TECH NOTE 2
Complementary Forage Systems
Planning—Is CFS for me?

FutureDairy investigated options to mitigate the ever-increasing limitations imposed by land, water and labour availability and cost in Australian dairying.

A key strategy for farmers is to increase home-grown forage production and consumption. This, in turn, can improve profitability. FutureDairy has proved that forage yields from complementary forage rotations (CFR) can be more than double those of pasture. This has been demonstrated on both research and commercial farms.

Complementary forage systems (CFS) integrate CFR into pasture-based dairy systems. This can be done in many different ways and tailored to individual farmers' needs.

When using forage crops, FutureDairy's approach is to start by setting goals that are based on what is possible (and then determine what is feasible) rather than constraining goals based on known limits to the current farm situation.

FutureDairy has shown that production of ~30,000L milk/ha or ~2,000kg milksolids/ha from home-grown forages and more than 7,500L/cow (>500 kg milksolids) are achievable with only ~1t of concentrate/cow.

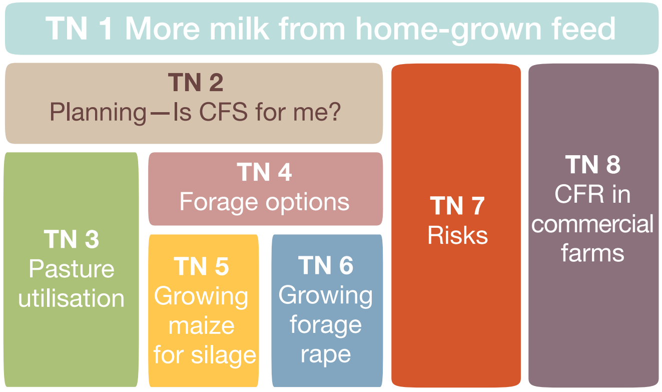
Complementary forage systems may allow you to:

- **Increase total forage yield, and therefore milk from home-grown feed, and farm productivity and profitability.**
- **Replace more expensive bought-in supplements (thus potentially reducing economic risk).**
- **Increase the efficiency of use of nutrients and water.**

This tech note describes:

- **A step-by-step process for the first stage of whole system planning—a general assessment of the suitability of CFS as an option for your farm.**
- **An example of how to apply CFS principles on your farm.**
- **The applicability of FutureDairy's Feedbase Planner tool.**

This tech note reports on FutureDairy's findings. Further work/discussion is needed regarding the specific application of these findings in different commercial dairy systems.



Complementary forage systems (CFS) integrate the use of forage crops into a pasture-based system to increase the amount of feed produced on farm and, from this, farm productivity. These integrated systems offer Australian dairy farmers a real and proven option to profitably increase productivity from home-grown feed or reduce a farm's reliance on more expensive bought-in feeds.

FutureDairy has developed this series of CFS tech notes that will help you to:

- Understand what CFS is about.
- Assess whether CFS is an option for your farm or not.
- If yes, plan the feedbase needs of your farm and decide what forages could best suit your needs.
- Grow and manage the most common forages used in a CFS.

In other tech notes of this series (www.futuredairy.com.au) you will find details of the capacity for complementary forage systems to increase productivity as well as a process of how to implement CFS on your farm.

Planning is a crucial part of that process and is dealt in more detail in this tech note.

This tech note will help you answer the questions:

- **Is CFS an option for my farm?**
- **Can CFS help me meet my personal and business goals?**

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What kind of plan?

There is rarely one 'right' or 'wrong' technical solution that suits all farms. This is because price of milk, input costs, seasonal conditions, farm infrastructure and human resources are highly variable and farmer circumstances are very individual.

A farm plan can be seen as a two-staged process:

Stage 1: Assessing the farm's business directions. It considers questions such as:

Where do I want to take this particular farm?

Do I need to produce more milk?

Do I need to increase milk production from home-grown feed?

This tech note helps you consider these issues.

Stage 2: Making specific decisions for your particular farm including how to get there, capital investment, full costs, risk etc. This must be tailored to your individual situation and is beyond the scope of this tech note.

This tech note focuses on stage 1, the general assessment of feedbase planning, and more specifically on the question: *Is implementing a complementary forage system on my farm likely to meet my production goals?*

For simplicity, we call this general evaluation of the potential implementation of CFS on your farm the 'plan.'

