Dairy farming in the subtropics with raingrown pastures and no irrigation - the M1 farmlet

Findings from the "Sustainable dairy farm systems for profit" project

M5 Project Information Series - Studies on Mutdapilly Research Station and subtropical dairy farms 2001 to 2005

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OVERVIEW

DURING the low rainfall period between September 2001 and August 2005, information collected from the M1 raingrown-crop and pasture 20-cow farmlet at Mutdapilly - scaled and modelled into a 280-cow farm - produced a positive cashflow and an average operational return on assets of 0.7%. Average annual gross margin per cow was $640, and operating profit $40 per cow. Average production was 6,150 litres/cow/year.

These results were obtained in a less-than-ideal environment for a raingrown pasture dairy farm. In a more typical environment for raingrown-pasture-based dairying – especially >1,000 mm coastal or upland areas – better results could be expected.

Advantages of a raingrown-pasture based system include simplicity of management; protection of soil resources during intense summer rainfall; use of tropical forages that have high water-use efficiency and growth that coincides with higher-rainfall months; potential for a milking-free period of 6-8 weeks.

Limits of the system include its vulnerability to rainfall shortfalls; lower quality of tropical forages for milk production; difficulty of maintaining a tight calving pattern, especially in spring; and vulnerability to low milk protein %.

INDUSTRY BACKGROUND

RAINGROWN-PASTURE based dairy farms in Australia's subtropical region tend to be located in the higher rainfall areas of northern NSW and the upland areas of Beechmont, Mt Mee, and Maleny in southeast Queensland, Eungella in central Queensland, and on the Atherton Tableland in north Queensland.

Farms in these regions have a summer-dominant median rainfall of more than 1,000 mm/year, and depend on rainfall to grow tropical pastures over spring, summer and autumn. In some districts the tropical pastures are dormant or frosted in winter, so a small area of cultivated winter oats or ryegrass oversown into summer-growing pastures is incorporated into the forage plan.

The *'Sustainable dairy farm systems for profit'* project tested this type of farming system under Victorian and New Zealand-style dairying - where the herd is seasonally calved to coincide with peak pasture growth.

Managing the system this way would mean a lower average annual milk price, with the major production period coinciding with lower spring/summer milk prices. However, it was anticipated that the lower average milk price would be offset by lower costs of production.

Strengths and weaknesses of this dairy farming system in northern Australia

Strengths

- A simple system that takes advantage of the high forage growth period of a subtropical, high summer rainfall environment.
- High water-use efficiency for forage production.

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Strengths (continued)

- No irrigation, so no business susceptibility to uncertain irrigation water supplies or water price increases.
- Permanent tropical pasture base that protects the soil and farm resource, reducing erosion and runoff and preserving soil organic matter.
- Lends itself to seasonal calving and a potential non-milking period of 6-8 weeks per year. Block or batch calving simplifies herd management through the year.
- Relatively low capital requirement - except for land.
- Strongly appreciating land values due to urbanisation and close proximity to major cities.
- Some of the most picturesque, liveable country in northern Australia, adding to farming lifestyle, aesthetics and proximity to facilities.
- Access to off-farm employment and to casual farm labour.
- Access to potentially low-priced by-products such as brewer's grain, fruit and vegetable pulps if close to a major city.

Weaknesses

- Proximity to urbanisation makes expansion difficult and places farming practices under close scrutiny.
- Competition for land and high land values.
- Forage production vulnerable to low rainfall, particularly a dry spring.
- Seasonal calving produces a period of negative cashflow, which needs to be allowed for in budgets and scheduling of financial repayments.
- Mating during hot summer months and significant reproductive difficulties make it difficult to retain a tight, once-a-year spring-calving period.
- Intensification (increased stocking rate, higher supplementary feeding) increases risk of pollution via runoff, leaching, odour.
- High seasonal dependency can increase dependency on purchased fodder, resulting in higher variable costs.
- Potential for substandard milk protein and payment penalties for majority of lactation with spring-calving herds.
- Based on lower quality tropical forages, which have lower potential for milk production.
- Spring/summer milk prices tend to be lower as processors seek even year-round milk supplies.
- Storage and feedout facilities required for purchased forages.

LESSONS FROM THE M5 FARMING SYSTEMS PROJECT

THE aim of the *Sustainable dairy farm systems for profit* project was to research the possibilities of the common dairy farming systems in the subtropical region. The project looked at intensification and its implications, with a goal of 10% return on assets and 600,000 litres/labour unit.

The project's M5 farmlets at the Mutdapilly Research Station provided four years of data, through both good and bad farming seasons.

NB. The 20-cow farmlets were managed under research station conditions and in the low-rainfall Mutdapilly environment, so results cannot be directly extrapolated to commercial farms across Queensland and northern NSW. However, the farmlets project does indicate potential ways forward for similar farming systems in the region.

MUTDAPILLY M1 FARMLET HERD

THE Mutdapilly environment is not typical of raingrown-pasture based dairy farms in the subtropical dairy region. Mutdapilly has a lower average annual rainfall (800 mm), and deep cracking clay soils limited by poor internal drainage and coarse surface structure.

The 20-cow M1 farmlet herd was modelled on:

- Farm area of 150 ha with 280 cows (milking and dry).
- No irrigation and an annual rainfall of >800 mm/annum.
- Only a small area of land suitable for cropping and cultivation.
- A forage system based on grazed raingrown tropical pastures with a small component of raingrown annual winter forage such as oats or ryegrass.
- High stocking rate – 2.4 cows/ha on summer pasture and 8.4 cows/ha on winter crops with 1.9 cows/ha on the whole farm.
- One calving season – 100% in spring.
- High level of purchased supplementary feed – 3 tonnes grain/cow and 1 tonne hay/cow per year.
- High milk production targets – 7,040 litres/cow/305-day lactation; 632,327 litres/labour unit.
- Minimal investment in plant and equipment.

Weather conditions

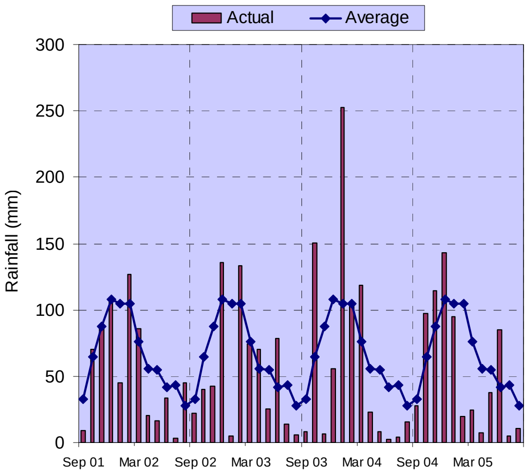
THE farmlet project years from 2001 to 2005 were based on the 12-months from September to August to fit with summer-winter seasons.

Rainfall

Mutdapilly average annual rainfall is 801 mm; however average rainfall over the project was significantly less at 680 mm per annum *(Figure 1)*.

