Use of "technologies" which are appropriate for production of low-cost milk from grazed pasture;

A New Zealand perspective.

1. Dairy Systems
2. Dairying in New Zealand
3. Technologies in New Zealand Dairy Systems

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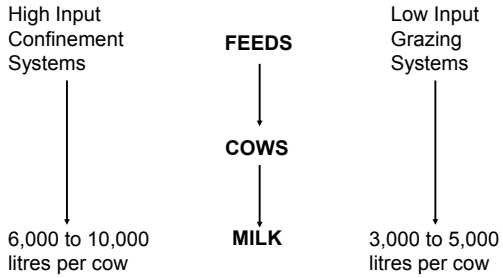
Milk Production Systems



Seasonal Milk Production from Pasture

Practiced for hundreds if not thousands of years

A sustainable system of milk production!

Pastoral dairying; 1600

General Conditions in New Zealand

- New Zealand exports about 90% of all its milk, as dairy products; Causes low price
- No subsidies or tariffs in New Zealand; Causes low price
- Grass grows and can be grazed all year; Enables low costs of production

Standardised Milk Prices (US c/litre; June 2004; 3.6% fat, 3.3% protein)

- France: 29.0
- Germany: 28.7
- Netherlands: 26.5
- UK: 24.4
- US: 38.8
- NZ: 15.5

(Irish Farmers Journal; 28/8/04)

Technologies for increased profit, despite low milk price

- A huge range of technologies can increase milk production
- But fewer technologies can increase profit despite low milk price
- In New Zealand's pastoral systems, many small improvements in all components; successfully integrated into the system, these give steady gains