The plan

The plan shows how a complementary forage system can increase milk production from home-grown feed or reduce reliance on concentrate. The plan should be simple, goal motivated, conservative and strategic.

Simple: A common mistake in farm planning is trying to fine tune too much too soon. Remember, the first task is about evaluating the potential of CFS to increase productivity. More complex details or fine tuning of the business case may be required but at a later stage in the planning process.

Goal motivated: An appropriate goal will drive the plan.

Conservative in its assumptions: This is not a contradiction with the above. Having clear goals will help to push boundaries. But making unrealistic assumptions in terms of forage or animal production will be detrimental and frustrating!

Strategic in its timeframe: Strategic or longer-term planning needs to come first. There is little advantage in doing any tactical or short-term planning if the more strategic goals of the system are missing.

Planning approach

Traditional feedbase planning in agricultural systems often starts at the 'paddock' and then considers the 'system'. This means questions such as 'what can I grow in this paddock?' are asked before questions like *'what feed do I need and when do I need the feed from this paddock? Or, more importantly, how much profit do I need from my farm?'*

FutureDairy advocates a proactive and efficient approach where the desired goal of pushing the boundary is clearly defined. In both commercial and research farm settings FutureDairy planning started with setting business goal/s which drive production, system and feedbase goals. This is shown in Figure 1.

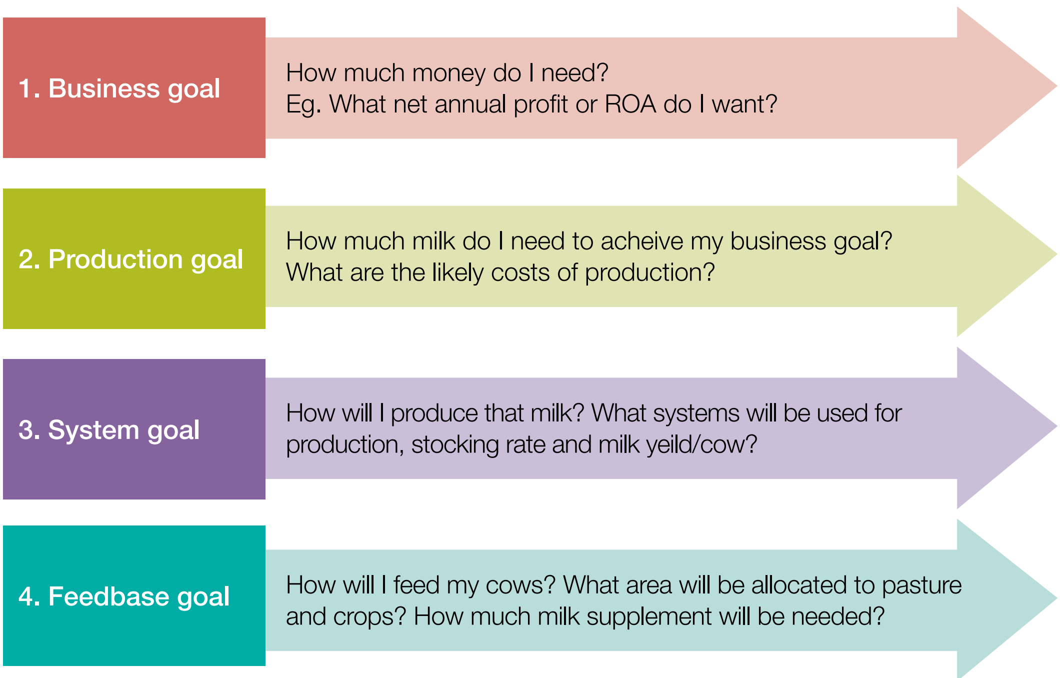

Figure 1. The 'goal' sequence in FutureDairy's planning process.

The hypothetical farm

To illustrate the feedbase planning approach, we use an example of a hypothetical 100-ha farm—Bill's farm—in which a complementary forage system can be an option to achieve the physical targets and from this, Bill's business goals.

Setting goals

Once Bill has determined his business goals, he will have a general idea of how much milk per farm or per hectare he should be aiming for. This will be based on his current system performance, cost structure, production costs etc.

