

Dairy farming with annual crops and limited irrigation - the M3 farmlet

Findings from the “Sustainable dairy farm systems for profit” project

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OVERVIEW

It is possible to profitably produce 7,000 litres/cow/year from forage crops with limited irrigation and purchased feed in Australia's subtropical dairy region – even with long dry seasons, high grain prices and restricted access to irrigation water.

Based on information collected from the M3 annual crops and limited irrigation 20-cow farmlet at Mutdapilly, and scaled and modelled to a 360-cow farm, this production system produced a positive cash flow and an average operational return on assets of 6.3% over the four years. Average annual gross margin/cow was \$950 and operating profit \$358 /cow.

Over four years the Mutdapilly Research Station limited-irrigation-cropping M3 farmlet produced an average of 6,870 litres/cow/year, at 4.00% milk fat (274 kg) and 3.15% protein (216 kg).



INDUSTRY BACKGROUND

CROPPING-BASED subtropical dairy farms are generally located on the Darling Downs and the inland Burnett regions of southeast Queensland's cereal belt. These farms have a summer-dominant annual median rainfall of 650 to 800 mm with limited or no available irrigation. Those farms with irrigation have approximately 0.5 ML available/milking hectare.

Strengths and weaknesses of this dairy farming system in northern Australia

Strengths:

- An annual cropping system, which has the capacity to 'best fit' forage production to climatic conditions and water availability by opportunistic cropping and conserving fodder in favourable seasons.
- Wide range of crops available to meet forage requirements.
- Soils that tend to be inherently fertile and structurally stable.
- Less humid environment more suited to dairy cows.
- Many cropping districts are also tick-free.
- Potential for a low variable cost of production.
- Generally cheaper land, with fewer impediments to expansion or impact from urbanisation.
- Good access to grain and purchased forage crops.

Weaknesses:

- Vulnerability to drought due to low and unreliable rainfall and limited irrigation.
- Reliance on specific cropping skills and machinery – or contractors – to manage and harvest crops.

Weaknesses (continued)

- Limited wet-weather areas, which can lead to environmental and animal health issues during rainy weather.
- Less potential for capital gain than coastal farms.

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 M3 FARMLET HERD

THE forage base, soils and rainfall (over the study period) typified that of cropping-based farms.

Forage base – annual raingrown crops and a small component of irrigated temperate pastures .

Soils – deep, cracking black clays limited by poor internal drainage and a coarse surface structure.

Rainfall – average of 680 mm/annum over the project (*Figure 1*).

The 20-cow M3 farmlet was modelled on:

- Farm area 260 ha with 360 cows (total adult herd). After weaning heifers were agisted off-farm until calving; dry cows were also agisted.
- Limited irrigation and 700mm annual rainfall.
- A forage system based on raingrown oats, lablab and forage sorghum with 10% of the farm planted to irrigated annual ryegrass +sorghum or a lucerne/prairie grass mix.
- Two calving seasons – 30% in spring and 70% in autumn.
- High level of purchased supplementary feed – 3 tonnes of concentrate/cow/year.
- Modest stocking rate - 1.4 cows/ha.

- High milk production – 7,300 litres/cow/305 day lactation; 600,000 litres/labour unit.
- \$582,150 investment in plant and equipment to intensify the system.

Weather conditions

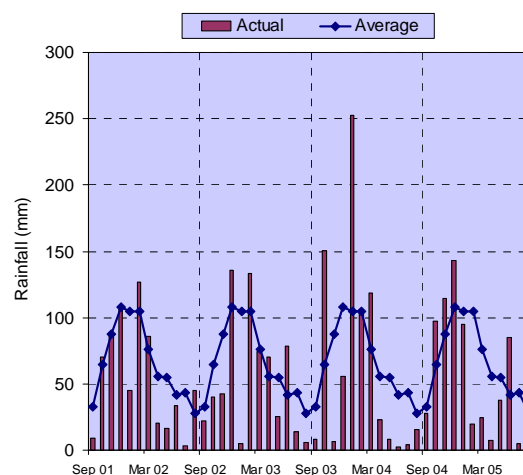
THE farmlet project years from 2001 to 2005 were based on the 12-months from September to August to fit with summer-winter seasons.

Rainfall

Mutdapilly average annual rainfall is 801 mm; however average rainfall over the project was significantly less at 680 mm/year (*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.