- 2001-02, 651 mm, 81% of average, reasonable spring, dry cold winter.
- 2002-03, 648 mm, 81% of average, dry summer but good winter.
- 2003-04, 751 mm, 94% of average, with a poor distribution, good start to spring and end to autumn, then dry summer and winter.
- 2004-05, 667 mm, 83% of average, good spring, poor autumn and early winter.

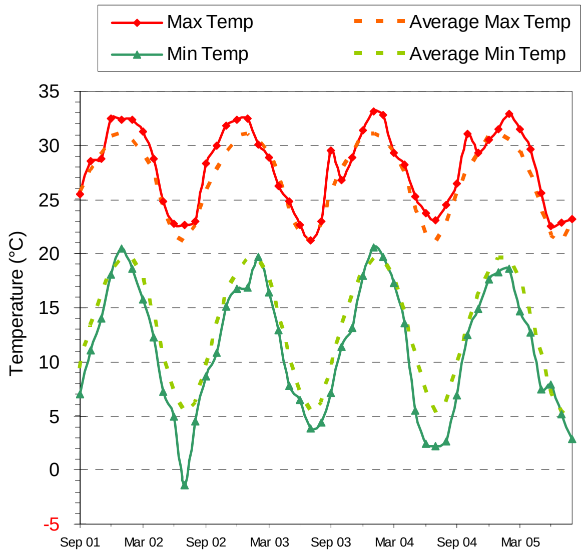
FIGURE 1. RAINFALL (mm) over the 4 years of the farmlets project.



Temperature

MUTDAPILLY is a location with wide temperature extremes *(Figure 2)*. The winter of 2002 was colder than average and the summer of 2003/04 particularly hot.

FIGURE 2. MEAN monthly minimum and maximum temperature (ºC) at Mutdapilly over the 4 years of the farming system project.



Milk production

OVER the four-year project, average annual milk production from the M1 raingrown-pasture farmlet was 12.7% under its target.

As shown in *Table 1* and *Table 2*, the M1 farmlet produced more than 5,900 litres/cow/year in the start-up year and 6,790 litres in its best year (with good winter rainfall). The lowest production year was year four, when a change in breed structure reduced milk yield but improved composition.

Although the M1 farmlet was furthest of all farmlets away from its production target, the herd was able to reach reasonable production levels by being fed (where possible) to meet forage requirements and by including 10 kg of concentrate/cow/day.

TABLE 1. MILK production per cow from the M1 raingrown pasture farmlet in each year of the project.

M1 farmlet	Litres/cow/year	Variation%
Budget/target	7,040	
2001-02	5,960	- 15.3
2002-03	6,790	- 3.5
2003-04	6,240	- 11.4
2004-05	5,600	- 20.5
4-year average	**6,150**	**- 12.7**

The 4-year average milk production was 11,490 litres/ha, with 4,655 litres/ha (40%) from homegrown grazed and conserved forage (by reverse calculation).

TABLE 2. AVERAGE milk yield, milk composition and liveweight of animals in the M1 farmlet over the 4 years of the project.

Litres/cow/year	6,150
Litres/cow/day	20.0
Milk fat	4.08% 251 kg
Protein	3.13% 192 kg
Lactose%	5.00%
Milk solids kg	443
SCC (x 1,000)	243
Liveweight kg	540

Figure 3 and *Figure 4* present daily herd and average litres/cow milk production patterns for the scaled up 280-cow M1 herd with its seasonal spring calving pattern. These figures are based on the 20-cow farmlet herd. A change in herd breed structure explains the drop in production in the last year.

Very hot conditions - with a maximum above 30ºC for most of the period between December 2003 and February 2004 - caused milk production of the grazed M1 herd to drop dramatically due to heat stress and reduced dry matter intake – but the drop was less dramatic than that experienced on the irrigation-based grazing systems.

FIGURE 3. DAILY herd milk production pattern (L) for a 280-cow, M1-style herd.

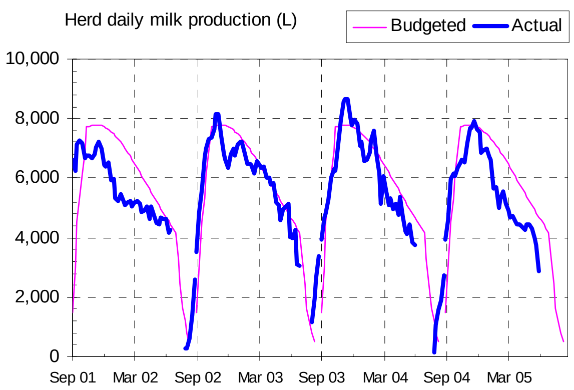
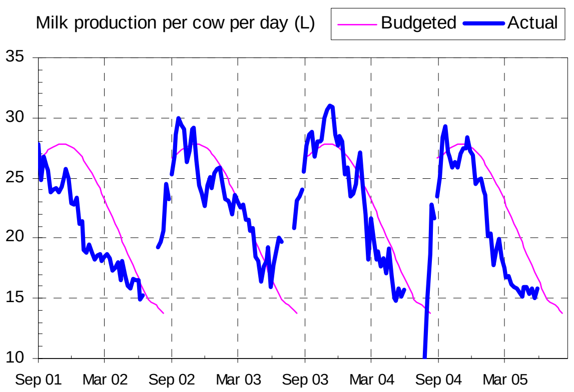


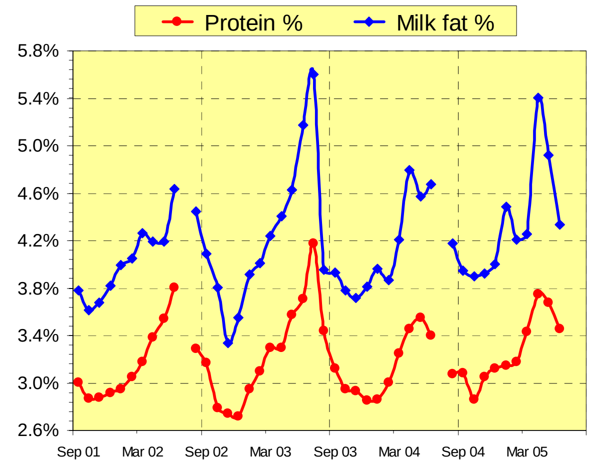
FIGURE 4. DAILY milk production pattern (L) per cow in a 280-cow, M1-style herd.



Milk composition

Milk composition for the M1 farmlet is presented in *Figure 5*. The spring-calved M1 herd showed the widest swings in composition, with a clear stage-of-lactation effect on milk protein and milk fat, and the clear spring/summer protein ‘crash’, typical of herds relying on tropical pastures during spring/summer. In 2002-03, it was March before the herd reached minimum milk fat and protein percentages required by some milk processors. Incorporating nine Jersey and Brown Swiss crossbred animals in the 20-cow herd during 2004-05 appeared to help lift milk fat by 0.25% and protein by 0.12%, while lactation yield dropped 730 litres compared with previous years.

FIGURE 5. MONTHLY milk composition of the M1 raingrown pastures and crops farmlet herd from 2001 to 2005.