Suppose Bill's current production is about 14,000 L milk/ha, or about 950 kg milksolids (MS) per hectare. This is already 40–50% above the national average. Bill has determined he needs to produce more than 20,000 L/ha hectare (about 1,400 kg MS/ha) to achieve his business goals. He is not sure how to do this or where to start. This is where FutureDairy's CFS planning process can help.

Let's assume Bill's cows average 7,000 L milk/lactation (or about 500 kg MS) at a stocking rate of 2 cows/ha on perennial pasture and concentrate only (Table 1). Bill wants to maintain individual production at that level.

Table 1. Bill's current system.

Production per ha	14,000 L or about 950 kg milksolids
Production per cow	7,000 L milk/lactation (or about 500 kg MS)
Stocking rate	2 cows/ha
Feeding system	Perennial pasture and concentrates only
Herd	200 Holstein-Friesian cows
Milking area	100 ha
Calving pattern	Year round
Replacement rate	25%
Average daily milk production	22 L/cow

To achieve his new target of about 20,000 L milk/ha Bill will have to increase stocking rate to about 3 cows/ha (3 cows x 7,000 L = 21,000 L milk/ha or about 1,500 kg MS/ha).

Increasing stocking rate by 1 cow/ha can be very challenging and requires very careful consideration of the impact on the system, including:

- Extra capital required to purchase the cows (if growth is in one step).
- Extra replacements (if growth is gradual).
- Capacity of the dairy.
- Extra time/labour required to manage and milk the extra cows.
- Feeding facilities (e.g. troughs, feedpad, resting areas, etc).
- Condition, size and distribution of the laneways.
- Factors associated with region, climate and type of predominant soil.

For simplicity we assume here that none of the above factors are a limitation for Bill's farm.

Is a CFS for Bill?

The key question then becomes: how does Bill plan for the larger herd without accessing more land? Is a complementary forage system an option for Bill?

To determine whether a CFS is an option, Bill will need to do some simple calculations as follows:

1. Quantify demand (herd requirements).
2. Define the pasture/forage base.
3. Balance energy deficits.
4. 'Challenge' the system (improved situation).
5. Check impacts of changes (mainly business/financial).

Feed demand

The new herd's requirements can be calculated in terms of either dry matter (DM) or metabolisable energy, (ME). FutureDairy uses metabolisable energy as it reflects the amount of energy that the animal can use for maintenance and production. This requires some key data from Bill's system goals (Figure 1), namely, the target stocking rate, target milk yield/cow and average live weight of the cows.

Table 2. Bill's goals.

Target stocking rate	3 cows/ha
Target milk yield/cow	7000 L or 500 kg MS per lactation
Average live weight	average live weight: 600 kg/cow

FutureDairy's Feedbase Planner uses metabolisable energy to calculate the changes in production.

Requirements can be calculated on a seasonal, monthly, fortnightly, weekly or even daily basis. Seasonal is the minimum timeframe required. Monthly interval is a good compromise between detail and simplicity and is the timeframe used in FutureDairy's Feedbase Planner.

With about 70% of the adult cows calving within each 12-month period, there would be a total of 158 cows and 57 heifers calving each year (replacement rate = 25%), to give an average of 200 cows in milk over the year.

The expected monthly mean milk yield per cow, milk fat and milk protein contents are needed to calculate requirements. Bill's cows produce an average of 22 L/day (about 1.5kg MS).

Table 3. Typical pasture growth rates (kg DM/ha.day) at Camden, for low-medium fertiliser and irrigation input kikuyu-based pasture oversown with short rotation ryegrass and for non-irrigated kikuyu pasture.

	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Kikuyu + SRR* (irrigated)	42	45	25	20	20	18	20	25	55	48	28	35	31.8
Kikuyu (non-irrigated)	20	20	15	10	5	0	0	0	10	25	30	25	13.0

* SRR: short rotation ryegrass

Bill can use this information (number of cows lactating and dry each month, liveweight and milk yield) to calculate energy requirements using simple equations such as those in FutureDairy's Feedbase Planner or tabulated energy requirements. If unsure, contact FutureDairy or seek advice from your consultant or service provider.

Pasture base

The second step of the planning process is to evaluate the forage options (pasture and crops if needed). This is the most difficult part of the feedbase planning process as it requires some knowledge or information of seasonal growth patterns of different forages.