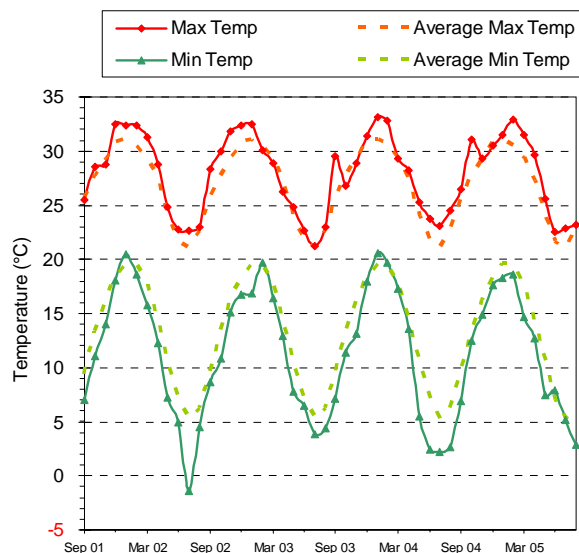
FIGURE 1. RAINFALL over the 4 years of the farmlets project.



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 (°C) at Mutdapilly over the 4 years of the farming system project.



Milk Production

THE M3 cropping farmlet was within 10% of its milk production target of 7,300 litres/cow/year in all years (Table 1 and Table 2).

TABLE 1. MILK production per cow from the M3 limited-irrigation cropping farmlet in each year of the project.

M3 farmlet	Litres/cow/year	Variation %
Budget / target	7,300	
2001-02	6,690	-8.3
2002-03	7,190	-1.4
2003-04	6,630	-9.2
2004-05	6,970	-9.1
4-year average	6,870	-5.9

The 4-year average milk production was 9,300 litres/ha, with 4,900 litres/ha, (53%), from homegrown grazed and conserved forage (by reverse calculation).

TABLE 2. AVERAGE milk yield, milk composition and liveweight of animals in the M3 farmlet over the 4 years of the project.

Litres/cow/year	6,870
Litres/cow/day	22.3
Milk fat	4.00% 275 kg
Protein	3.15% 217 kg
Lactose%	5.00%
Milk solids kg	491
SCC (x 1,000)	240
Liveweight kg	562

Figure 3 and Figure 4 present daily herd and average litres/cow milk production patterns for the scaled up 360-cow M3 herd, with its 30% spring and 70% winter batch calving. These figures are based on the 20-cow farmlet herd

Maximum daily temperatures above 30°C from December '03 to February '04 dramatically reduced milk production over this period – due to heat stress and its impact on dry matter intake, plus a lowering of forage quality, with irrigation difficult to manage during such heat.

FIGURE 3. DAILY herd milk production pattern (L) for a 360-cow, M3-style herd.

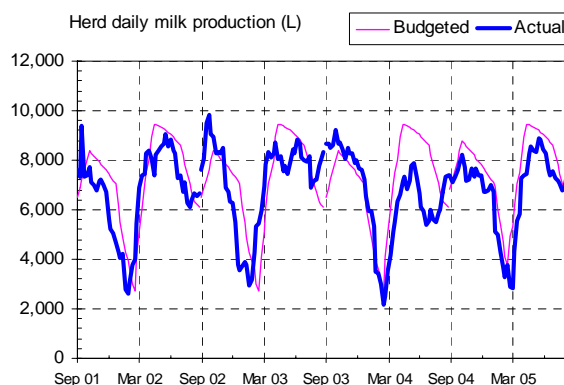
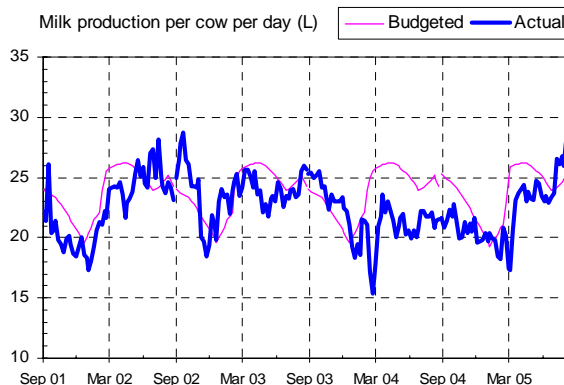


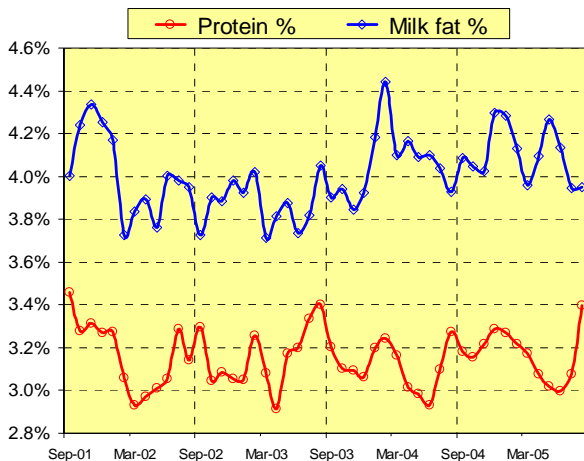
FIGURE 4. DAILY milk production pattern (L) per cow in a 360-cow, M3-style herd.



