Biofuel feedstocks as co-products on dairy farms: income and sustainability benefits.

- Project Update. Period: January to April 2014

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Funders: Westland Milk Products Ltd. and DairyNZ, + support from AgResearch and Lincoln University

Season Two

Fig.1: Miscanthus x giganteus (Mxg) shelterbelt; Paddock 21, Aylesbury Farm, Feb 17, 2014.

Miscanthus (Mxg) growth

Second-season Mxg shelterbelts

Under renewed irrigation, following repair in November of the centre pivot damaged in the September gales, growth rate of established Mxg shelter has remained impressive with paddocks 21 (Fig.1) and 6 reaching an average height of 2.0 m and 1.8 m, respectively, by mid-February. Maximum height for both shelterbelts was 2.3 m. Expected maximum height at the end of season 2 is 3 m so despite early setbacks from no irrigation during the spring drought these Mxg plants demonstrated impressive growth rates.

Mxg shelter in paddock 22 has also continued to show good recovery from the severe early season setbacks of drought and vehicle damage during pivot
repair. Despite no visible growth until mid-November average height is now 1 m without any loss of plants. It will be interesting to see how this year’s reduced growth affects next season’s performance.

**New planted Mxg shelterbelts**

The average height after 3 months growth for the new plantings this season is 35 cm for paddock 12 and 24 cm for paddocks K2 and K3. Average height for all paddocks at this stage last season was 50 cm. K2 and K3 are both irrigated with a rota-rainer and have had reduced irrigation compared to the centre pivot used elsewhere on the farm. This shows the necessity of adequate irrigation for attaining high yields in Canterbury. The rota-rainer delivers 36 mm each pass but was irrigating paddocks only every 8 days. On dry windy days evapotranspiration rates would be higher than the average daily amount of water applied and the soils would be in a state of negative water balance. This was reflected in soil moisture readings which were as low as 12% by volume $\theta_v$ on some occasions. This also illustrates the benefit of sheltering pasture from the effects of drying winds. The centre pivot at Aylesbury farm delivers a higher application rate of water and soil moisture levels of paddocks irrigated with the centre pivot never drop below 25% by volume.

The new plantings in paddock 12, although not yet under the centre pivot due to delay in replacing the end boom, have had adequate irrigation due to K-lines being installed and were one third taller than those in K2 and K3. Mxg plantings last season also performed better than these plants and this may be a reflection of higher sunshine and temperatures. Good establishment is important as research indicates that poor first season growth can delay attainment of maximum yield potential; however by season 5 planting density and initial growth are no longer limiting factors (Danalatos et al 2007).

**Shelter effects on pasture growth**

![Fig.2: Differences in grass growth between (a) unirrigated and (b) irrigated areas, Aylesbury Farm, Dec 30, 2013.](image)
After repair of the centre pivot pastures recovered quickly from drought (Fig.2) and shelter benefits on pasture growth started to become apparent. C-Dax readings taken at the end of February showed an increase in yield of 12% in the area of paddock 21 sheltered by the Mxg plants and in paddock 6 the yield increase was 10%. One possible driver for this is that leaves of pasture plants sheltered from the wind keep their stomata open longer, shown by a higher rate of stomatal conductance, due to reduced effects of water stress. As a result, they photosynthesise longer, resulting in more growth.

Stomatal conductance measurements were taken using a porometer (Fig.3) during late spring and summer and the results show that during drying northerly winds there is a higher level of conductance in sheltered clover plants. Clover leaves were chosen as they fit the measuring chamber better than ryegrass leaves. Fig. 4 shows average readings taken between 11.30 h and 15.30 h in paddock 21 on 23 January 2014. A strong north-westerly wind was blowing and the average temperature was 19 °C.

Fig. 3: Decagon porometer used for measuring stomatal conductance.

Fig. 4: Differences in stomatal conductance between sheltered and open-paddock area. Paddock 21, Aylesbury Farm on 23 January 2014.
Improved pasture yield

Using data collected from C-Dax pasture readings AgResearch produce maps illustrating the heights of pasture across the paddock. Fig.5 was produced from C-Dax readings taken from paddock 21 on 14 February 2014. Dots on the map indicate where readings from the C-Dax have been taken. The shelter area and control area are 40 m by 40 m in size and this is where concentrated C-Dax readings are taken. These areas have also been used to collect soil samples, pasture quality samples and record dung pat numbers post grazing. Comparing these two areas gives a direct comparison of pasture production with and without shelter. The remainder of the paddock is measured by passes of the C-Dax approximately 10 m apart and this provides a record of pasture growth over the whole paddock. Fig.5 shows that pasture height is highest near to the Mxg shelterbelt and also a possible shelter effect can be seen in the form of higher grass growth extending out from the shelter area.