The basic requirement is to have an estimate of monthly averages of pasture growth rate for the pasture types most common in your area or the ones you are using on your farm currently. These include:

- Perennial ryegrass–based pasture.
- Kikuyu-based pastures (mostly for NSW and QLD).
- Annual winter crops (e.g. short-rotation ryegrass; oats; rye; corn; barley).
- Annual summer crops (e.g. sorghum; millet).

It is advisable to model the current situation first and check if feed demand and feed availability are in line with farm's current performance.

Ideally the growth rate should be 'net growth or net accumulation rates'. For example, a growth rate of 20 kg DM/ha per day means that there are potentially 20 kg DM/ha per day that can be grazed and utilised by the cows. There is a specific tech note of this series that explains FutureDairy's pasture management approach in more detail. FutureDairy recommends obtaining growth rate data from local sources (agronomists, service providers, consultants and/or research station).

If using regional growth rates, adjust them according to your own skills, knowledge, confidence and experience as these will have a large impact on what is actually achieved.

You can 'represent' the current feedbase situation of your farm using the current growth rates and areas (in Bill's example a 100-ha farm) with different pastures.

You can start to balance the energy available from the feedbase with herd's requirements, using the knowledge of cow numbers, target production and growth rates for each pasture/forage type (and areas).

FutureDairy's Feedbase Planner is a simple budgeting tool to help with this task.

The current situation with 2 cows/ha

Let's continue with Bill's farm of 100 ha of effective area. Bill's whole farm has permanent kikuyu-based pasture with about half of the area under irrigation. Consequently only this area (50 ha) is oversown with short-rotation ryegrass each autumn. The farm has 50 ha of non-irrigated kikuyu pasture (low production) and 50 ha of well-irrigated kikuyu pasture oversown with ryegrass (high production).

Now refer to pasture growth rates for your area. Growth rate estimates for dryland areas are more difficult to predict than for irrigated pasture, as actual growth rates will change substantially between wet and dry years. Remember to be conservative in the assumptions—use average or less-than-average year data. For Camden, NSW (where most of FutureDairy's feedbase work has been carried out), typical growth rates for low to medium fertiliser input are shown in Table 3.

These growth rates give potential pasture utilisation of about 11 t DM/ha for irrigated pastures and about 5 t DM/ha for non-irrigated pastures.

The aim is to get an initial balance of energy available (from your pasture-base) and energy required (from your herd's requirements) as shown in Figure 2.

The shaded area in the graph represents the herd's energy requirements and the broken line represents the energy available from the pasture base. In this example the available pasture comes from 50 ha of irrigated kikuyu-based pasture oversown every autumn with short rotation ryegrass and 50 ha of non-irrigated kikuyu pasture (Table 3).

The graph clearly shows that Bill's farm could not sustain the current stocking rate (2 cows/ha) with pasture only. The next step is to estimate of how much supplement will be needed to meet energy requirements.

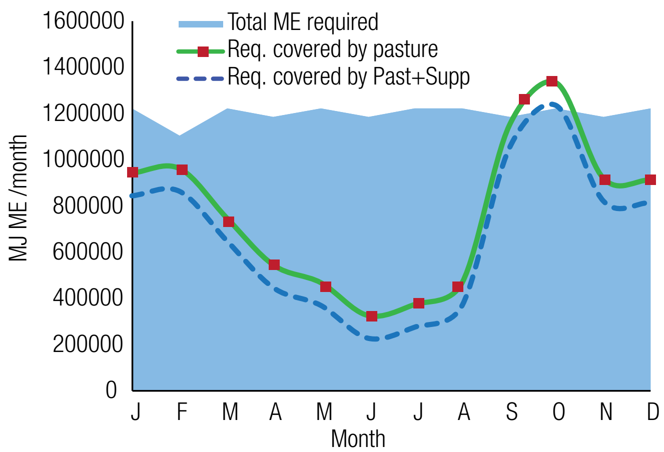

Figure 2. Monthly total energy (MJ ME) requirements (shaded area) and energy covered by grazed pasture (line).