Milk composition

Figure 5 gives monthly milk composition for the M3 herd over the 4 years. Part of the variation can be explained by stage of lactation effects from autumn and spring batch calving, but there are also effects of nutrition and cow body condition.

FIGURE 5. MILK composition of the M3 limited-irrigation cropping herd.



Calving pattern and reproduction

THE M3 farmlet seasonally calved 30% of the herd in spring (with summer mating) and 70% in autumn (with winter mating). The emphasis on autumn calving was to take advantage of winter milk price incentives and winter crops.

The 12-week summer mating period was planned for 20th November to 12th February, for a spring-calving period from 29th August to 21st November. The winter mating period was planned for 2nd May to 7th July, for autumn calving from 8th February to 19th April.

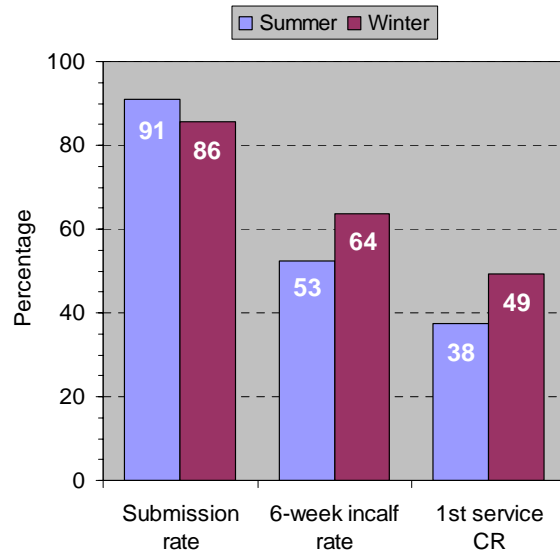
There was a high wastage rate in this herd, with 39% of cows replaced annually due to calving pattern reasons (they would not re-calve in the required season).

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.

The M3 herd struck similar problems to other farmlets in maintaining a spring-calving batch – as demonstrated by the 38% first-service summer conception rate in Figure 6.

FIGURE 6. M3 FARMLET herd summer and winter 21-day submission, 6-week in calf and 1st service conception rates (%).



Pastures and crops

THE forage plan for the M3 farmlet, scaled up to a 260-ha modelled farm is presented in Table 3, Lucerne and perennial temperate pastures were incorporated into the feed plan with the intention of providing grazing in the 10 to 12-week establishment periods between summer and winter crops and pastures. Lucerne and perennial temperate pastures also lend themselves to conservation.

TABLE 3. PERCENT and area of forages on a 260 ha modelled M 3-style farm.

% area	Ha	Forage type
15%	39	Tropical grass area
40%	105	Raingrown (RG) winter forage crop (oats)
34%	88	Raingrown (RG) summer forage crop (35% lablab, 65% sorghum)
4%	10	Irrigated ryegrass double cropped with forage sorghum
7%	18	Lucerne-prairie mix, limited strategic irrigation
100%	260	Total farm milking area

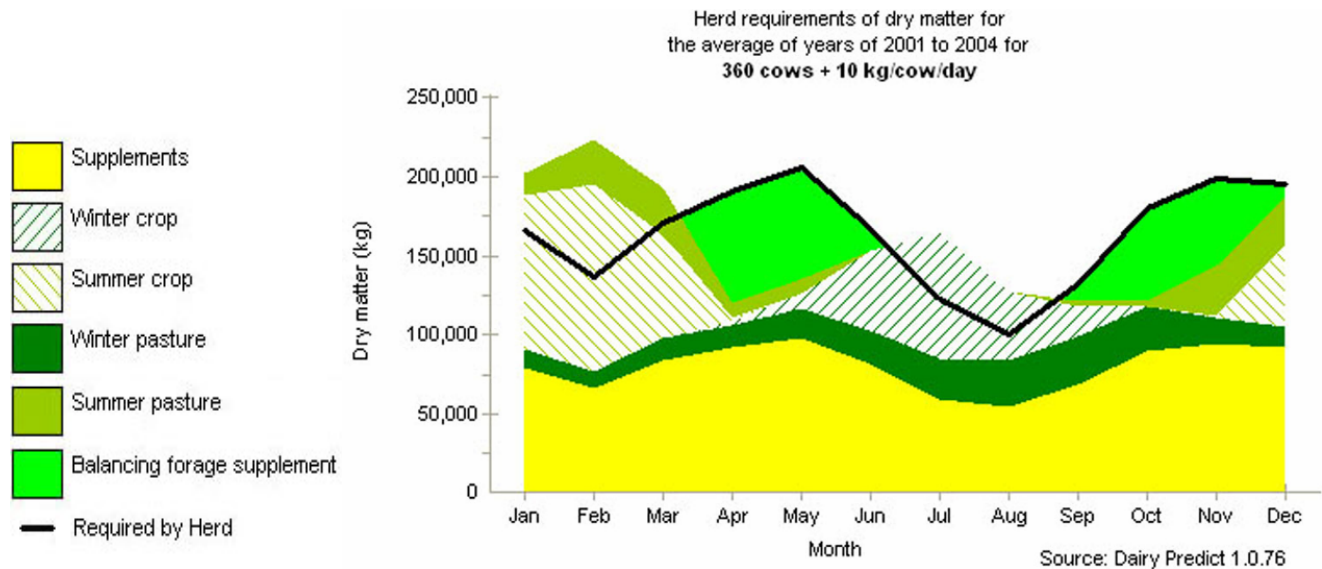
The farmlet stocking rate was 1.4 milking cows/ha. With batch calving there were times of year when dry cows were agisted and the stocking rate on the milking cow area was lower.