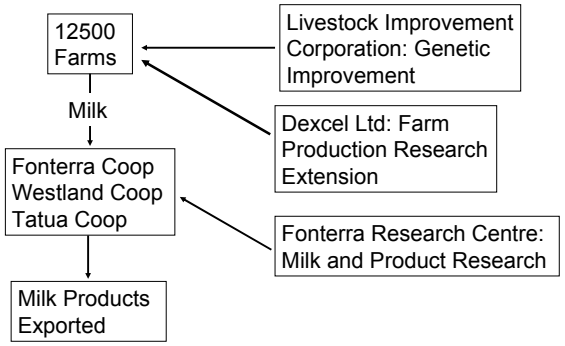
Key Technologies

Key Technologies

Key Technologies

Key Technologies

The Integrated NZ Dairy Industry; Cooperatively owned by NZ Dairy farmers



The Farmer - Owned Company

Milk Transport, 2000

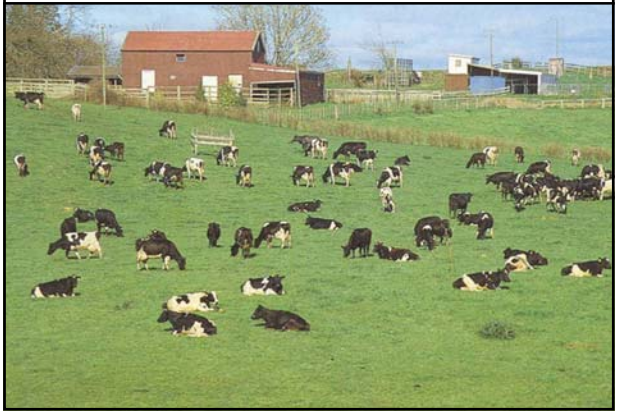
Progress since 1910

Progress since 1910

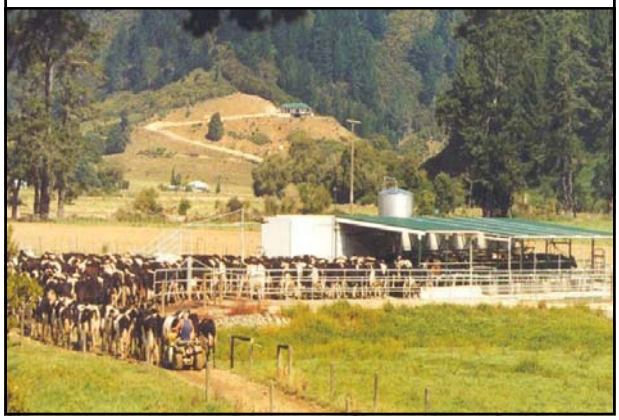
Progress since 1900. Dairyfarm; 1900

Dairyfarm; 1960

Dairyfarm; 1960



Dairyfarm; 2000



Dairyfarm; 2000

Changes on New Zealand Dairy Farms; 1950-2000

	Average in 2002	(Change)
Price for milk	NZ $4.00/kg MS	(x 0.6)
Number of cows	3.7 million	(x 2.2)
Number of farms	13,100	(x 0.4)
Cows per farm	290	(x 10.0)
Milksolids/cow	315	(x 1.7)
Milksolids/hectare	830	(x 3.1)
Milksolids/person	40,000	(x 7.6)
Pasture eaten t DM/ha	10.5	(x 2)
Feed "imported" (t DM/ha)	0.6	(from 0)
N Fertilizer (kg N/ha)	110	(from 0)

Grazed Pasture for Cows

Pasture is not a suitable feed for the high-yield dairy cow, because of limitations on intake

- Grazing cows; 15 to 20 kg DM eaten/day from 12 hours of grazing
- Total Mixed Ration; 20 to 25 kg Dm eaten/day from 4 to 5 hours of eating

BUT

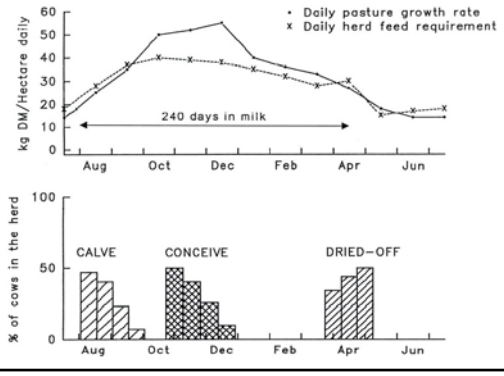
- Grazing systems offer many advantages, which contribute to low cost of production per kg milk (feeding, housing, labour, machinery, health)

Aims of New Zealand Dairy Farmers

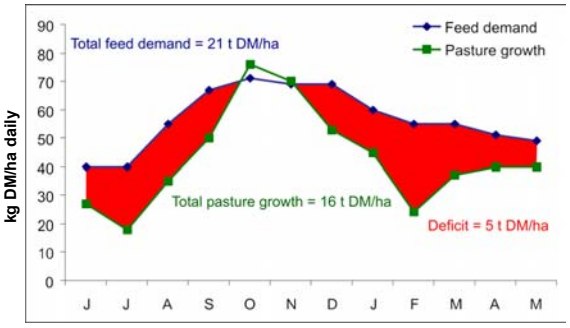
- Farm profit, reduced labour input, enjoy life!
- Profit is more closely related to milk/hectare than to milk/cow
- Optimize balance between high milk/cow and high milk/ha.
- High cows/ha ⟶ All pasture eaten, but low milk/cow
- High milk/cow ⟶ High F.C.E., but more pasture not eaten
- Supplements can enable both to be achieved

Saving Labour

New Zealand's Seasonal, Pastoral Systems: The basis; Pasture only



High stocking rate; plus supplements (S & J Van der Poel)



Feeding Cows on Pasture

Feeding Cows on Pasture

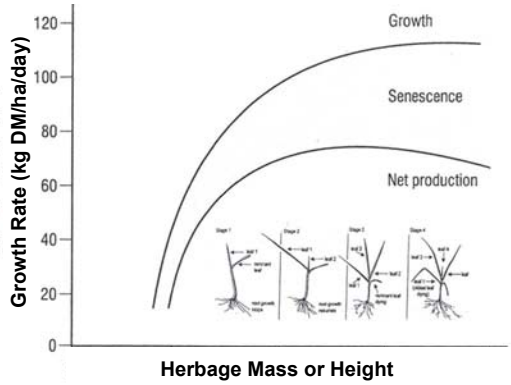
Mechanics well understood;

- Pasture intake per day =
  g DM/bite x Bites/minute of grazing x Minutes of grazing per day

Main factors;

- Height and mass of pasture pregrazing (bite size)
- Amount offered per day (average bite size and grazing time)
- Pasture quality (Digestibility; MJ ME/kg DM)