Table 4. Achievable pasture growth rates (kg DM/ha.day) of kikuyu-based pasture oversown with short rotation ryegrass (and short rotation ryegrass alone) with medium-high level of fertiliser and irrigation input and for non-irrigated kikuyu pasture. Growth rates of dryland kikuyu are the same as those in Table 2.

	Area (ha)	J	F	M	A	M	J	J	A	S	O	N	D	Mean
		Daily growth rate (kg DM/ha)												
Kikuyu + SRR* (Irrigated)	35	55	50	35	30	22	22	24	35	60	65	45	50	41.0
Kikuyu (Non-irrigated)	50	20	20	15	10	5	0	0	0	10	25	30	25	13.0
SRR*	15					35	30	25	25	45	60			37.0

*SRR: short rotation ryegrass

Balance energy

The third step is to balance energy requirements. Bill is using only grain-based concentrates fed in the dairy and bought-in hay fed in the paddock as required. Feeding an average of 4.5 kg/cow of concentrate per day (varying from 4 kg/cow in spring to a maximum of 6 kg/cow in winter) will go a long way to reduce the energy deficit. But there will still be a feed gap in winter when a large amount of supplementary hay (about 1.1 t DM/cow per year) is required. There could be many different combinations of grain and hay in this case but for Bill, this is a relatively expensive situation as both feedstuffs are bought-in.

Figure 3 shows the new energy balance of this farm after feeding the concentrates and the hay. Now the broken line has separated from the square-symbol line to represent the total energy supply (pasture plus supplements, broken line) from the pasture only energy supply (square-symbol line).

There is a small surplus of energy in spring indicating concentrate intake can be reduced during these months or just left as safety margin in the planning exercise.

Challenge the system

The fourth step is to challenge the system. Bill needs to increase stocking rate by 1 cow/ha to achieve his production and business goals. The question then is: how can Bill do this on 100 ha given that the system seems to be constrained already with only 200 cows?

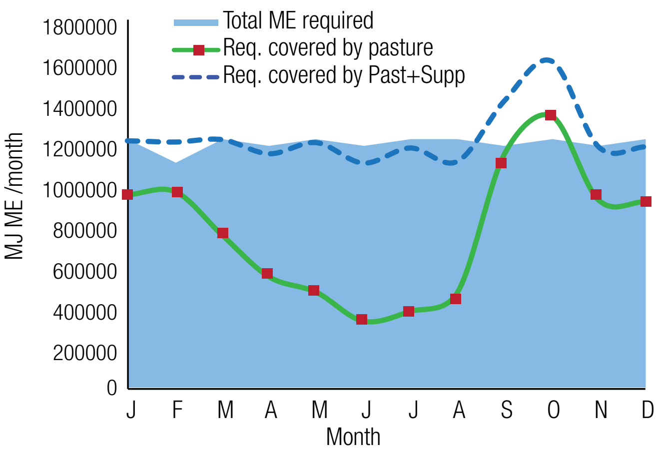

Figure 3. Monthly total energy (MJ ME) requirements (shaded area) and energy covered by grazed pasture (square symbol line) and pasture plus supplements (broken line) for the initial scenario (200 cows).

This is where the FutureDairy's complementary forage system and principles can help most (refer to other tech notes in this series).

The main question Bill wants to answer is whether his farm can effectively increase its feedbase production to carry more cows. Current pasture utilisation (average from irrigated and non-irrigated kikuyu-based pasture) is about 7.5 t DM/ha, so there appears to be room for improvement. The pasture utilisation tech note in this series provides a step-by-step guide to improving pasture utilisation.

FutureDairy has demonstrated that more than 20 t DM/ha can be utilised from a kikuyu-based pasture. By following FutureDairy's guidelines, Bill should be able to improve pasture utilisation on the irrigated area from current about 11 t DM/ha to about 15 t DM/ha. In your case you will need to get local advice or regional information on what is achievable.

Given that irrigation on Bill's farm is limited to 50% of the farm area, the improvement in pasture utilisation on the irrigated land will not be enough to sustain the 50% increase in herd size. The CFS concept of partially replacing pasture area by double or triple forage crop-rotations with increased dry matter productivity may apply in Bill's case.