Figure 7 represents the M3 farmlet feed plan using the dairy feedbase decision model Dairy Predict. The feed plan shows a moderate surplus in

summer, a small surplus in winter, and a requirement to feed balancing forage supplement to fill shortages in autumn and spring.

The actual quantity of supplementary forage fed is presented in *Figure 8*.

FIGURE 7. A REPRESENTATION of the forage supply and supplements fed to the modelled M3 farming system produced by Dairy Predict.



Conserved forage - homegrown and purchased

WITH a strong emphasis on fodder conservation, and potential for opportunistic cropping, the M3 farmlet system has the capacity to ‘best fit’ forage production to variable low-rainfall conditions, compared with systems such as grazed pastures, which aim to meet cows’ daily requirements with fresh forage.

For maximum advantage from this farming system, periods of surplus growth need to be exploited by conserving excess forage and/or by planned growth of forage-conservation crops during good seasons.



The M3 cropping program was designed to achieve a summer forage surplus for conservation as hay or silage. At Mutdapilly all the grazed farmlets experienced periods of the year when there was insufficient fresh forage to meet herd requirements.

These gaps were filled with homegrown conserved forage in farmlets M3 and M4, and with purchased forage in farmlets M1 and M2.

The quantity of conserved forage fed per cow each year on the M3 farmlet is given in *Table 4*, expressed as both hay (85% DM) and pit silage (38% DM). The proportion of this forage that was homegrown is also presented

In the farmlet study, all forage was conserved in round bales and fed in the paddock in feed-rings. On a commercial dairy farm, feeding this amount of conserved forage would be more conveniently done on a feed pad and maybe using a mixing wagon. The project’s financial analysis of this type of farming system included a mixing wagon as part of setting up.

TABLE 4. CONSERVED forage fed (per cow) on the M3 farmlet each year, expressed as hay or silage equivalents. (Tonnes wet weight, hay 85% DM, silage 38% DM).

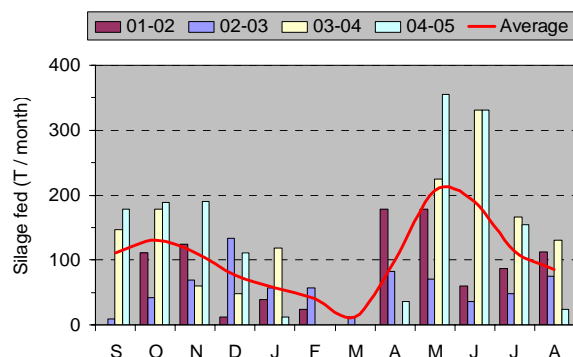
Conserved forage	Year				4-year Average
	01/02	02/03	03/04	04/05	
as Hay	1.1	0.9	1.7	2.0	1.4
or Silage	2.6	1.9	3.9	4.4	3.2
% HG	64%	53%	100%	58%	71%

The pattern of feeding conserved forage to the M3 farmlet herd for each year, plus the average pattern over the 4 years is presented in *Figure 8*.

Expressed as silage equivalents, the amount fed

ranged from 700 tonnes wet weight to 1,600 tonnes/year when scaled up to a 360-cow enterprise.

FIGURE 8. THE AMOUNT of conserved forage fed to the M3, 360-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 M3 farmlet. Low rainfall was the main reason for lower N applications in some years.

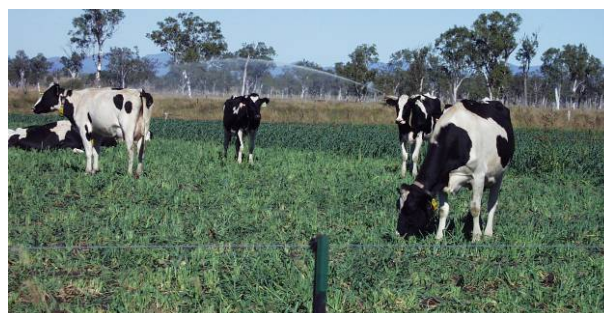
Table 6 presents the amounts of N applied to the M3 farmlet/cow/year. By industry standards, the average N fertiliser use of 60 kg/cow/year on the M3 farmlet is regarded as low use of N fertiliser. However the quantity of N coming onto the farm through 3 tonnes of supplements/cow/year was high - 92 kg/ha or 68 kg/cow - 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 M3 farmlet.