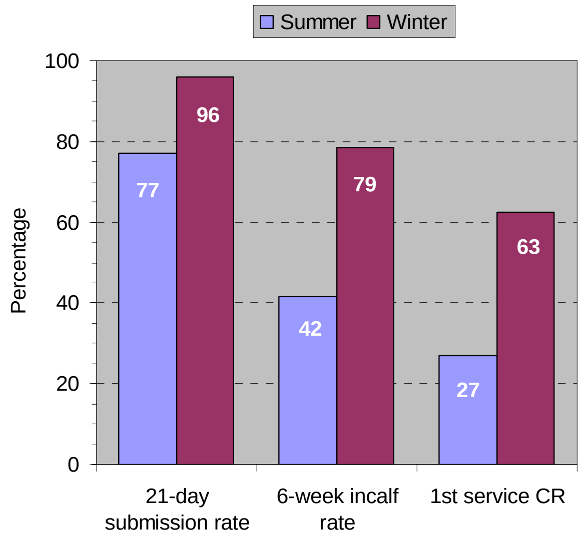


Calving pattern and reproduction

THE calving pattern of the M1 herd was chosen to allow cows to produce milk from low-cost tropical pastures over spring/summer. The plan was to seasonally calve all cows in spring from September onwards; as a result, mating occurs in late spring/summer from November onwards. Summer is a particularly difficult time to get cows in calf in the region, which proved to be the case in this project. Consequently, the farmlet herd could only maintain the planned strict spring-calving pattern by replacing cows.

The herd had poor reproductive performance (*Figure 6*) with low summer in-calf rates despite a highly-interventionist approach to reproductive management. While the summer 21-day submission rate was more than 77%, the average 6-week in-calf rate was 42%, reflecting a poor first-service conception rate of 27%. Inseminator error was checked and discounted. Cows exiting for calving pattern reasons were essentially sound, but would not re-calve in the required season.

FIGURE 6. M1 FARMLET herd summer and winter 21-day submission, 6-week in calf and 1st service conception rates (%).



Data from the winter mating in *Figure 6* is from cows that were still in the M1 herd, but had failed to become pregnant in the summer mating period. The figures show that they were reproductively sound; these cows were 200+ days-in-milk when the winter mating commenced.

The summer mating period was lengthened and started earlier, to increase the chances of getting cows pregnant before the heat of summer. However, these strategies produced additional problems, with no green feed available in late July when cows started calving.

In all years there was a break in milk production; in 2002-03 it was less than 4 weeks. If forage was in short supply, cows were dried off early, so late-calving cows had a short lactation.

The M1 farmlet had the highest turnover of animals due to failure to go in calf during the designated mating period. Average replacement rate for reproductive reasons was 41%, indicating a major issue for farms attempting to maintain a strict spring-calving pattern in the subtropical environment.

To satisfy the research methodology, cows that did not fall pregnant in the mating season corresponding to their calving season were replaced when 300 days in milk with a pregnant cow due to calve in the appropriate calving season.

In the economic analysis of the enterprise, an allowance was made for the cost of replacing animals. On a commercial farm, well-bred Holstein Friesian cows producing 7,000 litres/cow/year would milk on in late lactation and - with increasing fat and protein % - would continue to produce adequate milk solid yields. A 14 to 15-month inter-calving interval could be tolerated with these types of animals, but an extended batch calving or year-round calving pattern would be required.

Pastures and crops

The M1 farmlet forage plan scaled up to the 150 ha modelled farm is summarised in *Table 3.*

The farmlet stocking (SR) rate was 1.9 milking cows/ha. In the M1 farmlet, cows were kept on the farmlet area when dry. There was a period in June when all cows were dry. All farmlet cows entered a pre-calving herd 3 weeks before expected calving date

TABLE 3. PERCENT and area of forages on a 150 ha modelled M1-style farm.

% area	Ha	Forage type
78%	117	Tropical grass area
22%	33	Raingrown (RG) winter forage crop (oats)
100%	**150**	**Total farm milking area**

With no irrigation, the M1 farming system was based on tropical rhodes grass pastures in spring and summer, and oats in winter. In the winter of 2004, not all paddocks could be planted to oats so forage sorghum was planted in these paddocks the following summer as an opportunity crop.

This farming system is highly sensitive to rainfall distribution, which has a major impact on forage dry matter production. *Figure 7* presents rhodes grass growth rate over three summers. Summer rainfall in 2003/04 was favourable for production of rhodes grass and forage sorghum – resulting in a 100% increase in total forage DM yield compared with the previous year. Tropical rhodes grass quality was highest in November-December and lowest in April-May when pastures matured and senesced.

FIGURE 7. THE VARIABLE pattern of rhodes grass growth across the last 3 years of the project, highlighting the vulnerability of this system to seasonal conditions.

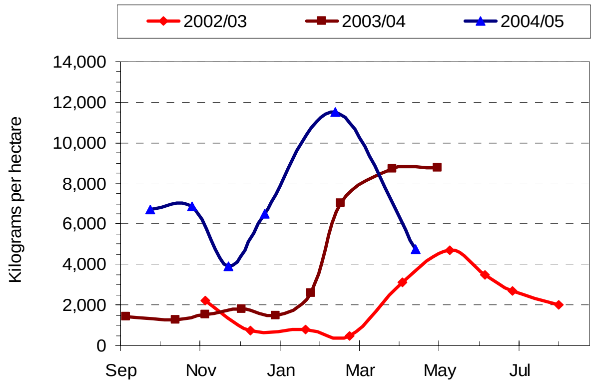
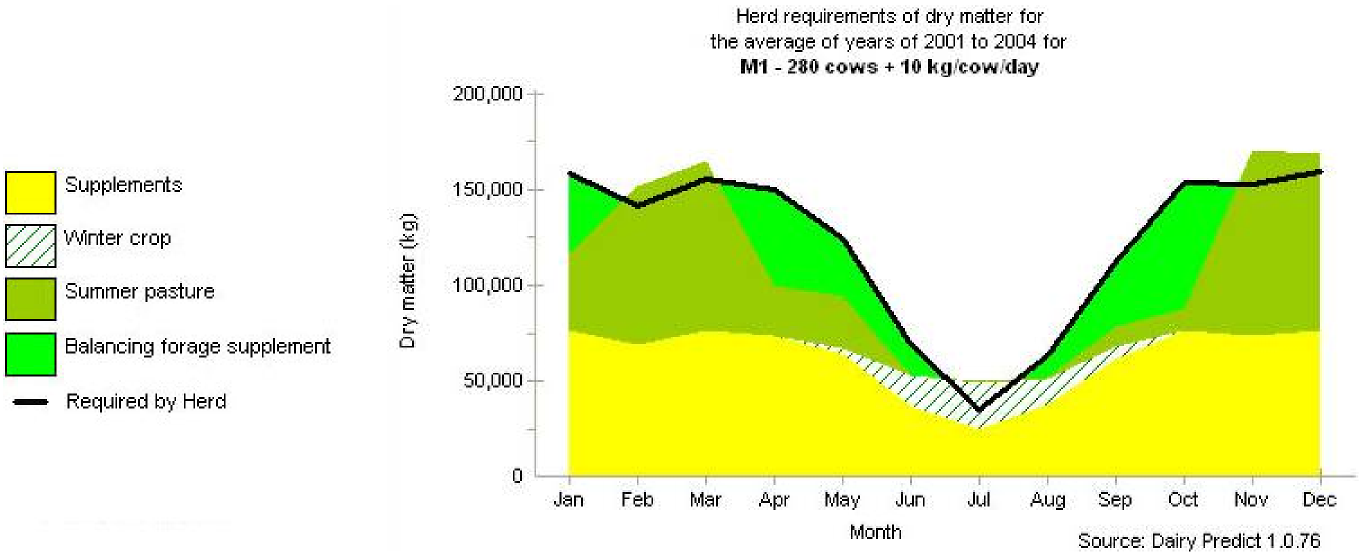


Figure 8 represents the M1 farmlet feed plan using the dairy feedbase decision model Dairy Predict. The feed plan shows little surplus homegrown forage and a requirement for balancing forage supplements to meet shortages from early autumn to late spring.