FutureDairy's CFS's planner allows you to 'play by trial and error' in an easy way. For example, based on FutureDairy's research findings, a good option for Bill would be to grow maize for silage which would provide the bulk feed and increase forage utilisation per hectare. Maize silage can be followed by a short rotation ryegrass, brassicas (forage rape) or annual clover crops (or combinations of these). Together, these will help sustain the higher stocking rate over the autumn-winter period and reduce the need to buy more expensive feed such as concentrates or hay.

Bill's maize crop will have to be grown under irrigation. FutureDairy has established that a minimum cropping area of about 10% of the whole farm area is required to have a significant impact on total home-grown feed (see Tech Note 1).

A simple double-crop forage rotation option may provide Bill with a good feedbase base to achieve his production goal. He could replace about 15 ha of the irrigated pasture with maize for silage followed by a short rotation ryegrass in autumn-winter. The areas and pasture growth rates for Bill's improved situation are shown in Table 4.

Table 5. Predicted need of supplementary feed including maize and pasture silage.

Supplements (kg/cow/day as fed)	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Concentrate	7	7	7	7	8	8	8	8	7	7	8	8	7.5
Pasture Silage	10	6	0	0	0	0	0	0	0	0	0	0	1.3
Maize Silage	0	0	12	10	15	18	18	14	0	0	0	0	7.3
Hay	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Despite the changes in the feedbase, Bill will have to increase concentrate intake as shown in Table 5 to achieve his goal of running 300 milking cows on 100 ha. Tools such as FutureDairy's Feedbase Planner allow the user to experiment with different amounts of supplementary feed to meet requirements.

This increase in concentrate will *per se* result in an increased milk production per cow (if diet formulation and feeding management practices are both adequate). This was demonstrated by a lactation study by FutureDairy: a herd of mixed age cows fed about 9 kg concentrate/cow day produced almost 30% more milk (8,500 L milk/lactation of fat corrected milk) than their herd-mates fed only 4.5 kg concentrate/day (6,500 L milk/lactation).

However, to remain conservative with our assumptions in Bill's case we considered no change in milk yield/cow. Anyway, the greatest advantage of planning is not in the potential extra milk but in the early knowledge of the extra need of concentrate (so you can prepare for this change better!).

Figure 4 shows the final energy balance for Bill's farm running 300 lactating cows after the above changes in the feedbase and feeding regime. Note the bigger difference between total requirements (shaded area) and those covered by pasture only (square symbol line) in comparison with the same farm running only 200 cows (Figures 2 and 3).

In Bill's improved scenario pasture consumption would decrease on a per cow basis but increase on a per hectare basis. This is shown in Figure 5, which represents the annual diet composition of both scenarios. In both cases about 60% cows' diet was covered by home-grown feed. But with 300 cows this was achieved by replacing some pasture area with maize for silage followed by short-rotation ryegrass.

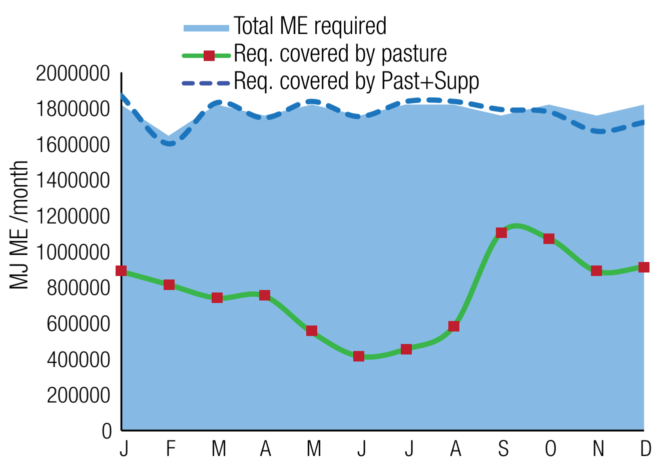

Figure 4. Monthly total energy (MJ ME) requirements (shaded area) and energy covered by grazed pasture (square symbol line) and pasture plus supplements (broken line) for the improved scenario (300 cows).