Forage type	Kg N/ha applied in year				Average Kg N/ha
	01/02	02/03	03/04	04/05	
Tropical grass	138	276	147	201	190
Rain-grown winter forage	64	110	3	21	49
Rain-grown sorghum forage	157	58	76	74	91
Irrigated ryegrass sorghum	281	261	240	290	268
Lucerne-prairie	68	-	-	8	39

TABLE 6. NITROGEN fertiliser applied to the M3 farmlet/cow/year.

	Year				4-year average
	01/02	02/03	03/04	04/05	
Kg N per cow	71	81	37	50	60



Irrigation and water use

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

The M3 limited-irrigation cropping farmlet was designed to have 10% of the farm irrigated, consistent with farms with a similar forage system. The irrigation allocation was 6.0 ML/ha or 0.47 ML/cow.

Irrigation records were available for three winter-summer seasons (April to March) from 2002 to 2005 (Table 7).

TABLE 7. IRRIGATION water allocation and use in the M3 farmlet.

Allocation		% allocation available		
Per ha	Per cow	02-03	03-04	04-05
6.0	0.47	92	53	51

- In 2002-03 irrigation was relatively unrestricted, and the farmlet received 92% of its total allocation.
- In 2003-04 restricted irrigation water supply and pumping difficulties limited the total volume of irrigation water to 53% of allocation. Up to 40% of the annual ryegrass area was substituted with a more water-efficient oats crop, and the winter irrigation season reduced.
- In 2004-05 irrigation use was reduced due to replanting of lucerne, which restricted irrigable area. M3 received 51% of its allocation.

When irrigation was restricted, the strategy was to schedule available water to the most water-efficient crops. In the M3 farmlet, irrigated annual

ryegrass had priority over lucerne and other temperate mixtures. In 2003-04, part of the irrigated annual ryegrass area was planted to oats instead, followed by an early sorghum crop to make as much use of available water as possible.

Over 3 years of data collection, the M3 farmlet received 66% of its water allocation, equivalent to 3.94 ML/irrigable ha, 0.41 ML/farm ha or 0.31 ML/cow.

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 (tonnes DM/ML effective rainfall + irrigation) for irrigated forages in the M3 farmlet are given in *Table 8*.

TABLE 8. AVERAGE DM yield (t DM/ha) and WUE (t DM/ML) of forages in the M3 farmlet.

Forage type	Yield	Effective rainfall + irrigation	WUE
Ryegrass	9.2	5.3	1.8
Perennial temperate mixtures	9.9	8.8	1.1
Irrigated forage sorghum	16.6	4.6	3.6
Raingrown oats	4.0	2.4	1.9
Raingrown forage sorghum	13.0	4.2	3.0
Raingrown lablab	8.6	3.8	2.4
Rhodes grass	6.7	4.0	1.6

Of all the farming systems, the M3 system recorded the highest water-use efficiency for forage production.

Rainfall over the study period was fairly typical for farms in the cropping zone - 600 to 800 mm average rainfall.

During very difficult dry seasons, the farmlets proved that growing and conserving forage sorghum is an efficient way to use limited rainfall and irrigation water supplies, and an important means of filling feed gaps.

Forage sorghum varieties now available for conservation offer a flexible warm-season alternative to maize, if water is limited. You can expect 10 tonnes DM/ha from dryland forage sorghum with adequate stored moisture from a winter-fallowed paddock.

On the M3 farmlet, forage sorghum yielded up to 21 tonnes DM/ha with irrigation and proved to be a highly efficient user of water - averaging 3.6 tonnes DM/ML (effective rainfall + irrigation).

On this basis, with limited spring irrigation, it is advised to shift the focus for irrigation water away from ryegrass to tropical forage in October.

Water-use efficiency of milk production

WATER-USE efficiency for milk production is litres of milk from homegrown forage/ML water (effective rainfall + irrigation). A litre of milk from homegrown forage is a calculated figure based on total milk production, adjusted for supplements and purchased forage. Figures for each farmlet are presented in *Table 9*. Based on rainfall and limited irrigation, the M3 farmlet recorded a water-use efficiency for milk production from homegrown forage of 790 L/ML water.

TABLE 9. EFFECTIVE rainfall and irrigation inputs (ML/farm ha) and WUE (L milk/ML water) in the M5 farmlets.

