

Biochemical methane potential of timothy, tall fescue and red clover silages harvested at different stages of maturity

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Euroopan maaseudun
kehittämisen maatalousrahasto:
Eurooppa investoi maaseutualueisiin

A vertical photograph on the left side of the slide shows a large pile of green grass silage being processed. The silage is being cut into small pieces, which are flying through the air, creating a misty or dusty atmosphere. The background is a clear blue sky. The silage is piled on a red surface, likely a conveyor belt or a large container.

Background:

- In Finland grass silage is one optional raw material for biogas production
- The production costs of grass silage should be covered by the price of methane, not yet economically feasible
- Is there any possibilities to cut down the production costs of grass silage?



- machinery costs make up one third of the silage production costs (Peltonen, 2010).
- Typically dairy farms have effective machinery to harvest the silage as optimal harvest time is only one week in first cut

April						
Su	M	Tu	W	Th	F	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

May						
Su	M	Tu	W	Th	F	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

June						
Su	M	Tu	W	Th	F	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

July						
Su	M	Tu	W	Th	F	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27

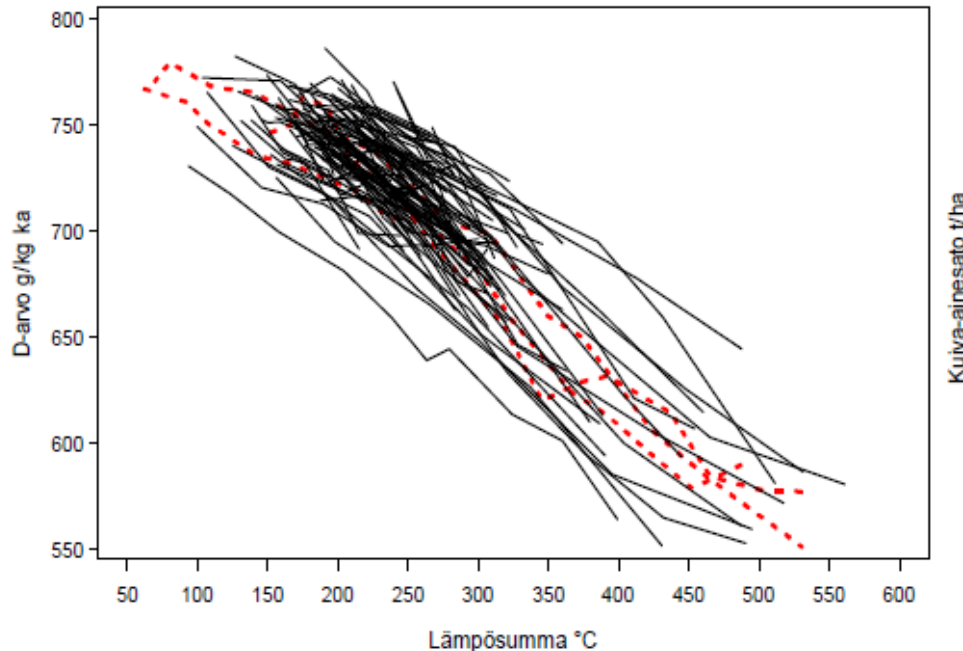
August						
Su	M	Tu	W	Th	F	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24

September						
Su	M	Tu	W	Th	F	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