The actual quantities of supplementary forage fed are presented in *Figure 8.*

FIGURE 8. A REPRESENTATION of the forage supply and supplements fed to the seasonally calving modelled M1 farming system produced by Dairy Predict.



Conserved forage - homegrown and purchased

The M1 farmlet had a budget to purchase 1 tonne /cow/year of hay. This quantity was exceeded in all years due to dry seasonal conditions *(Table 4)*.

Table 4. QUANTITY of conserved forage (tonnes hay) fed on the M1 farmlet each year and percentage that was homegrown.

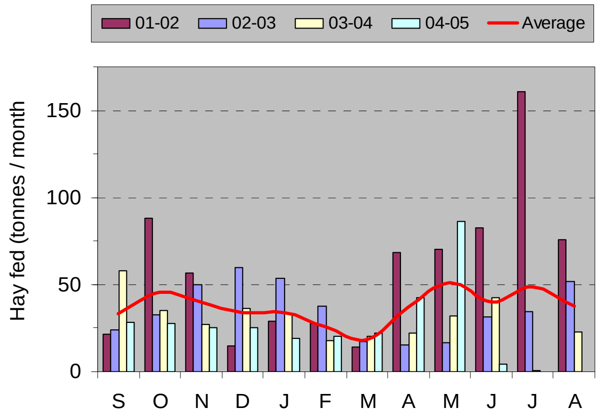
	01-02	02-03	03-04	04-05
Tonnes hay/cow	2.6	1.6	1.3	1.1
% homegrown	0%	0%	30%	45%

One of the priorities of many farming systems is to conserve forage whenever possible. Fodder conservation was not a primary objective in the M1 farmlet; instead there was a flexible approach to grazing/conserving to ensure best use of all forage grown. Favourable seasonal conditions provided the opportunity to conserve 0.5 tonnes/cow of rhodes grass hay in Feb/Mar of 2004 and 2005.

The winter 2004 oat crop was planted late and ready to graze when cows were close to drying off. The crop was conserved as haylage, yielding equivalent to 0.4 tonnes hay/cow, and fed back when the herd started to calve in August 2004. Not all paddocks in 2004 could be planted to oats due to dry conditions, so were planted to forage sorghum the following summer. Instead of grazing, two cuts were made for hay/silage in December and February – yielding 7.6 tonnes DM/ha (about 8.4 tonnes hay/ha or 0.4 tonnes/cow).

The pattern of feeding conserved forage is shown in *Figure 9*. As the farmlet herd was fed a partial mixed ration (PMR), some conserved forage was fed throughout the year. The quantity of hay fed ranged averaged 450 tonnes/year, but was as high as 710 tonnes in the first 12 months. Expressed as silage equivalents the average was 1,050 tonnes per annum.

FIGURE 9. THE AMOUNT of conserved forage fed to the M1, 280-cow enterprise each month in each year of the project, plus the average over the 4 years.



Fertiliser use

TABLE 5 presents the quantities of nitrogen fertiliser applied to forage areas on the M1 farmlet. The summer fertiliser plan was to fertilise the rhodes grass in October, December and late February each year with 100 kg N/ha as urea. In some years it was considered a risk to make a full application, so half the amount was applied. The winter fertiliser plan was to apply fertiliser at planting and after grazing. If there was limited soil moisture then fertiliser was not applied.

Table 6 presents the amounts of N applied to the M1 farmlet/cow/year. By industry standards, the average N fertiliser use of 105 kg/cow/year on the M1 farmlet is in the medium to high range for this type of farming system. The quantity of N coming onto the farm through 3 tonnes of supplements/cow/year was also high - 149 kg N/ha/year or 80 kg/cow/year - and some of this N would have been redistributed to paddocks in dung and urine.

TABLE 5. NITROGEN fertiliser applications per hectare for each pasture and forage type on the M1 farmlet.

Forage type	Kg N/ha applied in year				Average
	01/02	02/03	03/04	04/05	
Tropical grass	255	276	184	240	239
Raingrown forage oats or sorghum	83	96	4	17	50

TABLE 6. NITROGEN fertiliser applied to the M1 farmlet per cow per year.

	Year				Average
	01/02	02/03	03/04	04/05	
Kg N per cow	116	126	77	102	105

Water use

RAINFALL over the four years averaged 680 mm per year, compared with the Mutdapilly average of 801 mm *(Figure 1)*. One megalitre (ML) water is equivalent to 100 mm rainfall over 1 hectare.

Effective rainfall

In calculating water use efficiency (WUE) of forages and milk production, irrigation plus effective rainfall (rather than total rainfall) was used. Effective rainfall is the fraction of total rainfall that is available for pasture and crop growth. Daily rainfall of less than 5 mm was excluded, and only the first 50 mm of heavy rainfall included in daily totals. For crops, only 20% of total rainfall in the preceding fallow was considered effective.

Water-use efficiency of forage production

Typical forage yields, (tonnes DM/ha), and water use efficiency (WUE) (tonnes DM per ML effective rainfall) for raingrown oats, forage sorghum and rhodes grass in the M5 farming systems project are given in *Table 7*.

TABLE 7. AVERAGE DM yield (t DM/ha) and WUE (t DM/ML) of forages in the M1 farmlet.

Forage type	Yield	Effective rainfall	WUE
Oats	4.0	2.4	1.9
Forage sorghum	13.0	4.2	3.0
Rhodes grass	6.7	4.0	1.6

Water-use efficiency of milk production

Water use efficiency can also be expressed as litres of milk from homegrown forage per ML effective rainfall. A litre of milk from homegrown forage is a calculated figure based on total milk production adjusted for supplements and forage fed. WUE figures for each farmlet are presented in *Table 8*.

TABLE 8. EFFECTIVE rainfall and irrigation inputs (ML/farm ha) and WUE (L milk/ML water) in the M5 farmlets.

Farmlet	Effective rainfall	Effective rainfall + irrigation	WUE
M1	5.8	0	1,020
M2	5.8	1.0	1,310
M3	5.8	0.4	790
M4	5.8	3.6	1,260
M5 feedlot	5.8	4.0	1,820

With rainfall and irrigation expressed as ML per farm area, the cut and carry M5 feedlot had the highest WUE - measured as milk produced per ML (effective rainfall + irrigation) water.