Growth of Grazed Pasture; Biology Well Understood

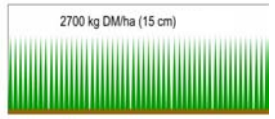


Electric Fence to Control Grazing

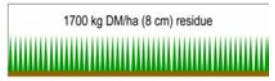
Quantitative Grazing Management

200 cows on 80 hectares; pasture only

- **Before Grazing**
  Maximum green leaf
  Minimum dead matter
  11.5 to 12.0 MJ ME/kg DM



- **After grazing by lactating cows: 1000 kg DM/ha eaten**
  Require: 16 kg DM/cow
  Or: 3200 kg DM/herd
  Require: 3.2 ha/day
  80/3.2 = 25 day rotation



- **After grazing by dry cows: 1600 kg DM/ha eaten**
  Require: 8 kg DM/cow
  Or: 1600 kg DM/herd
  Require: 1 ha/day
  80/1 = 80 day rotation

Pasture plus Supplements; Management of Substitution

200 cows on 80 hectares; half pasture and half silage

- **Before Grazing**
  Maximum green leaf
  Minimum dead matter
  11.5 to 12.0 MJ ME/kg DM

Plus Silage

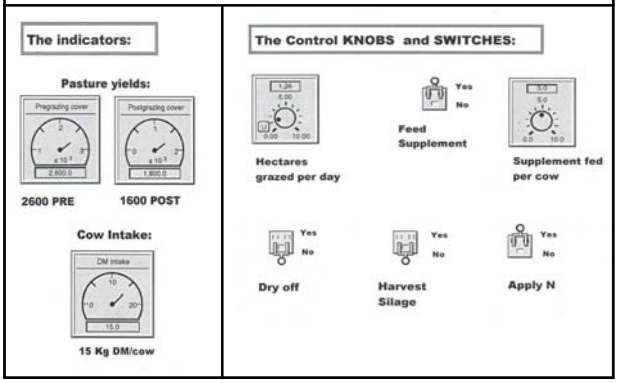
- **After grazing by lactating cows:**
  Require: 8 kg DM/cow from pasture
  Or: 1600 kg DM/herd
  Require: 1.6 ha/day
  80/1.6 = 50 day rotation

Plus Silage 8 kg DM/cow

- **After grazing by dry cows:**
  Require: 4 kg DM/cow from pasture
  Or: 800 kg DM/herd
  Require: 0.5 ha/day
  80/0.5 = 160 day rotation

Plus Silage 4 kg DM/ha

The Virtual Day-to-day Control Panel of Pasture Balance



Feed demand per hectare (Stocking Rate); Still a Key Factor

Feed demand ÷ Pasture supply is the key to feeding cows adequately and to utilizing the pasture fully

Cows per hectare is not sufficiently accurate now because

- Cows can be Jersey or Holstein Friesian
- A hectare can grow 10 or 20 t DM/year
- On many farms the hectare is not the only source of feed, because they import other feeds

Comparative Stocking Rate

- $$\frac{\textbf{kgLW}}{\textbf{Total feed offered; t DM}}$$
  (incl. pasture grown plus all other feeds)
- Calibrated versus experiments with pasture only.
- Optimum for profit; 85 kg LW/t DM
  = 4.7 t DM offered/Jersey Cow (400 kg)
  = 5.9 t DM offered/HF cow (500 kg)
- In future, the top line (kg LW) will become Genetic Feed Demand calculated from Breeding Values for Liveweight, and yields of milk and solids

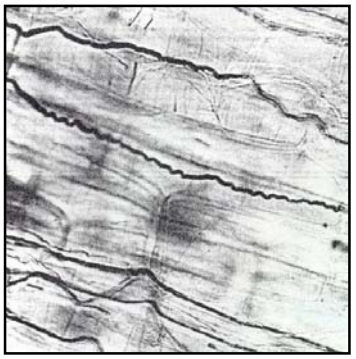
Factors contributing to the increased use of other feeds, eg: maize for silage

- Improved yield of maize for silage (x3; since 1960) and lower cost/t DM
- Improved genetic merit of cows, greater yield potential, and higher responses to extra feeds
- Improved machinery for harvest and conservation of forages, and feeding of all feeds, and reduced labour
- But dairy farm profit not always increased

Pasture Production

- Continued selection for improved cultivars of grasses, mainly ryegrasses, and clover
- Average pasture production has increased (x 1.5), due to improved genetics and soil fertility
- New cultivars with increased digestibility, and increased soluble carbohydrate concentrations.
- Endophytes in ryegrass

Endophyte mycelium growing between plant cells in ryegrass



Endophytes in Ryegrass; "Wild" and "Selected"

- Ryegrass is often infected with the endophyte (internal fungus)
- This protects the plant against insects through its release of peramine
- But the "wild" endophyte's alkaloid Lolitrem B causes "ryegrass staggers" in summer.
- And it can cause heat stress through its vasoconstrictor, ergovaline
- ARI, a selected "safe" endophyte which contains peramine, but not Lolitrem B nor ergovaline, protects ryegrass with no adverse effects on cows

The Cows Required for Pastoral Systems?