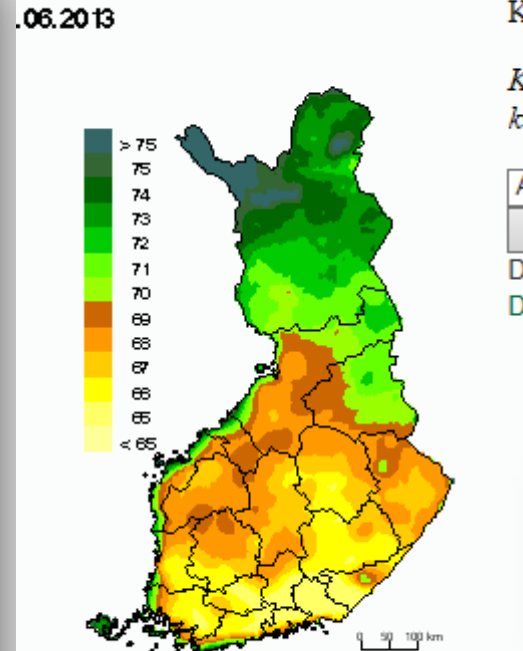


- One possibility to reduce machinery cost is to divide the capital cost over a larger amount of silage harvested. If the optimal harvest time for a biogas plant differs from the optimum of a dairy herd, the same machinery could be utilized for both purposes.
- Is it possible to delay the harvest ? How rapidly does biochemical methane potential (BMP) drop when grass matures?

Quite much research work is already done related to relationship between digestibility, grass maturity and the weather conditions, but there is not data available how these are reflected to BMP of the harvested grass silage



Kuiva-ainesato t/ha



Materials and methods:

- **12 frozen silage samples** collected in earlier experiments as time series of harvest times

- 6 samples silages from grass species, primary growth:

- mixture sward timothy/meadow fescue (*Phleum pratense* / *Festuca pratensis*)

- tall fescue monoculture (*Festuca arundinacea*)

both harvested at three different stages of maturity

- 6 samples, silages red clover (*Trifolium pratense*) monoculture: two primary growth and four regrowth silages



• Särkijärvi, S., Sormunen-Cristian, R., Heikkilä, T., Rinne, M., Saastamoinen, M. (2012) Effect of grass species and cutting time on in vivo digestibility of silage by horses and sheep. *Livestock Science* 144, 3, 230-239.

• Kuoppala, K., Rinne, M., Tuori, M., Pursiainen, P. and Vanhatalo, A. (2006) Puna-apilasäilörehujen sulavuuden määrittäminen laboratoriomenetelmin. In: Happonen, A. (eds) *Maataloustieteen Päivät 2006*. Suomen maataloustieteellisen seuran tiedote 21, 7 pp.

Materials and methods:

- **In vivo digestibility measured in digestibility trial using sheep**
- **in vitro digestibility measured using cellulase method**
- **indigestible NDF content of the silages measured using nylon bag technique as 12 days incubation in rumen**
- **dry matter, ash, crude protein, ash, NDF, ADF, lignin**

- **Biochemical methane potential (BMP) measured using the automated methane potential test system (Bioprocess Control AB, Sweden)**
- **BMP measured as three replicates – only 12 samples could be measured at the same time**



Which of the parameters are able to explain differences in BMP potential?

A regression model $Y_{ijk} = A_i + B_j \cdot X + e_{ijk}$ was fitted to the data separately for each independent continuous numeric variable, using REG procedure of SAS.

Units are presented on DM bases as this is the practice of the D-value predicting services available at the moment in Finland.

- **Grass silages**

BMP was 344 l CH₄ kg⁻¹ VS and BMP decreased with increasing maturity.

- *in vitro* digestibility predicted the BMP with a high coefficient of determination ($R^2 = 0.79$).
- In spite of the high correlation, the slope between BMP and D-value had a small value.



