note that hemp absorbs a significant amount more carbon than barley which is not reflected in the Overseer modelling.

[2] https://www.agweb.com/article/growing-hemp-for-cbd-seed-or-fiber-naa-chris-bennett/
[3] https://www.coloradocbdseed.com/hemp-clones
[4] https://www.agweb.com/article/growing-hemp-for-cbd-seed-or-fiber-naa-chris-bennett/
[5] https://kush.com/blog/cbd-spot-prices-feb-2019/

Table 1: Key modelling outputs

Key outputs

	Base	Hemp (seed and fibre)	Hemp (CBD)	Change from base
Physical				
Number of cows	622	580	580	-7%
Stocking rate (cows/ha)	2.8	2.6	2.6	-7%
Milk solids (kg MS/ha)	1,162	1,080	1,080	-7%
Nitrogen used (kg N/ha)	149	136	136	-9%
Financial				
Gross Income ($/ha/yr)	7,915	7,915	24,418	-
Total Farm Expenses ($/ha/yr)	5,138	5,137	8,740	-
Economic Farm Surplus ($/ha/yr)	2,774	2,776	15,663	-
Environmental				
Nitrogen lost to water (kg N/ha/yr)	42	41		-2%
Greenhouse gas C02 equivalents (kg/ha/yr)				
Methane	7,536	6,769		-10%
Nitrous oxide	3,198	2,907		-9%
Carbon dioxide	998	938		-6%

Table 2: The effect of hemp seed price per kilogram and seed yield per hectare on economic farm surplus (EFS)

Hemp	Yield	-60%	-40%	-20%	0%	20%	40%	100%
Price	kg seed/ha	360	540	720	**900**	1,080	1,260	1,800
-60%	$ 1.82	2,430	2,463	2,496	2,529	2,561	2,594	2,692
-40%	$ 2.73	2,463	2,512	2,561	2,611	2,660	2,709	2,856
-20%	$ 3.64	2,496	2,561	2,627	2,692	2,758	2,823	3,020
0%	**$ 4.55**	2,529	2,611	2,692	**2,774**	2,856	2,938	3,184
20%	$ 5.46	2,561	2,660	2,758	2,856	2,954	3,053	3,348
40%	$ 6.37	2,594	2,709	2,823	2,938	3,053	3,167	3,511
60%	$ 7.28	2,627	2,758	2,889	3,020	3,151	3,282	3,675

Table 3: The effect of price per kilogram of flower and flower yield per hectare on Economic Farm Surplus (EFS)

CBD	Yield	-60%	-40%	-20%	0%	20%	40%	60%
Price	kg/flower/ha	520	780	1,040	**1,300**	1,560	1,820	2,080
-60%	$ 53	1,154	2,537	3,920	5,304	6,687	8,070	9,453
-40%	$ 80	2,537	4,612	6,687	8,762	10,836	12,911	14,986
-20%	$ 106	3,920	6,687	9,453	12,220	14,986	17,752	20,519
0%	**$ 133**	5,304	8,762	12,220	**15,678**	19,136	22,594	26,052
20%	$ 160	6,687	10,836	14,986	19,136	23,285	27,435	31,584
40%	$ 186	8,070	12,911	17,752	22,594	27,435	32,276	37,117
60%	$ 213	9,453	14,986	20,519	26,052	31,584	37,117	42,650

Discussion

Incorporating 10% of effective farm area in hemp (seed & fibre) provides an economic farm surplus of $2,776/ha which is very similar to the dairy farm base model ($2,774/ha). However, gains of $50/ha can be captured for every 10% increase in hemp seed price.

The CBD crop has a significant impact on profitability. It has a very high cost structure ($30,000/ha) but this is compensated by the high returns ($190,000/ha) associated with CBD varieties.

When incorporated into a dairy farm business these profits are diluted with milk income resulting in an overall economic farm surplus of $15,663/ha, equivalent to 5.6 times more profit than the base dairy farm.

The sensitivity tables show that the variability in the Economic Farm Surplus (EFS) is much greater for hemp produced for CBD compared to hemp seed varieties. CBD has a much higher growing cost, therefore if yields and price drop, it will influence economic farm surplus.

There is a 1 kg N/ha reduction in N-loss when growing 10% of the milking area in hemp which is a negligible impact on N-loss to ground water. This small gain is a direct result from running fewer cows. Hemp crops require relative amounts of fertiliser N to reach maximum biomass yields as demonstrated by Finnan & Burke 2013[6]. This study demonstrated that biomass production was optimised at nitrogen applications of 120 kg N/ha at sowing.

There is however a significant positive impact on greenhouse gasses emissions from the farm system when incorporating hemp crops. This was driven by a reduced stocking numbers (eating less biomass) and exporting hemp herbage biomass off the farm, rather than consuming it by animals and converting to methane. This does not take into account increased hemp carbon sequestration (which is not modelled in Farmax).

[6] https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12045

Farmers trialling hemp for CBD production in the USA have demonstrated there are inherent risks associated with growing high CBD varieties[7]. Although most of the risks are not unique to growing hemp (CBD), they carry heightened levels of importance due to the cost of growing and the potential value of the crop. The main risks highlighted are:

- Clone integrity and quality – Some farmers are finding it difficult to access adequate quality clones, resulting in a high percentage of male plants contaminating the crop and rendering them worthless; also, growing clones which are not at the specified levels for CBD content which has a significant impact on profit.
- Industry knowledge and skilled labour - The hemp industry in is relative infancy, therefore, there is a lot of trial and error to maximise biomass production. Hemp CBD is can be viewed as a "high risk, high reward" crop option by dairy businesses, therefore, it is not an option all farmers would be willing integrate.
- Harvesting and processing – High value CBD hemp crops are currently harvested by hand which is very labour intensive and time consuming. New harvesting technology will be established over time to improve labour efficiencies.
- Weather – It is yet to be established which regions or weather conditions are best suited to maximise biomass or CBD production (in an outdoor growing situation), however, like any cash crop (grain, pulses) weather conditions through the growing and harvest cycle will have a significant impact on production and profit.

To secure adequate quantity and quality of CBD biomass for processing, there would need to be a high level of quality control across the hemp CBD value chain. Therefore, if dairy farmers were to integrate hemp (CBD) into their systems they would need strong guidance and support through the growing and harvesting process to meet the required standards.

A contract planting and harvesting service model would assist with risk mitigation for famers. Another option is a farm-lease (all or portion of farm) model if the processor was willing to oversee and control the growing process. This would increase the risks for the processor, but potentially increase the quality and quantity of product for processing.

Conclusion

Integrating hemp seed and fibre crops into a dairy system would be a viable option financially whilst also acting as tool to reduce greenhouse gas emissions on-farm. More scientific work is needed to be able to quantify the direct impact of hemp on carbon and nitrogen in the atmosphere and soil for the models.

Profitability is maintained (seed) or increased (CBD) and emissions are reduced which are two key factors that would support adoption of a hemp crop in a dairy system (and be attractive to Government). However, there needs to be further consideration to the level of control throughout the growing/harvesting process to ensure a constant supply of quality product being produced at minimal risk.

[7] https://www.agweb.com/article/growing-hemp-for-cbd-seed-or-fiber-naa-chris-bennett/