The Cows Required for Pastoral Systems?

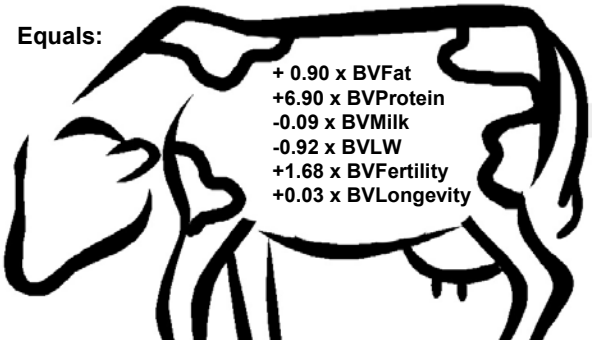
The Cow Required for Pastoral Systems

- For all systems: cows must convert feed efficiently into large amounts of milk, and remain healthy
- In addition, for seasonal, pastoral systems: must be able to walk and graze, and conceive every 365 days
- The present NZ Animal Evaluation System (Breeding Worth) is a measure of:

($ income - $ cow costs) per kg feed, and includes six traits

Breeding Worth; $ Net Income/4.5 t DM eaten

Equals:

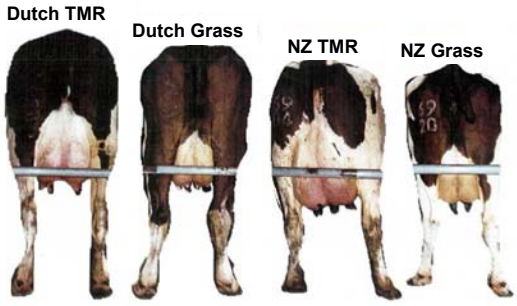


This requires a large database and large computer capacity, and was not feasible in the past

Interactions between Genotypes and Feeding Systems

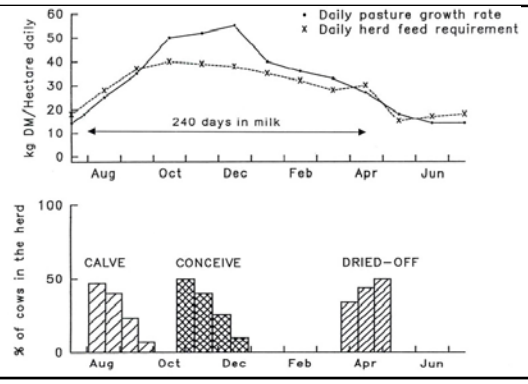
- Confinement or feed-lot systems; high intake and 6000 to 8000 l/cow
- Grazing systems; low intake and 3000 to 4500 l/cow
- Cows which are genetically the best performers under high intake: high yield systems are genetically different from cows which are the best performers under grazing systems

G x E Interactions; E. Kolver



720	459	kg MS/cow	602	465
29	62	% not pregnant	14	7

Compact Periods of Mating and Calving Essential for Seasonal System



Fertility in the dairy cow, and its management

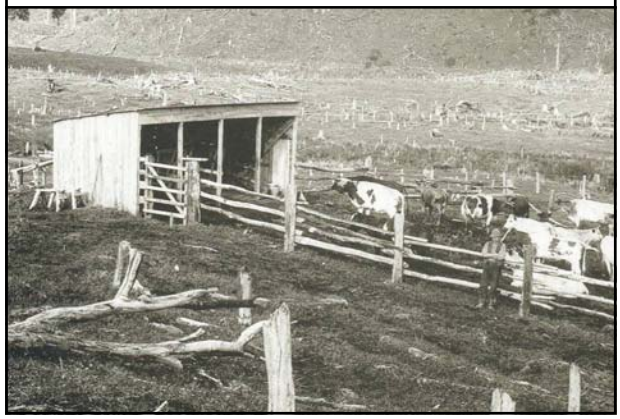
- Compact calvings and matings, with low non-pregnancy rates, were achieved by the best herds in the 1950s. Infertile cows were culled.
- 1970s and 1980s, progesterone devices to stimulate oestrous, and corticosteriods to induce premature calving. Fewer infertile cows were culled
- Modern New Zealand cows have longer post partum anoestrous intervals than those from 1970
- Good management of health, feeding and mating plus genetic selection will improve fertility, with reduced use of hormones