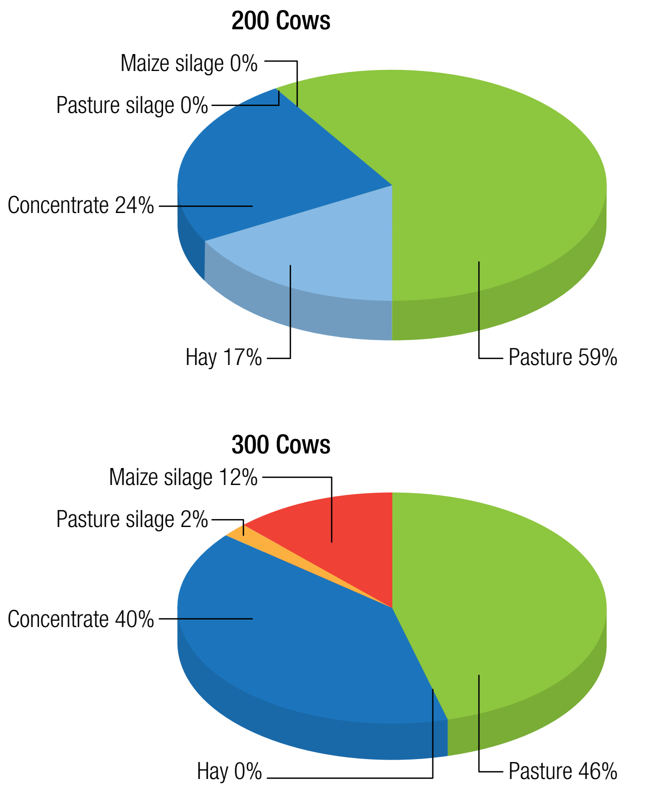

Figure 5. Total annual diet composition (%) for the initial scenario (200 cows) and the improved scenario (300 cows) of the example farm.

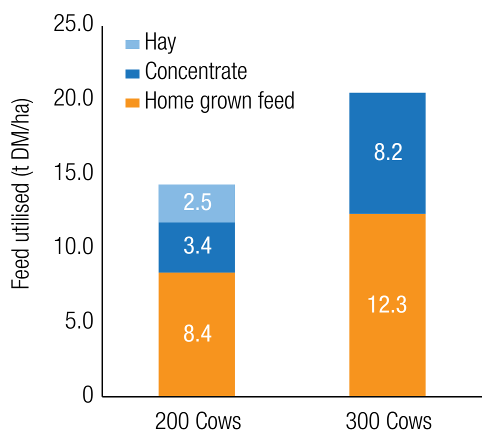

Figure 6. Total annual feed utilised (t DM/ha) for the initial scenario (200 cows) and the improved scenario (300 cows) of the example farm.

When these feed consumption figures are expressed on a per hectare basis (Figure 6), it becomes clearer that a much greater amount of home-grown feed (about 50% more!) would be utilised with the higher stocking rate scenario (from 8.4 to more than 12 t DM/ha over the whole farm area).

Impact on business

The final step is to check the financial implications. Before embarking on any change or even on a more detailed business plan, you will have to include business and financial figures which will be unique to your individual circumstances.

The analysis must consider all the extra capital and operating costs. For example, Bill will probably require an extra labour unit to help with the increased number of cows and at least a forage wagon and a tractor to feed the silage (if he doesn't already own this machinery). Some physical infrastructure such as a feedpad or troughs may be required.

The additional costs must be fully evaluated before any actual change is made on farm. In addition, the operating costs of feeding silage over four or five months must be accounted for.

A partial budgeting approach—in which all the extra income and costs arising from the proposed changes are considered—is recommended. Details are beyond the scope of this tech note (refer to the FutureDairy's CFR Economic Report in the reference list).

Where to from here?

The next step is to fine tune the details and make a comprehensive evaluation of the whole system and in particular the impact of the changes you are now planning to make. This requires careful consideration of:

- The economic implications of any change on all aspect of the farm.
- The potential factors that may limit implementation of a CFS on your farm.
- The impact of a CFS on farm management.
- Impact of a CFS on farm management.

Economic implications

The economic implications for your farm may involve any of the following:

- Purchasing cows: unless growth occurs gradually and from your own replacements.
- Developing new feeding structures such as silage pits, feedpad or troughs.
- Purchasing new machinery for extracting and feeding the silage.
- Additional labour to manage the larger herd.
- Irrigation equipment.
- Anything else that may require capital investment or increase your production costs.

Carefully evaluate the capital investment (and timeframe!) required by using common tools such as the internal rate of return to the investment.