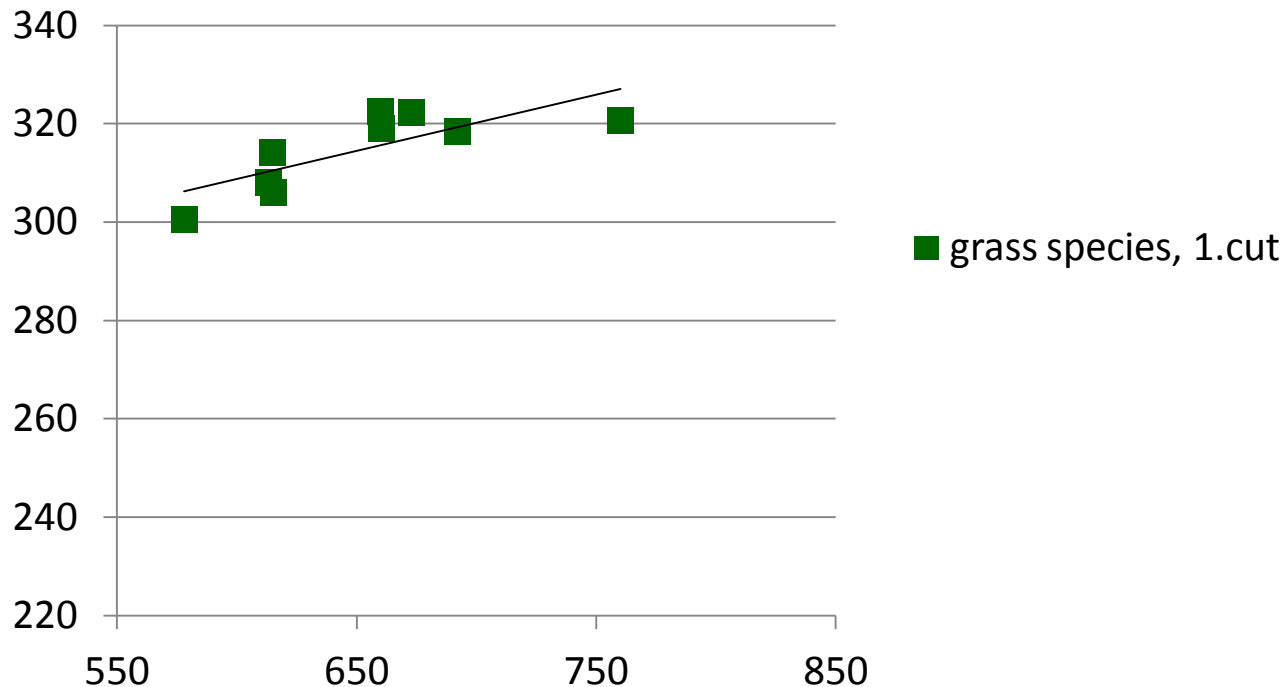
Results:

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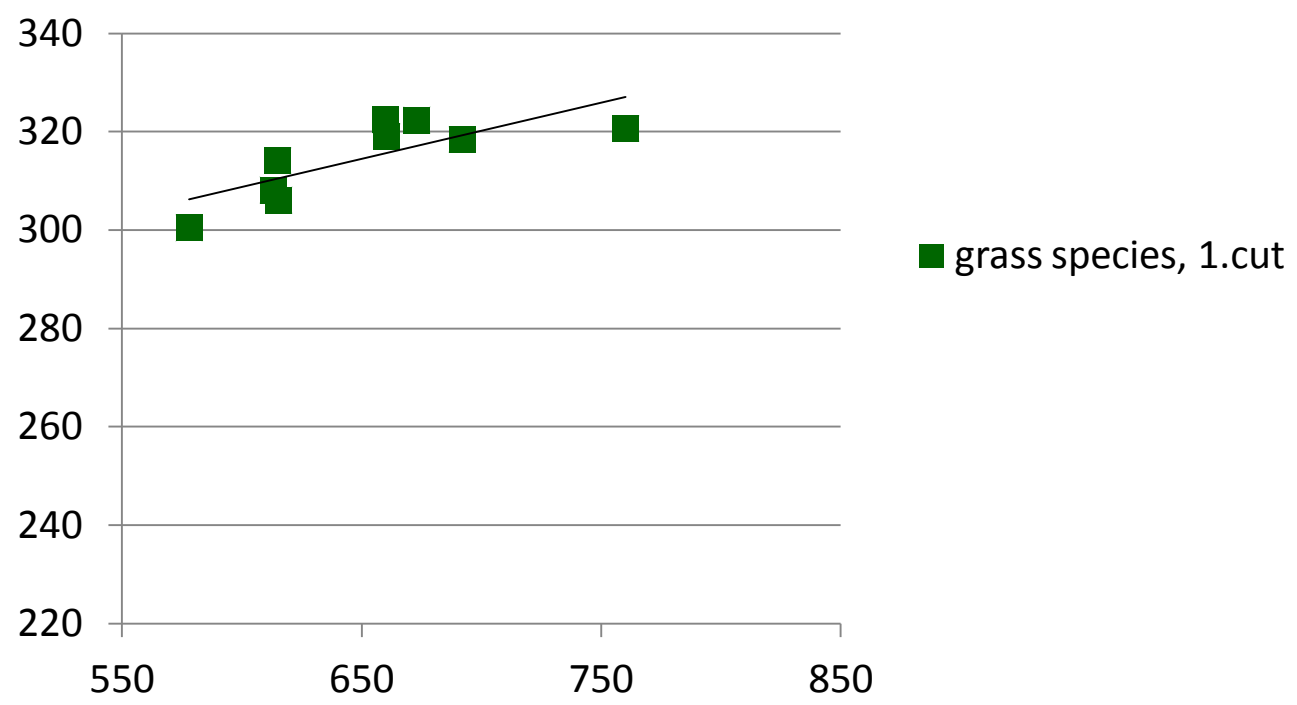
Some more samples