Farmlet	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

Rainfall and irrigation are expressed as ML/ farm ha. The cut and carry M5 feedlot had the highest WUE measured as milk produced/ML (rain + irrigation) water. The M4 (full irrigation) and M2 (limited irrigation) grazed pasture farmlets produced similar amounts of milk/ML under very dry seasonal conditions. M3 had the lowest WUE for milk production.



Concentrate feeding

THE M3 farmlet feed budget incorporated 3 tonnes of grain concentrate/cow/lactation (10 kg/cow/day, as fed). 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 or 50/50 – which is optimal for cows of high genetic merit.

The concentrate ration (*Table 10*) 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 10. AVERAGE concentrate ration fed to the M3 farmlet herd (kg/cow/day as fed).

M3 concentrate	kg/cow/day (as fed)
Grain	7.8
Molasses	0.1
Protein meal	0.8
WCS	1.7
Minerals	0.3

With a run of dry seasons, the average (homegrown + purchased) forage/concentrate ratio

fed to the M3 cropping farmlet herd over the 4 years was 55/45.

As well as feeding higher rates of concentrate, each farmlet used a higher stocking rate than the industry average. Stocking rates for the M3 farmlet were 1.8 cows/ha on the whole farm and 14.8 cows/ha on the irrigated pastures. 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 M3 farmlet herd was fed the concentrate ration as 4 kg of mixed grain/cow/day in the dairy, with the balance of grain and protein meal outside the dairy in troughs twice 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 11*), high grain feeding impacted on total variable costs. Purchased feed and forage costs were highest in year two (2002/03) at 14.7 c/L. However production was maintained and concentrate costs were spread over a large volume of milk.

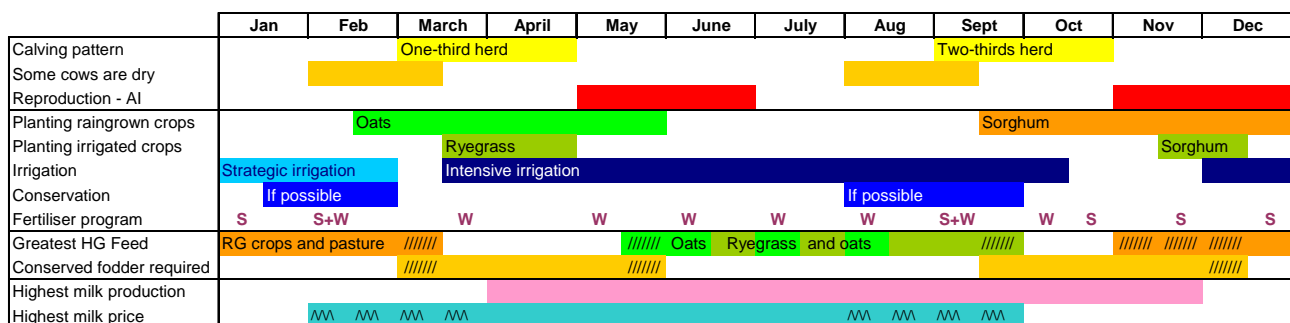
TABLE 11. AVERAGE cost of the M3 concentrate mix over the 4 years of the project.

M3 concentrate cost	01-02	02-03	03-04	04-05
\$ per tonne as fed	247	321	223	224

Calendar of operations and farm activities

A YEARLY calendar of operations and farming activities for the M3 farmlet is presented in *Figure 9*.

FIGURE 9. A CALENDAR of farming operations for the M3 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 that fertiliser application rates on individual farms may need reconsidering. 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 12*.

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 highest on farmlets M1 and M2, which had an emphasis on perennial grass pastures rather than annual crops.

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 12. 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 high level of supplementary feeding (homegrown roughage as well as purchased concentrates) requires investment in well-designed

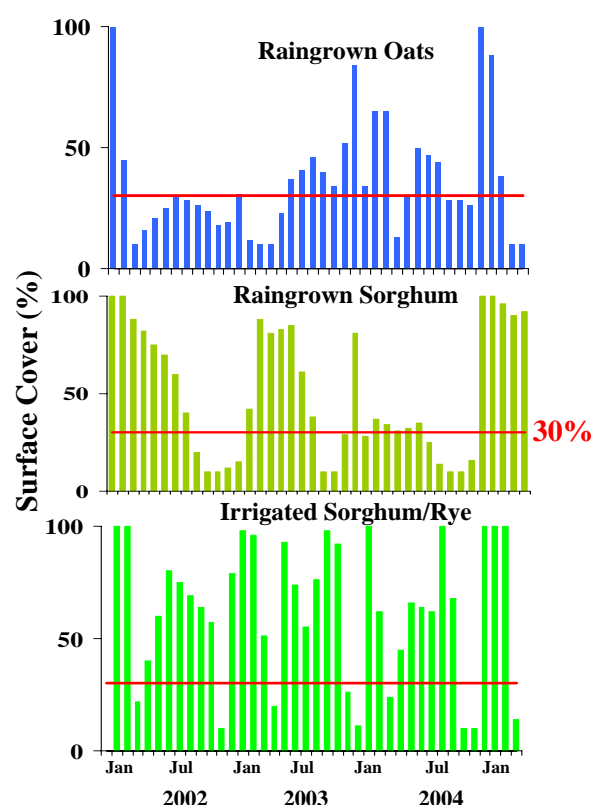
feedout and loafing areas to ensure efficient use of these feedstuffs, as well as enabling wastes to be appropriately managed. Unless these facilities are well designed and managed, animal health, odour and nutrient management issues are likely to arise.