For example, Bill will need to consider any capital investment or additional costs associated with increasing the herd size.

FutureDairy recommends seeking specialised advice before embarking on any change that involves substantial capital investment.

Limitations

Potential limitations to the implementation of CFS on a farm include access to water, cropping areas and access to contractors.

Water supply: Consider how much water is available for irrigation and how secure the water is. Forage crops can be grown without irrigation in some coastal regions with relatively good rainfall. The greatest benefits will be obtained where at least some irrigation is available to secure crop yields. An intensified CFS system can help plan and fulfil feed requirements better, but will require more certainty in the availability of water to achieve optimum yields.

Cropping areas: Consider if your farm has areas that are suitable for cropping. Will you set up your CFR area close or far away from the dairy? If you are planning to increase the amount of grazed fresh forage in the diet of cows, the area used must be a reasonable walking distance from the dairy. Consider how suitable that area is for intensive grazing management (e.g. soil type, drainage, etc.).

Some farmers use the CFR to increase the amount and quality of conserved forages. In this case set up the intensified forage area far away from the dairy to maximise the grazing area close to the dairy.

Contractors: Consider how easy it is to access suitable contractors and agronomic advice in your region. We know from working with commercial farmers that access to contractors and agronomists influences total yields and forage quality. Double and triple-crop complementary forage rotations are more intensified operations so they require increased agronomic skills and accurate timing of management decisions.

For example, missing the sowing of a brassica crop immediately after the summer crop can increase the chances of further delays in sowing due to early autumn events. Late sowing means spending the same amount of money (seed, fertiliser, contractor etc) but getting substantially less feed during the critical times of autumn and winter.

All this requires a more precise management approach regardless of whether you are doing the work or using a contractor. In some regions, contractor availability is scarce and therefore the implementation of these intensified systems should be considered even more carefully.

Farm Management

Plan ahead for labour requirements associated with sowing, spraying, irrigating, feeding and conserving. Consider how the timing of activities fits with your work calendar. We have learnt from working with commercial farmers that simple tasks such as monitoring crops and spraying for weeds and pests in a timely fashion can play a major role in determining success or failure of forage crops.

Make sure you have access to equipment and facilities for direct graze and conserve/feed out options (and accessibility to pits in winter).

Consider the impact that growing the crop will have on the grazing rotation. You may need to fill a potential feed gap while waiting for crops to grow.

Crop selection

Consider crop selection decisions in detail. The following list is not a full list of factors to be considered. But it emphasises the need to plan a CFS on paper before putting it into practice. The number of factors to be considered—and their relative importance—will depend on your individual farm situation.

- Match the crop varieties and their maturity dates to climatic conditions, soil type and fertility.
- Match the crop to ration/diet needs of the herd. Will those crops fill the gap and nutritional requirements of cows given their stage of lactation and your production goals?
- Prepare for likely nutritional issues associated with crops; for example potential nitrate toxicity, with forage rape.

Final remarks

A CFS involves more complex management. Additional skills and knowledge are required when managing new forage types. Poor pasture management cannot be improved by growing forage crops.

FutureDairy developed this series of tech notes to provide detailed information about the pros and cons of the CFR/CFS technology as well as some key practical guidance. This tech note is not a recipe for increased production but rather a step-by-step approach to the first stage of feedbase planning. It helps you make a general assessment of the suitability of CFS options for your farm. We have placed particular emphasis on the application of CFS principles developed by FutureDairy.

We used Bill's hypothetical farm of 100 ha as an example but you should use your own farm and goals to plan your system and check (on paper first!) the feasibility of any potential changes before you actually make them happen.

The core of the CFS concept is to achieve substantial improvements in total forage produced on-farm. This in turn requires a support structure including (but not limited to) access to good agronomic skills.

More information

Contact Associate Professor Sergio (Yani) Garcia
ph 02 9351 1621 or sergio.garcia@sydney.edu.au

References

Copies of these articles are available from FutureDairy, ph 02 9351 1631 or the Dairy Australia library ph 1800 824 377, email library@dairyaustralia.com.au.

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Terminology

Complementary Forage System (CFS) refers to the whole farming system; that is the combined pasture and forage cropping area; **Complementary Forage Rotation (CFR)** refers to the area allocated to double or triple cropping.

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