Heat detection for Artificial Insemination:
Kamar detector
Tail paint

Milk Harvesting; Facilities and the Cow

- The need to milk cows twice daily dominates life on the dairy farm, for the people and the cows
- Facilities and cows have changed in the past, and will change in the future

Milking shed; 1900



Turnstyle Rotary; 2000

60 – 200 cows/hour per person

Herringbone; 2000

60 – 100 cows/hour per person

Milk Harvesting; Changes in the Cow; Past and Future?

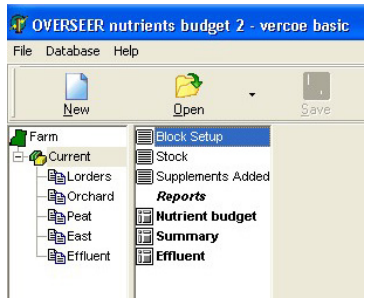
The cow has changed, because methods have changed

- Originally suckled by calf 8 to 12 times daily
- Then milked by hand, with the calf present
- 1950: many cows required manual stimulation
- 1970: no time to give stimulation
- 1990: few cows required stimulation
- Future: half the cows in NZ do not require twice daily milking in 2030?

Soils, Fertilisers and Water

- Increased use of fertilisers, especially N, and increased cows per hectare
- Increased use of irrigation
- Increased risk of nutrients leaching into waterways
- Increased risk of damage to soils, especially heavy, wet soil
- "New" methods of land development; giant plough (flipping and draining topsoil); conversion of planted pine forest into pasture

Overseer Model to manage fertiliser nutrient inputs



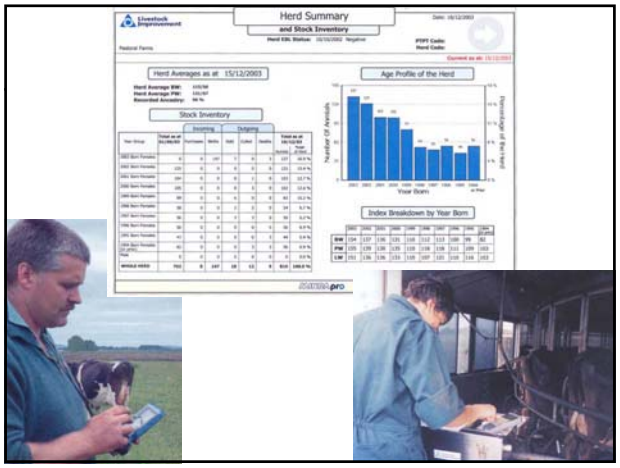
Protection of Wet Soils; Wintering barn; 1950