- **The practical value of the result:**

It seems that BMP of the grass primary growth can be predicted using the same system developed for milk production

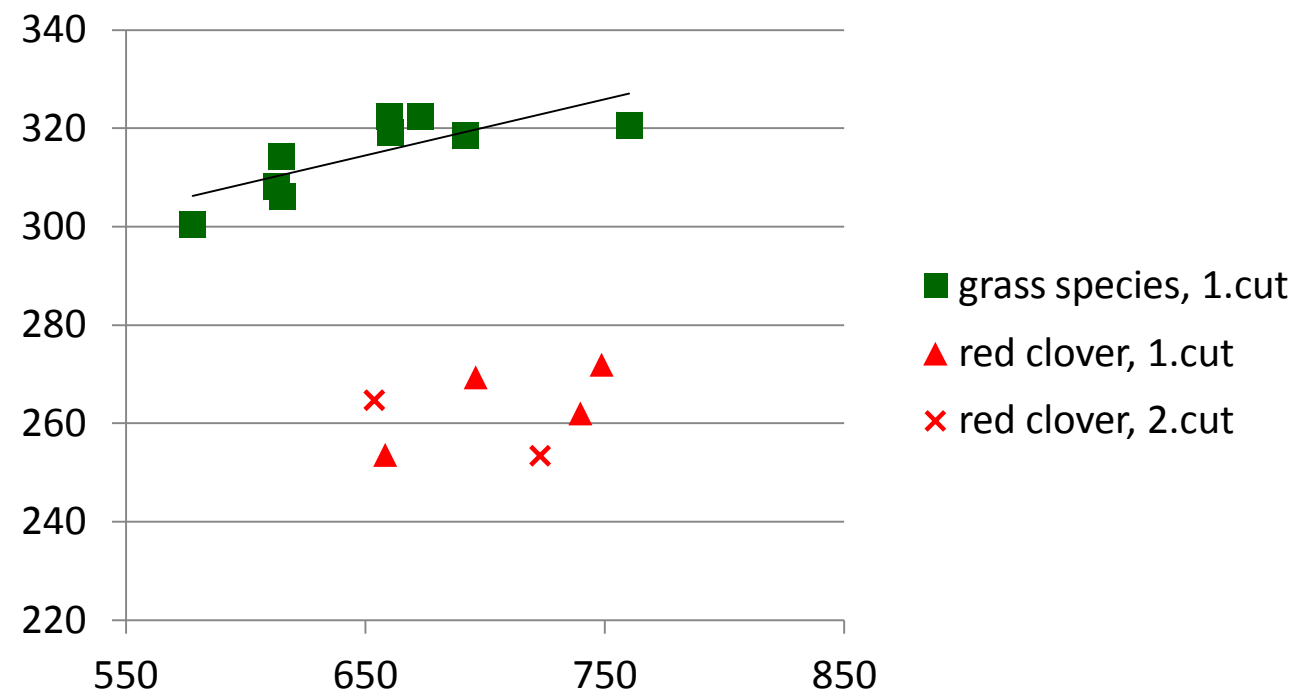
However, when D-value changed from 700 to 600 g kg⁻¹ DM, the BMP decreased only 5 %.