Reliance on annual cropping makes this system more vulnerable to soil erosion and to organic matter and soil structural decline. So it is important to use agronomic and grazing practices that maintain ground cover, particularly over summer. Double-cropping of the winter ryegrass area with forage sorghum provides good soil protection for most of summer.

Using herbicides instead of cultivation in the early phase of fallow significantly extends the period of time with an adequate level of soil cover. However, cover levels remain inadequate during the summer erosive period if tillage is not replaced completely with herbicides.

Visual estimates were made of soil cover during summer and winter (*Figure 10*) of the raingrown oats and sorghum, and irrigated and double cropped ryegrass-sorghum paddocks. Double-cropping provides good soil protection for most of summer.

Figure 10. SOIL cover under raingrown oats and sorghum, and irrigated and double cropped ryegrass-sorghum on the M3 farmlet.



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 13*). 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 13. 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 131-cow M3 farm into a 360-cow enterprise is presented in *Table 14*.

The 4-year average key financial indicators for each of the Mutdapilly modelled farmlets are presented in *Table 15*. All farming systems, including M3, had a positive operational 4-year average return on assets.

Scaling up the production results and costs of the 20-cow Mutdapilly M3 farmlet herd over 4 years, the limited-irrigation cropping M3 farming system returned a gross margin of \$950/cow/year, for an average operating profit of \$358/cow/year.

Annual business results for M3 are summarised in *Table 16*.

Using the estimated capital costs of expansion in *Table 14*, at average industry asset values, and scaling up the production results of the 20-cow M3 farmlet herd to a 360-cow herd, the M3 farming system produced a positive cash flow and operational return on assets (RoA) in all years. Average RoA over the four years was 6.3% compared with a budgeted 10.2%. Average operating profit margin was \$358/cow/year. Average feed-related cost on the M3 farmlet over the four years - including dry years with increased purchased feed at increased cost - was 15.8 cents/litre.

TABLE 14. THE ESTIMATED capital required in 2000-01 to change a typical 125-cow M3 farm (from QDAS) to a 360 cow herd on the same land area.

Extra capital required - M3	\$
Land	0
Buildings	
Dairy buildings	50,000
Total Buildings	50,000
Plant/equipment	
Vat	70,000
Feed pad	9,500
Feed wagon	80,000
Water	12,000
Silos	15,000
Effluent	40,000
Total Plant / equipment	226,500
Livestock	305,650
PDA / Shares	0
TOTAL	582,150



TABLE 15. 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 16. BUSINESS traits and KPIs of a typical M3 farm in QDAS in 2000-01, and the annual and 4-year average figures from the modelled M3 farm.

BUSINESS TRAIT SUMMARY	QDAS	M3				
	2000-01	2001-02	2002-03	2003-04	2004-05	Average
Liquidity						
Dairy cash surplus (\$)	22,656	127,906	88,237	154,869	228,397	149,852
Interest costs per cow (\$)	131	159	159	159	159	159
Solvency						
Equity %	83%	58%	59%	60%	61%	60%
Liabilities per cow (\$)	1,872	2,267	2,267	2,267	2,267	2,267
Profitability						
Change in Net Worth per year (\$)		26,100	39,378	52,978	67,031	46,372
Return on Assets % (operational)	-0.0%	5.1%	3.3%	6.7%	10.2%	6.3%
Return on Assets % (Capital+operational)		9.2%	7.8%	11.5%	10.0%	9.6%
Return on Equity %	-0.0%	3.7%	0.7%	6.5%	12.2%	5.8%
Operating profit (\$/cow)	-4	277	181	379	595	358
Efficiency						
a) Capital efficiency						
Asset turnover ratio %	18%	47%	49%	44%	46%	46%
b) Financial efficiency						
Feed related costs (c/L)	15.4	16.3	18.7	14.2	13.8	15.8
Forage costs (c/L milk from forage)		8.7	7.4	7.1	4.7	7.0
Margin over feed related cost (c/L)	20.1	21.7	18.7	23.1	24.9	22.1
Gross Margin per cow (\$)	808	889	779	964	1168	950
c) Physical efficiency						
L / cow / year	5,399	6,694	7,194	6,627	6,968	6,871
L / hectare	2,596	9,064	9,742	8,973	9,435	9,304
Litres / labour unit	337,444	602,459	647,491	596,406	627,111	618,367
Cows / labour unit	63	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.