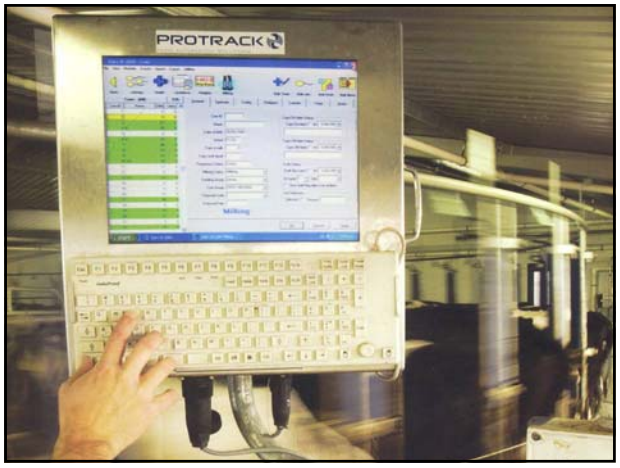
Protection of Wet Soils; Herdhome; 2003

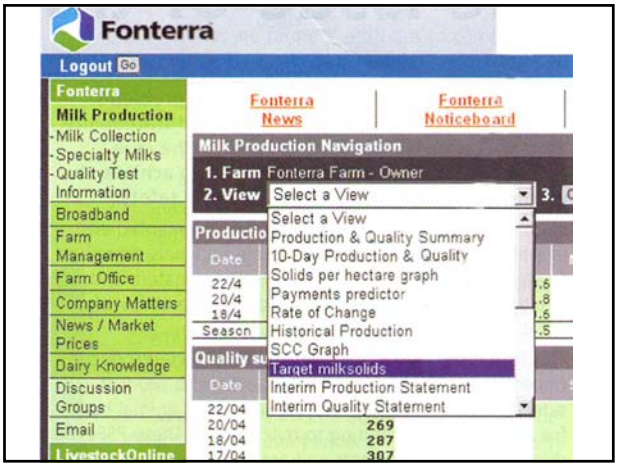
Protection of Wet Soils; Herdhome; 2003

Information for improved management and operation of the farm

- Increase in amount of information
- Improvements in design of information, and in the speed of availability
- About cows, genetics, productivity, fertility
- About milk, quantities, composition, quality; district averages for comparisons
- About pasture yields and growth rates
- Financial performance of the farm







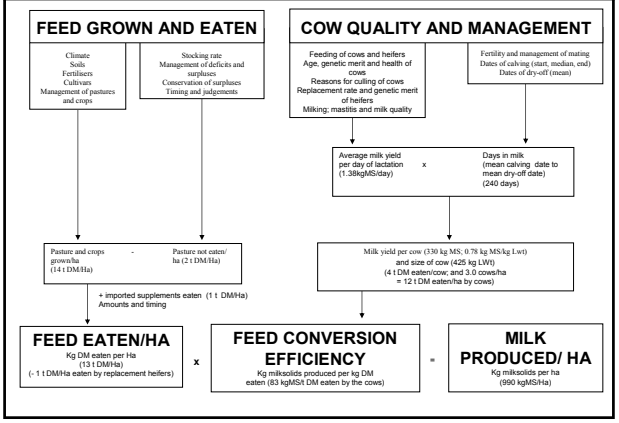
The Future?

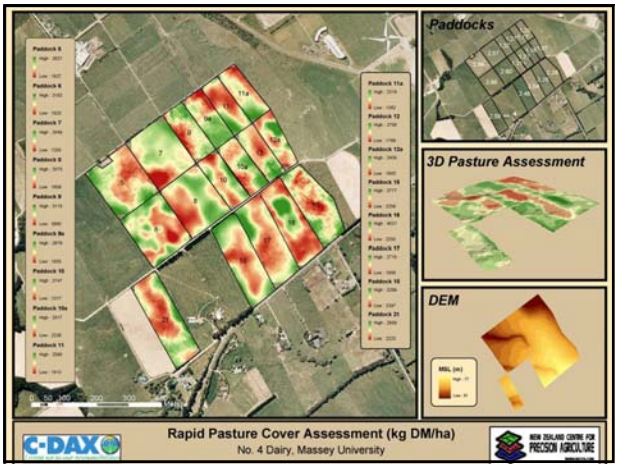
- Labour and feed will be the two most limiting factors on-farm
- Water, access to it, and effects on it will be major factors
- Once daily milking, with selected cows will be a major development
- Non-seasonal systems of milk production will increase, where feed supply is suitable. Maybe with extended lactations?
- Organic milk production systems will increase
- Genetic selection will have to focus on a range of systems

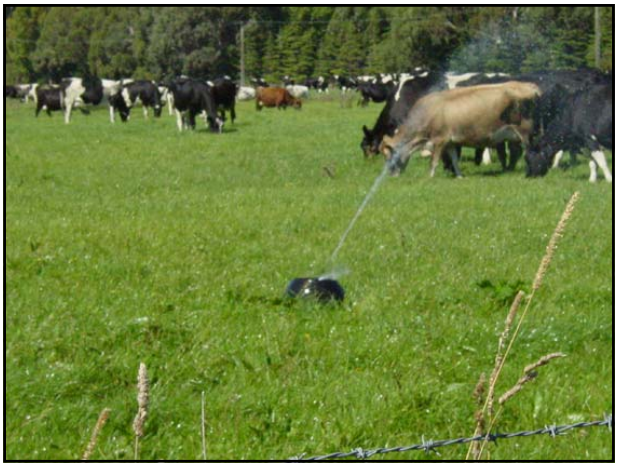
Conclusions: Low-Cost Milk Production in NZ

- New Zealand has climatic advantages for growth and grazing of pasture; these will continue to be the basis of its dairy production
- Improvements in cows, and pastures will continue to increase milk output per kg feed, per person and per farm
- Many small, but coherent and cumulative improvements in all components, will be combined and integrated into the whole system to produce significant total gains.