Concentrate feeding

THE M1 farmlet feed budget incorporated 3 tonnes of concentrate/cow/lactation (10 kg/cow/day) and 1 tonne of hay/cow/lactation.

The project aimed to study the impact of intensifying the common farming systems of the region – including increased levels of concentrate feeding to maximise forage utilisation and to support higher production per cow.

The project aimed to use concentrates to optimise milk production from forage and increase returns per ha. Increased use of energy-dense concentrates is one of the best ways to do this, within the limits of a forage/grain ratio of 60/40 to 50/50 – which is optimal for cows of high genetic merit.

With a run of dry seasons, the average (homegrown + purchased) forage/concentrate ratio fed to the M1 raingrown pasture farmlet herd over the 4 years was 50/50.

The concentrate ration *(Table 9)*, consisted of mixed grains, sorghum, barley and wheat; cottonseed and soybean meals, molasses and whole cottonseed, with formulation adjusted seasonally on the basis of forage nutrient content and availability and the herd's level of production and stage of lactation. The herd also received trace minerals and phosphorus.

TABLE 9. AVERAGE concentrate ration fed to the M1 farmlet herd (kg/cow/day as fed).

M1 concentrate	kg/cow/day (as fed)
Grain	5.3
Molasses	3.1
Protein meal	1.0
WCS	1.3
Minerals	0.2
Total	10.9

As well as feeding higher rates of concentrate, each farmlet used a higher stocking rate than the industry average. Stocking rate for the M1 farmlet was 1.9 cows/ha on the whole farm; 2.4 cows/ha in summer on tropical pastures and 8.4 cows/ha on winter; milking cows had access to tropical pasture throughout the year. Dry cows were not grazed on the farmlet area, but were "agisted" on other paddocks at Mutdapilly.

The focus was maximum production and utilisation of forage, including conservation of any surplus.

Method and timing of feeding concentrates to avoid slug feeding was an important management consideration with the higher rates of concentrate.

The grazed M1 farmlet herd was fed their concentrate ration as 4 kg of mixed grain per day in the dairy, with the balance of grain and protein meal - plus a small amount of forage - in a partial mixed ration once a day.

Managing the cost of purchased feeds – both concentrates and forages - is critical to the performance of this system. With concentrate prices increased by drought conditions during the project *(Table 10)*, high grain feeding impacted on total variable costs for the M1 herd. Purchased feed and forage costs were highest in year two (2002/03) at 16.9 c/L, due to high supplementary feed costs. However production was maintained and concentrate costs were spread over a large volume of milk.

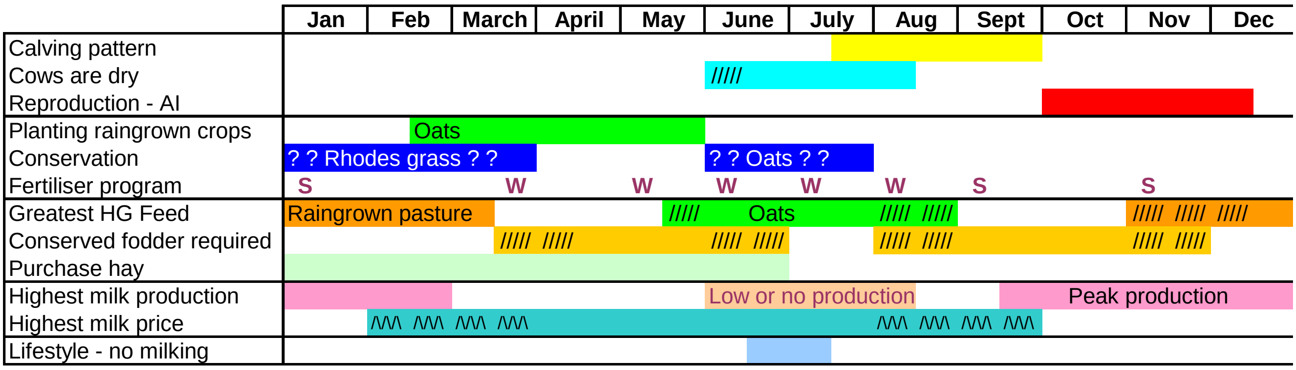
TABLE 10. AVERAGE cost of the M1 concentrate mix, including molasses, over the 4 years of the project.

M1 concentrate cost	01-02	02-03	03-04	04-05
$ per tonne as fed	214	273	224	209

Calendar of operations and farm activities

A YEARLY calendar of operations and farming activities for the M1 farmlet is presented in *Figure 10*.

FIGURE 10. A CALENDAR of farming operations for the M1 farming system



S = summer, W = winter fertiliser program
///// = dependant on seasonal conditions
/\/\/\ = varies with processor supplied

Nutrient balance on the farmlet

SUPPLEMENTARY feeds supplied 45 to 80% of N inputs onto the farmlets, highlighting the economic and environmental importance of distributing manure over the farm.

All forage systems on the farmlets used less N fertiliser than anticipated. Dry weather reduced the opportunities to apply N to raingrown crops and pastures. Also, soil analyses showed increasing soil N levels, so planned application amounts were reduced. This indicates how fertiliser application rates for individual farms may differ from current recommendations.

A simple whole-farm nutrient-balance model was developed during the course of the project to consider the ratio between farm inputs (supplementary feeds, fertiliser) and outputs (milk, meat and forage sales) in terms of their nitrogen (N), phosphorus (P) and potassium (K) content.

Running figures for all farmlets through *The Farm Grid Nutrient Balance Model* produced the results summarised in *Table 11*.

N ratios are difficult to interpret; ratios of between 3.0 and 4.0 are about as efficient as could be expected with systems heavily reliant on N fertiliser. The N input/output ratio was outside this range on farmlets M1 and M2 - suggesting potential for refinement of fertiliser application rates.

Most interest is with P, with a ratio of 1.0 to 1.5 considered ideal, and anything above 2.0 seen as undesirable. All systems were within acceptable limits at the whole farm scale.

K is not seen as a problem as a potential pollutant.

TABLE 11. THE units of nutrient input for N (nitrogen), P (phosphorus) and K (potassium) required to produce a unit output (2001-2005).