Reduced evapotranspiration rates

Mobile data logging equipment has been built by Lincoln University technician Stephen Stillwell and this is being tested in the University nursery (Fig. 6) before being placed on farm. By using the meteorological data this collects and interpreting these data using the Penman equation for calculating evapotranspiration rates comparisons between sheltered areas and open paddock can be performed.
Cattle and shelter

One of the unanswered questions surrounding the provision of shelter for cattle is do they actually use it? Events at the beginning of March, when there was wet weather and a severe southerly winds blowing for three days, go some way to resolve this. When placed in paddock 21 for the night, most of the cows congregated at the northern end of the paddock as they turned their backs to the wind and walked until they found shelter or could not go any further.

The consequences, as illustrated in Fig.7, were severe pugging of the paddock and as the cows broke into the Mxg shelter, they stripped the leaves from the plants. The advantage of having Mxg as a shelterbelt in this case is that it will
regrow and these plants have already started to produce leaves. Also, despite the 300 to 400 cows trampling through it, most of the stems remained upright. More importantly is the loss of production from the pugged pasture which could be as much as 30% over a season.

The fact that the cows behaved in exactly the same way the next day in a paddock with no shelterbelt shows they do walk away from the prevailing wind. However if the Mxg had been planted all around the paddock, and was at its full height of 4 m, the cows may have been sheltered enough from the southerly wind to not walk to the northern end of the paddock. When the springers (cows due to calve) were put into paddock 21 the next day, they did turn their backs to the wind but also made use of the limited shelter (due to early-season damage) afforded by the Mxg shelter in paddock 22 (Fig.8).

![Fig.8: Cows sheltering from a southerly wind in paddock 21, Aylesbury Farm, 2 March, 2014.](image)

**Presentations and media promotion**

On January 27 a group from DairyNZ, hosted by Ina Pinxterhuis, PhD, Senior Scientist, South Island, visited Aylesbury Farm to find out how Mxg can benefit dairy farms and become an integrated component of the farming system. This was organised as part of DairyNZ’s funding agreement which involves passing on information about this research to the wider dairy industry.

In February I gave a talk on our research at the 2\textsuperscript{nd} National Conference on Biological Farming Systems at Rotorua, 20 – 21 February 2014. This was well received and generated considerable interest, the furthest of which was from a delegate based in Malaysia. Since then we have Mxg enquiries from Iran.
On 13 March TV3 News filmed Prof. Steve Wratten and I (Fig.9) at Aylesbury Farm for a news item on our Mxg research. This was screened on March 17 and can be viewed at


Fig.9: Chris Littlejohn and Steve Wratten being filmed for TV3 News, 13 March 2014.

As a follow-up to this news coverage and as a ‘teaser’ for the Open Day which will be held at Aylesbury Farm on 14 May, Steve Attwood,(Convergence) representative for Westland Milk Products Ltd., is organising a press release to further promote this research. The Open Day will be primarily aimed at invited representatives from the dairy industry and associated interested organisations including banks. Another more farmer oriented Open Day will be held next season.

Journal submissions

A journal article on the ecosystem services (ES) and ecosystem dis-services (EDS) provided by Mxg as a shelterbelt on dairy farms is being prepared with a view to submission late winter. This will analyse a number of ES (e.g., improved pasture production, reduced irrigation need, improved pollination rates) and EDS,( e.g., flammability, pugging), and an attempt will be made to provide a monetary value for these. Helping with this will be Katie Bicknell, Senior Lecturer in Economics at Lincoln University, and it is great that Katie has offered her expertise for this.
Thanks

I wish to acknowledge those who have given their support to this project, in particular the funding from Westland Milk Products Ltd and DairyNZ, and the welcome assistance and equipment from AgResearch. From all the media attention the work is receiving it is clear that this work is novel and of high potential.

Regards

Chris

References