- **Red clover**

The average BMP of clover silages was 291 l CH₄ kg⁻¹ VS.

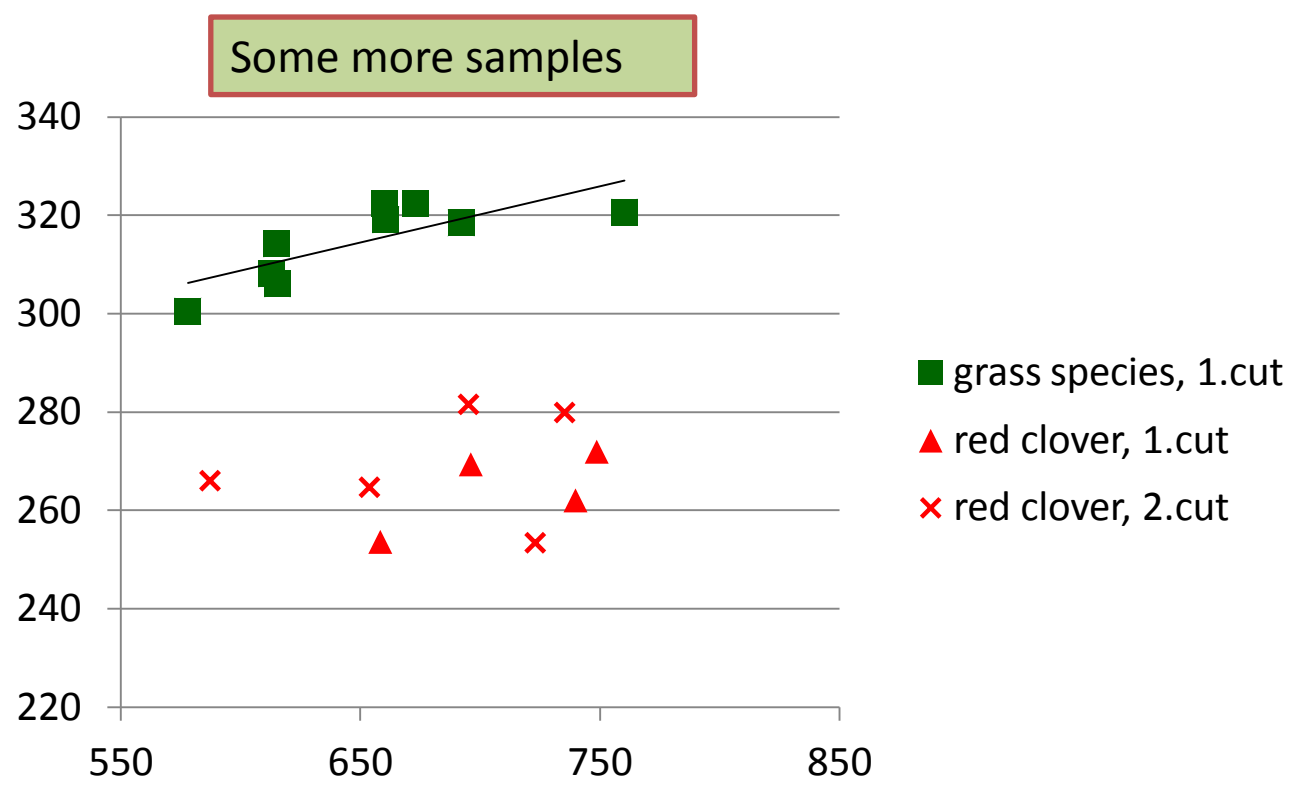
- Unlike grass silages, the differences in chemical composition or digestibility of the clover silages did not explain the differences in BMP results in this data.