Farmlet	N	P	K	Description
M1	5.8	1.9	3.9	Raingrown tropical pasture some oats
M2	5.1	1.7	3.6	Limited irrigation pastures
M3	3.6	1.9	1.6	Limited irrigation forage crops and ryegrass
M4	3.1	1.4	1.3	High irrigation pastures and forage crops
M5 feedlot	2.5	1.3	1.2	Feedlot home-grown irrigated silage and hay

Other environmental considerations

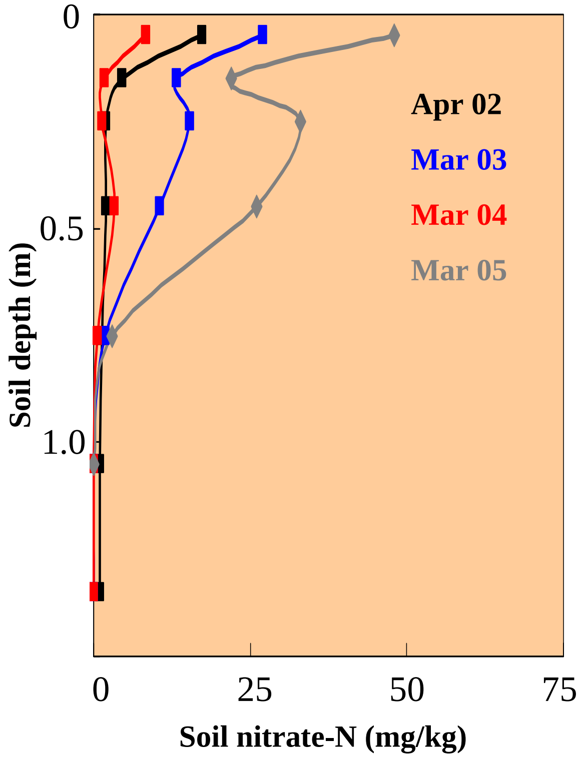
THE M1 farming system attempted to match forage production in a summer-rainfall environment with the feed requirements of a seasonally-calved milking herd. This matching of environment with production has potential benefits, with perennial grasses actively growing over the summer period, and minimal cultivation and soil impact. With ground cover retained, the soil base is protected from erosion. Perennial pastures also reduce the risk of deep drainage during intense summer rainfall, and maintain or improve soil organic matter.

However, fallowing of winter cropping ground over summer makes this area of the farm vulnerable to erosion, nutrient leaching and organic matter decline. Zero tillage, plus a short-term summer crop with one grazing or one cut, would reduce this risk.

High stocking rate and reliance on raingrown pasture make this system vulnerable to overgrazing during dry periods.

Nitrogen fertilised pastures are vulnerable to loss of N through leaching, and to acidification, especially on well-drained soils. Soil nutrients (to at least 0-10 cm and 10-20 cm depth) should be monitored every two years and fertiliser use adjusted accordingly; lime should be applied as indicated by soil test results.

Figure 11. The distribution of nitrate-N (mean sample values) in the soil profile at the end of the growing season for raingrown rhodes grass.



Monitoring showed significant residues of nitrate-N in the soil profile at the end of some growing seasons in raingrown rhodes grass paddocks fertilised with up to 200 kg N/ha/year (*Figure 11*). This indicates that potential forage yield (and therefore fertiliser use) was overestimated. On the high-clay soils and low rainfall conditions at Mutdapilly, this did not present a problem for potential loss of N through leaching below the plant root zone. However it could be a risk in soils and weather conditions where deep drainage is likely.

Business results

AN average milk price - based on the pricing formulae used by Dairy Farmers, Parmalat and Norco - was used in the financial and business trait analysis for all farmlets *(Table 12)*. The difference in milk receipts between farmlets reflects varying season of supply, milk composition and volume incentives.

Dairy income includes milk receipts, livestock sales, fuel rebates and genetic incentives.

Individual dairy farms will know their average dairy income, so can make a comparison between the farmlet data and their own enterprise.

TABLE 12. AVERAGE milk receipts and dairy income for each of the modelled farmlet herds.

	M1	M2	M3	M4	M5 feedlot
Milk receipts c/L	33.3	34.1	34.6	34.9	37.2
Dairy income c/L	36.6	37.4	37.9	38.4	40.9

The capital required to change a typical QDAS 134-cow M1 farm into a 280-cow enterprise is presented in *Table 13*. The assets required to move a typical M1 raingrown pasture farm to a more intensive, higher production farming system required more capital than the project initially estimated. Extra investment was needed for stock purchases, supplementary feed storage and feeding out, effluent management, dairy expansion including a larger vat, and increased water reticulation.

The 4-year average key financial indicators for each of the Mutdapilly modelled farmlets are presented in *Table 14*. All farming systems, including M1, had a positive operational 4-year average return on assets.

Scaling up the production results and costs of the 20-cow Mutdapilly M1 farmlet herd over 4 years, the raingrown pasture and crop based M1 farming system returned a gross margin of $640/cow/year, for an average operating profit of $40/cow/year.

Annual business results for M1 are summarised in *Table 15*. M1 achieved very modest business results - this farmlet exceeded its purchased forage budget; forage and grain prices were higher due to drought; and milk production was lower from a rain-dependent forage system.

Four years of study on the M1 farmlet at Mutdapilly indicates that basing dairying on raingrown pastures in a drier, 680-800 mm, sub coastal region is not highly profitable. In that type of dairying environment, a raingrown system is better based on larger areas of forage crops, with greater use of conserved forage crops as part of the feed-year plan. Feed-related costs were higher than budget, especially in the earlier years, due to the extra purchased feed required to meet herd requirements during the very dry years of the project, with no stores of conserved fodder at the commencement of the M1 farmlet 'business'.

TABLE 13. ESTIMATED capital required in 2000-01 to change a typical 134-cow M1 farm (from QDAS) to a 280-cow herd on the same land area.

Extra capital required – M1	**$**
Land	0
Buildings	
Dairy buildings	50,000
Total Buildings	50,000
Plant/equipment	
Vat	55,000
Feed pad	8,500
Feed wagon	65,000
Water	12,000
Silos	15,000
Effluent	30,000
Total Plant / equipment	185,000
Livestock	184,550
PDA / Shares	0
TOTAL	**$419,550**

TABLE 14. BUSINESS traits and KPIs of the five modelled farming systems, averaged over the 4 years of the project.

BUSINESS TRAIT SUMMARY	**M1**	**M2**	**M3**	**M4**	**M5**
Liquidity					
Dairy cash surplus ($)	20,757	63,146	149,852	192,817	518,213
Interest costs per cow ($)	155	155	159	162	150
Solvency					
Equity %	57%	60%	60%	65%	64%
Liabilities per cow ($)	2,216	2,217	2,267	2,312	2,141
Profitability					
Change in Net Worth per year ($)	56,995	30,281	46,372	40,510	89,483
Return on Assets % (operational)	0.7%	2.8%	6.3%	6.6%	13.9%
Return on Assets % (Capital+operational)	7.7%	7.0%	9.6%	11.1%	18.0%
Return on Equity %	-4.1%	-0.1%	5.8%	6.4%	17.7%
Operating profit ($/cow)	40	158	358	436	823
Efficiency					
a) Capital efficiency					
Asset turnover ratio %	44%	45%	46%	43%	64%
b) Financial efficiency					
Feed related costs (c/L)	17.8	17.9	15.8	15.9	16.8
Forage costs (c/L milk from forage)	7.5	7.6	7.0	9.6	10.4
Margin over feed related cost (c/L)	18.9	19.5	22.1	22.5	24.1
Gross Margin per cow ($)	640	747	950	1,128	1,497
c) Physical efficiency					
L / cow / year	6,148	6,534	6,871	7,395	9,182
L / hectare	11,491	17,779	9,304	20,541	39,492
Litres / labour unit	551,719	672,050	618,367	665,526	883,815
Cows / labour unit	90	103	90	90	96

TABLE 15. BUSINESS traits and KPIs of a typical M1 farm in QDAS in 2000-01, and the annual and 4-year average figures from the modelled M1 farmlet.