Companion farmers and farmer members of the project-planning group felt that intensifying this system would only work with an emphasis on conserving feed rather than grazing.

They raised a number of logistical issues in grazing a large herd (300 + cows) in a predominantly dryland, extensive grazing environment.

Implications of moving to a system with an emphasis on conserved feed included increased capital investment on the property – to incorporate a well-designed feedout area, shade, silage pits, water, manure disposal, feed wagon and manure spreader.

The alternative is to remain with a grazed system and a smaller herd size.

Other implications raised by moving to a larger herd size (300+ cows) with this raingrown/limited irrigation annual cropping system included:

- Is it possible to economically keep feed up to cows in a predominantly dryland farming system?
- Is there enough stock water to fill large troughs with good flow?
- Would a more viable alternative be to put emphasis on grazing over winter and feeding conserved forage in summer?
- Will the intensification create problems with manure and smell, particularly in wet weather?

Positive implications of intensifying an annual cropping farm by increasing forage conservation and reduced (or no) grazing include an easier cropping program, reduced compaction, and easier farm layout.

With good planning, a batch-calved large herd and better forage utilisation could improve cash flow and planned time off.

CONCLUSIONS AND RECOMMENDATIONS

Business considerations. There appears to be potential for increased production per cow for limited-irrigation cropping-based farms in the subtropical dairy region. 2005 QDAS data indicates average production per cow in northern NSW is 5,250 litres/cow/year and in SEQld it is 5,385 litres/cow/year. The Mutdapilly M3 limited-irrigation cropping farmlet averaged 6,870 litres/cow/year over four years, under less-than-ideal dry conditions and irrigation water restrictions.

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.

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 raised by the raingrown M1 farmlet are also pertinent to M3-style farms.

Intensification. High stocking rates can accentuate the feed gaps that occur between forage seasons. 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 cropping-based system makes it 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.

Tropical forage. Make the most of regional advantages. Tropical 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. 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 crops can achieve high annual dry matter yield, maintain ground cover through summer, and build up soil organic matter. Raingrown tropical forage crops such as forage sorghum and maize will produce more utilisable tonnes of 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 forage can achieve milk production of 11.5 to 13.5 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.

Conserving fodder. Periods of surplus growth need to be exploited by conserving excess forage. All farmlets – including M3 – had periods of the year when forage did not meet herd requirements. On M3 these anticipated gaps were filled with planned use of homegrown or purchased forage. Despite the higher stocking rate than usual for a raingrown cropping/limited irrigation farm, there were also periods on the M3 farmlet when there was surplus forage sorghum, which was conserved.

Increasing the quantity of conserved homegrown feed reduces reliance on purchased forage – but requires either the purchase of relevant equipment or the use of contractors.

Increasing the use of conserved feed over summer - rather than grazing - increases the options for controlling heat stress and reduces the risk of soil compaction during wet weather, but may require increased capital investment. The routine use of conserved forages requires installation of a well-designed feedout area, and a manure-management strategy to minimise the risk of polluting surface and ground waters.

Before increasing the use of fodder conservation, consider its impacts on farm management time and

labour, machinery for harvesting, and infrastructure to store and feed out the forage.

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 is 1,100 litres of milk per megalitre of water for raingrown farms and 1,400 litres/ML for fully irrigated farms.

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

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

Farming systems that have limited irrigation and heavy reliance on raingrown forage need to fully exploit the subtropics' climatic strengths, which include summer-dominant rainfall and high radiation levels in winter. Aim for 30 tonnes DM/ha/year. A double-cropped paddock of ryegrass and forage sorghum yielded 22 tonnes DM/ha in one year (2003-04).

The feed base needs to be flexible, always open to alternatives, and able to adjust to changes in prices, forage availability and rainfall. Be ready to take advantage of any good seasons. Preparing for high-forage growth opportunities is as important as preparing for drought. Being prepared will include having a forage conservation strategy; a nitrogen fertiliser program; the capacity to plant crops with minimal or no ground preparation; and strategies to minimise the impact of high rainfall and to maximise water retention.

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 the

profitability and performance of this farming system. Having purchasing requirements and plans, plus adequate storage facilities in place, 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. Raingrown cropping farms can reduce their environmental impact with emphasis on summer cropping, planting with zero tillage and managing fallow periods with herbicides rather than cultivation.

Access to irrigation water means a summer forage crop can often be grown on winter-forage land, providing soil cover and reducing the risk of erosion.

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.

Fertiliser needs to be adjusted to take into account the level of nutrients brought onto the farm in purchased feeds.



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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,

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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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