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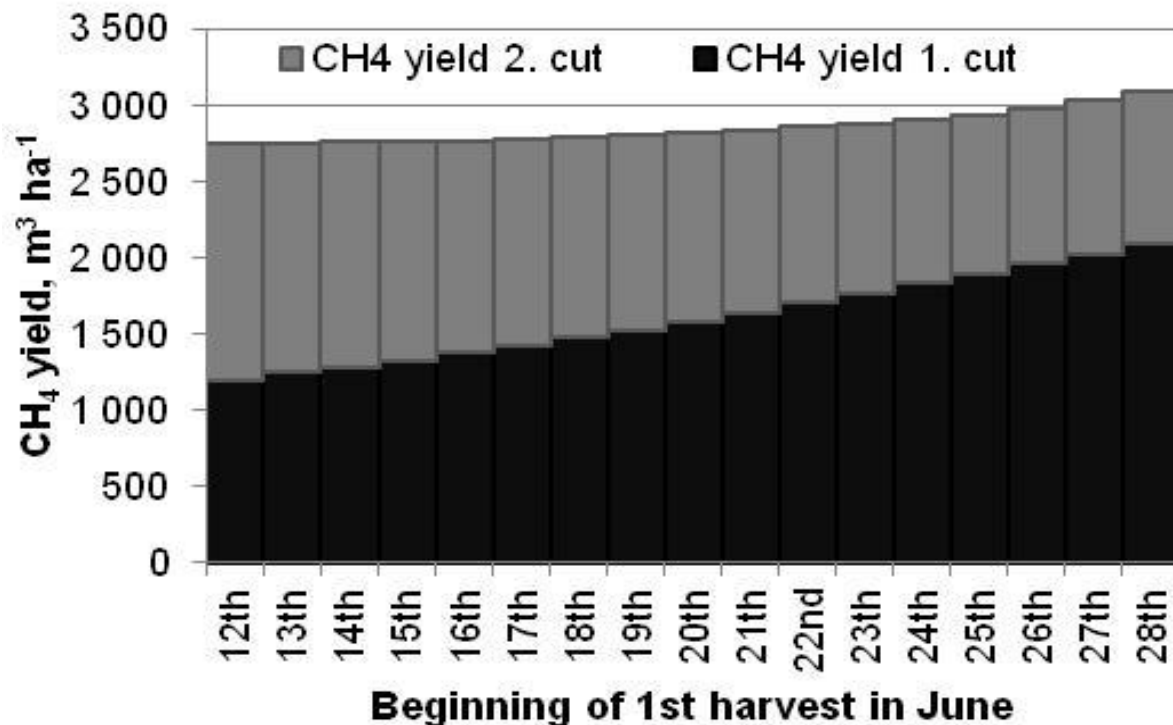


The combined effects of changes in grass maturity and yield on total methane yield were demonstrated assuming that the start of harvest of primary growth varied.

- Weather data from 2010 and
- Finnish forage yield and quality models

- Timing of first cut was restricted so that digestible organic matter was 570 – 730 g kg⁻¹ DM
- and the start of the second cut started 30 days after the finish of first cut but not earlier than 30th July.

When combined with the yield accumulation data, it is concluded that towards the end of June the yield increases rapidly compared to the decrease in BMP. Based on these calculations, postponing the first harvest appears to be beneficial for a biogas plant.