	QDAS	M1				
BUSINESS TRAIT SUMMARY	**2000-01**	**2001-02**	**2002-03**	**2003-04**	**2003-05**	**Average**
Liquidity						
Dairy cash surplus ($)	43,410	-26,588	25,432	50,418	33,766	20,757
Interest costs per cow ($)	105	155	155	155	155	155
Solvency						
Equity %	79%	55%	56%	57%	58%	57%
Liabilities per cow ($)	1,500	2,216	2,216	2,216	2,216	2,216
Profitability						
Change in Net Worth per year ($)		16,150	50,384	84,389	77,056	56,995
Return on Assets % (operational)	2.2%	-2.9%	1.0%	3.0%	1.9%	0.7%
Return on Assets % (Capital+operational)		0.9%	10.0%	10.0%	10.0%	7.7%
Return on Equity %	2.8%	-11.0%	-3.7%	-0.1%	-1.7%	-4.1%
Operating profit ($/cow)	160	-146	52	152	103	40
Efficiency						
a) Capital efficiency						
Asset turnover ratio %	28%	44%	50%	44%	40%	44%
b) Financial efficiency						
Feed related costs (c/L)	15.8	20.0	19.6	15.9	15.5	17.8
Forage costs (c/L milk from forage)		11.1	6.4	6.2	6.2	7.5
Margin over feed related cost (c/L)	20.6	16.3	17.2	20.1	21.9	18.9
Gross Margin per cow ($)	850	471	657	746	686	640
c) Physical efficiency						
L / cow / year	5,506	5,963	6,793	6,238	5,597	6,148
L / hectare	4,918	11,145	12,697	11,659	10,462	11,491
Litres / labour unit	335,345	535,124	609,636	559,783	502,330	551,719
Cows / labour unit	61	90	90	90	90	90

COMPANION FARMER EXPERIENCES

The M5 project assessed the real expansion opportunities and implications for subtropical dairy farms by involving 22 commercial farms as Companion Farms to the project. The 6 farms in northern NSW, 9 in coastal southeast Queensland, 5 on the Darling Downs/South Burnett, 1 in central Queensland and 1 in north Queensland represented a broad cross-section of Australia's subtropical dairy farms – in terms of location, herd size and farming style.

Potential for raingrown dairy farms in 1,000-1,650 mm rainfall areas. In higher rainfall areas than Mutdapilly, dairy farms can oversow tropical grasses with raingrown ryegrass through winter, and grow raingrown corn and forage sorghum for silage, plus grazed fertilised kikuyu through spring/summer.

Having the ability to grow raingrown ryegrass means that a batch of cows can be calved in autumn to take advantage of higher milk prices, and another spring-calving batch can make use of tropical pastures at their best in spring. Silage from spring pasture surpluses and specially-grown summer forage crops can be used to fill feed gaps, and to allow summer pastures to be setback earlier in autumn for ryegrass to be planted sooner.

Provided with details and results of the Mutdapilly M1 farmlet, northern NSW dairy farmers commented that in their higher-rainfall environment, they would expect that a 100 ha farm could carry 300 cows – 3 cows/ha – and that the herd could produce 7,500 litres/cow with well-grown, well-utilised kikuyu/ryegrass if supplemented with 3 tonnes grain/cow and 1 tonne of hay/cow/year.

Calving pattern. Farmers were generally concerned with the M1 farmlet's strict adherence to a spring-calving pattern, with its poor reproductive performance for re-mating and having peak yield coinciding with the lowest-milk-price months.

Some raingrown farms in northern NSW manage their herds to calve from March onwards onto raingrown pastures. Their environment allows for annual ryegrass to be grown without irrigation, which allows fresh cows to milk well and continue at a higher yield through lactation. Calving at this time of year also coincides with winter milk price incentives.

Other raingrown farms have shifted to calving year-round with larger batches in March/April -

reducing the risks associated with unpredictable seasons and coinciding a batch of fresh cows with winter price incentives and quality winter feed.

Batch-calving herds listed the advantages as concentrated calf rearing and AI over a short period; reducing labour requirements for the rest of the year; ability to take clear break every year; well-timed calving batches can maximize pasture utilization and lower production costs.

Herds that are batch calving raised a number of management issues: the need for adequate facilities including calf-rearing sheds, and milking shed/vat/machine capacity to handle a large number of fresh cows and new calves; the need for extra seasonal labour requirements at calving/early lactation/heat detection/mating; the need for skilled and well-managed labour at crucial periods to ensure a tight calving pattern, fresh cow care and calf rearing; fluctuating milk volumes and therefore cash flow; the need to adhere to strict mating period; and the need to decide the fate of cows that are not in calf during that period.

Feeding out supplementary feed. Feedout facilities tend to be minimal on most raingrown-pasture-based farms. Grain supplements are generally fed in the dairy. Some farmers already feeding 1.8-2.0 tonnes grain/cow/year believed they could increase that to 3 tonnes/cow/year (equivalent to 10kg/cow/day) and still feed all grain in the dairy, provided it was in pellet form. Other farms believed that the limit of grain feeding in the bails was 6 kg/cow/day.

Hay and silage are fed along fence lines in dry weather and on feed pads (where available) in wet conditions. Some farms have already invested in mixer wagons, hay rings and improved feedout facilities. However further intensification - with associated increased supplementary feeding - will require some extra investment in facilities and equipment on the majority of farms.

Mixer wagon or not? Companion farmers shared a variety of opinions on the place of a mixer wagon in a raingrown pasture-based farm.

Arguments for a mixer wagon included reduced feed wastage; a consistent reliable diet for milking cows; the ability to incorporate daily feeding of purchased or homegrown conserved fodder plus the extra grain in an intensified raingrown system. There appeared to be preference for a mixer wagon vs. hoping for irrigation water.

Arguments against included cost (although second-hand wagon appeared a reasonable alternative to these farmers), extra labour requirements, and the need for a permanent feedout pad or shed.

CONCLUSIONS AND RECOMMENDATIONS

Business considerations. There appears to be potential for increased production per cow for raingrown-pasture-based farms in >1,000 mm rainfall areas. 2005 QDAS data indicates average production per cow in northern NSW is 5,370 litres/cow and on the Atherton Tableland is 5,200 litres/cow. (These figures include the use of irrigation). The Mutdapilly M1 raingrown-pasture farmlet averaged 6,150 litres/cow/year over four years in a less-than-ideal environment for this style of dairy farming.

It is important to match the farming system to available resources (the natural resource base, the financial base and the social/management base) rather than the other way around. For example, an environment like Mutdapilly - with less than 1,000 mm annual rainfall - is more suited to raingrown dairying based on crops rather than pastures. In higher altitude areas with >1,000 mm rainfall, there is more opportunity for a longer period of continued tropical pasture growth, for mulch-striking winter forage into large areas of tropical pasture, and for growing raingrown ryegrass.