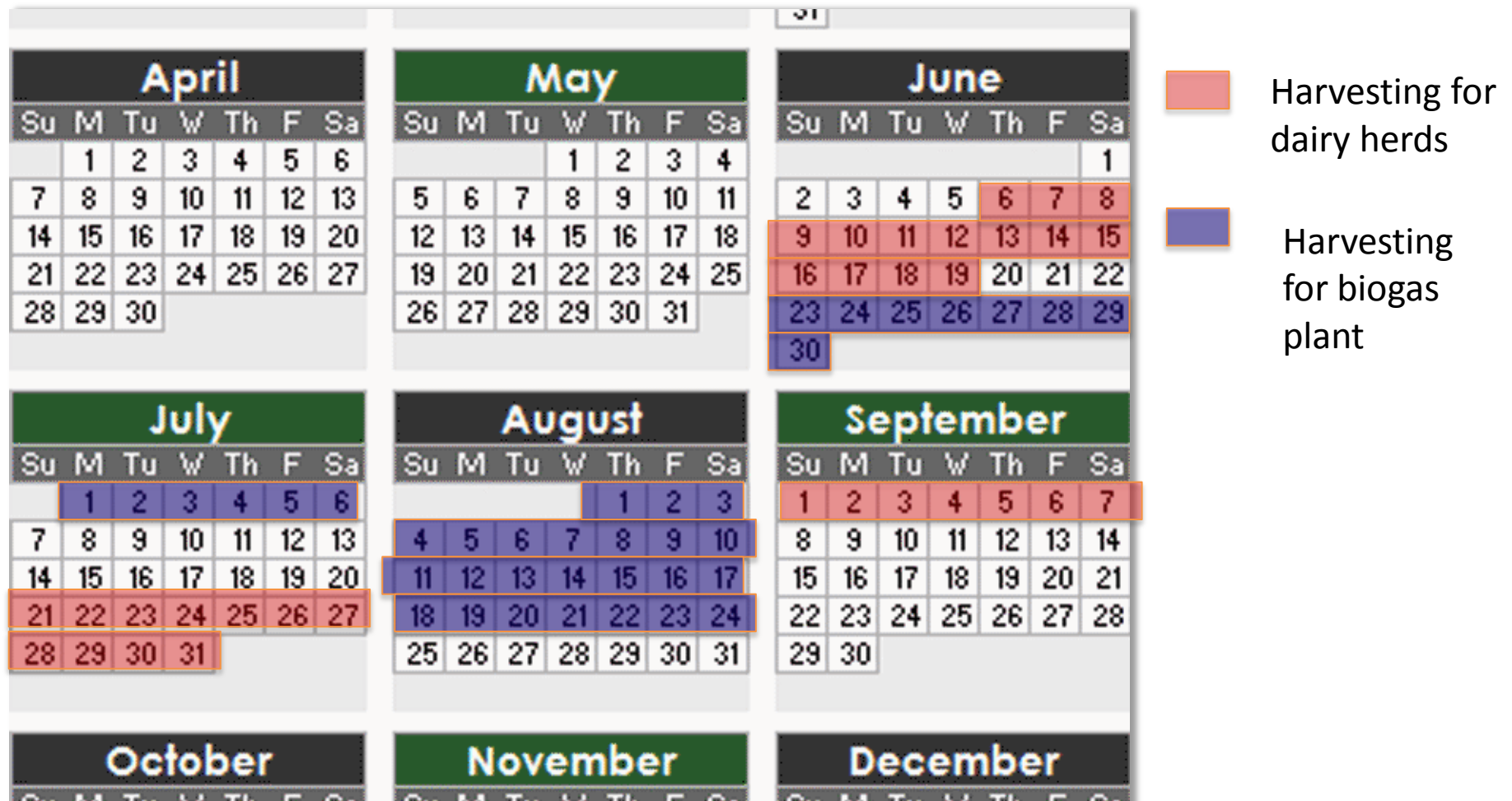


In the calendar of contractor:

- Work for the whole summer, better summer job for good drivers
- Easier to invest to good machinery

Benefit for both dairy herd and biogas plant:

Possibly more efficient system is reflected as lower harvesting cost



Thank You! Kiitos!

Silage harvested in the midnight sun in Jokioinen, in Southern Finland