The farmlet study found that the three key drivers of profit in dairy enterprises were production per cow, number of completed lactations and proportion of homegrown vs. purchased feed.

With increased competition for reducing supplies of irrigation water, many ‘irrigation’ farms have to operate as raingrown dairy farms, so the management options for this M1 style of dairying need to be considered in their farm plans.

Intensification. High stocking rates accentuate the feed gaps that occur between seasons on a raingrown farm. Higher levels of supplementary grain and forage overcome this difficulty to some extent. However, higher stocking rates make it imperative to have as smooth and short a transition between summer/winter and winter/summer forage programs as possible.

The farmlets highlighted the greater risk of intensive farming systems. Difficulties experienced due to dry or wet weather, machinery and equipment breakdowns, irrigation water shortfalls – inevitable in all farming enterprises – have more impact in a more intensive system.

Intensifying a raingrown-pasture system makes it more highly sensitive to drought, so the farm business needs to have planned alternatives – including the costs and returns of reducing herd size or reducing the amount of purchased feed. While a long-term drought requires more drastic management changes, a short-term feed shortage is best handled by maintaining feeding levels.

Impact of heat. Heat stress has a major impact on all dairy herds in the subtropical dairy region. It affected all farmlet herds at Mutdapilly - mainly through lower dry matter intake, lower milk production and poor reproductive performance during hot periods. The major impact on the M1 herd was poor reproductive performance, with the whole herd mated from November onwards. Milk production was affected, but less than other farmlet herds as production per cow was lower, cows were past their peak production, and generally this farmlet had its best forage during the summer months.

Calving pattern. Choose a calving pattern that is the best fit for both feed resources and seasonal milk prices through the year. The 100% spring calving pattern selected for the M1 farmlet – cows dry June/July calving from late July onwards and re-mating from November onwards – was selected to match milk production to the raingrown forage base. However, in the Mutdapilly environment, poor reproductive performance meant this pattern could not be sustained. Fresh cows and peak production also coincided with the lowest milk prices for the year.

Alternatives include switching to an autumn calving to coincide with higher autumn/winter milk prices – which is feasible in higher rainfall areas capable of growing sufficient raingrown oats and ryegrass, or on cropping-based farms with sufficient arable land to devote to winter cropping. Other pasture-based farms in higher rainfall areas find that cows calving from April onto raingrown winter forage peak well and milk well through lactation.

A change in breed away from pure Holstein Friesian may improve reproduction and heat tolerance. The likely reduction in litres/cow may be offset by improved milk composition, and receiving bonuses rather than penalties for milk protein. Crossbred stock (Holstein/Jersey) or other breeds may be better adapted to this style of farming.

Tropical forage. Make the most of regional advantages. Tropical pastures and crops have double the water-use efficiency for forage production compared with temperate species. They will generally produce twice as much forage per megalitre of rainfall. A raingrown farming system needs to take full advantage of that - including growing and conserving forage during peak periods of growth, for feeding out during low rainfall periods.

Well-grown and managed tropical grasses should be considered as an integral part of all dairy forage systems in the subtropics. They can achieve high annual dry matter yield, maintain ground cover through summer, and build up soil organic matter, e.g. the M1 raingrown Callide rhodes grass yielded up to 9 tonnes of dry matter/ha over the 2003-04 summer.

Raingrown tropical forage crops such as forage sorghum and maize will produce even more tonnes of utilisable dry matter per megalitre of rainfall than grazed tropical pastures, so they provide an opportunity for boosting annual dry matter yield on raingrown farms. They also provide a potential opportunity to produce silage during summer for feeding out the next year.

The key to maximising milk production from tropical pastures is the same as for temperate pastures - good growing practices including strategic use of fertiliser for maximum dry matter yield and quality, and grazing for maximum intake and quality. Maturing tropical grasses have higher fibre content than maturing temperate pastures, as high as 60-70% NDF. High diet NDF can restrict cow intake and lower milk production potential. For high producing cows the target for dietary NDF is 35%.

Tropical pasture forage can achieve milk production of 11 to 13 litres/cow/day. This is lower than the potential milk yields from temperates (15 to 17 litres/cow/day), but tropical species are well suited to the subtropical environment, and are the cheapest source of feed for milk production.

The feed base needs to be flexible, always open to alternatives, and able to adjust to changes in prices, forage availability and rainfall.

Conserving fodder. Periods of high forage growth need to be exploited by conserving excess forage. All farmlets – including M1 – had periods of the year when forage did not meet herd requirements. On M1 these anticipated gaps were filled with planned use of purchased forage. Despite the higher stocking rate than usual for a raingrown pasture farm, there were also periods on the M1 farmlet when there was surplus raingrown tropical grass and forage crops, which were conserved.

Water use. From the 4 years' study, the farmlets project developed several key water-use messages:

Each farm needs to find a balance between maximising milk yield and water-use efficiency for forage production. Water-use efficiency for milk production is increased by including tropical forages, however their lower quality can limit total milk yield.

The benchmark for milk yield from homegrown forage on raingrown farms is 1,100 litres milk/ML water.

Single-cut forage has higher water-use efficiency than grazed forage. Water use efficiency is improved as forage yield and utilisation increases.

Farming systems need to fully exploit climatic/rainfall patterns – especially farms relying on raingrown forage.

Losses in soil stored water during fallow need to be minimised.

Concentrate feeding. High levels of grain feeding can be profitable when combined with high production per cow, good forage utilisation and high stocking rate to prevent substitution of grain for forage. High utilisation of homegrown forage, including a combination of good grazing techniques and conserving surpluses, needs to be the focus.

Feeding grain supplements has direct benefits to milk production and the supply of starch can improve milk protein. Cow reproduction and condition also benefit.

The financial return from this farming system is very sensitive to changes in input prices. Planning and managing the supply and cost of purchased forage, grain and fertiliser is critical to its profitability and performance. Purchasing requirements and plans, plus adequate storage facilities, will enable forward and contract purchasing at lower prices. The alternative is to reduce reliance on purchased fodder by increasing available area – through purchasing or leasing extra land, or relocating the business to a forage-producing area with lower land price.

Environmental considerations. The M1 farmlet attempted to match forage production in a summer-rainfall environment with the feed requirements of a seasonally-calved herd. Matching the production system to the environment has many potential benefits – lower cost, active summer growth that protects the soil resource and minimises the risk of deep drainage.

However, intensifying the system with higher stocking rate and higher level of supplementary feeding has the potential to increase point-source pollution. Some investment may be needed in adequate feedout and effluent management facilities.

M5 INFO SERIES

THE M5 Info Series will provide dairy farmers and the industry with a wide range of information from the *Sustainable dairy farm systems for profit* project. Other topics in the M5 Info series are available at www.dairyinfo.biz on the home page look under,

- Information Databases
  - Dairy Farming - information handbook
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The *Sustainable Dairy Farm Systems for Profit* project at Mutdapilly Research Station and on associated commercial farms investigated the potential impact of intensification of five subtropical dairy farming systems on business productivity, on the social well being of farming families and on the farm environment.

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