The Integrated System







Milk Production Systems

- Developed countries; high milk yield produced per cow, require concentrated feeds and high price for milk. Not limited by technologies
- Developing countries; lower milk yields produced per cow, from mainly roughage feeds. Limited by available technology
- New Zealand, in latter category, but with temperate climate, good infrastructure, and farmer-owned dairy industry that is a successful dairy exporter

The benefits of external disciplines

- When UK joined The European Union, New Zealand Dairy Board was forced to develop other markets
- When subsidies were removed in 1984, this forced rigorous focus on low cost/kg milk and profit
- When Europe introduced 500,000 Somatic Cell Count/ml; NZ Dairy Companies introduced penalty level of 400,000 cells/ml
- NZ average decreased from 280,000 to 190,000 cells/ml in one year

Pasture is not a suitable feed for the high-yield dairy cow

Not a new discovery:

"On the other hand, if you have a cow giving anything upto 10 to 14 gallons (45 to 65 litres) she just cannot be turned out to grass"

(from "The High Yielding Cow"
by Robert Boutflour, 1966)

Main Aims of Technologies: To Increase Profit by Increasing:-

- Milk output per person and per farm
- Quantity and quality of pasture eaten/hectare (use of other feeds?)
- Quality of cows
- Quality of milk
- Quality of information and infrastructure

Use of Additional Sources of Feed

- Most farms now graze some/all of the non-lactating stock off-farm for some time during the year, eg:- heifers grazed off; 9 months to 21 months, 50% of dry cows grazed off for 8 weeks in winter
- Some farms also "import" additional feeds, (mainly silages, maize or pasture), but also palm kernel meal or grains. (less than 30% of total feed)
- A very small number of farms supply about 50% of total feed as horticultural by-products and silages

This Presentation :-

Will describe and illustrate the main components of the pastoral system, and associated technologies

- Feeding cows on pastures and other feeds
- Feed supply and demand
- Pastures, crops and other feeds
- The cows; genetics, fertility and milking
- Pastures, soils, fertilizers and irrigation
- Information for management purposes
- The future?

Growth of Grazed Pasture; Biology Well Understood

Net herbage production; the sum of (new growth – senescence) is maximized:-

- By keeping it within an optimum range of herbage masses
- By grazing ryegrass when there are 3 to 4 new leaves on each tiller

Optimising for Feeding and Growth

- These basic mechanics and biology have been translated into practical guidelines for use on farm, for example:-
  - **pregrazing:**
    2500 – 3000 kg DM/ha; 80% green leaf
  - **postgrazing:**
    1500 – 1700 kg DM/ha; lactating cows
    1100 – 1200 kg DM/ha; dry cows

The "Pasture Substitution Effect" and its management

- On a particular level of pasture feeding, the consumption of supplement will reduce pasture consumption
- The consequent increase in postgrazing herbage mass, can cause wastage of pasture and decreases in its future quality
- Successful farmers manage "substitution" by simultaneously:-
  - Feeding supplement
  - Reducing the pasture offered

  And – Maintain optimum postgrazing yields

Responses to Supplementary Feeds

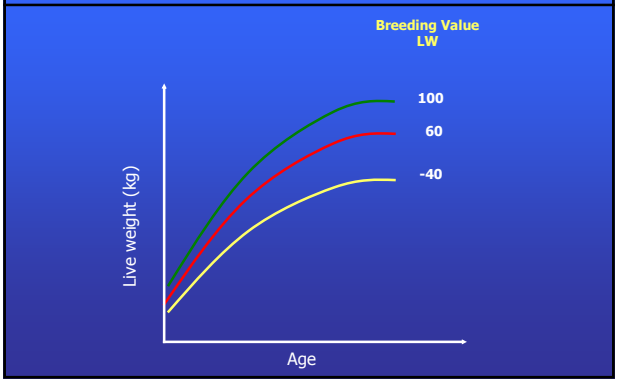
- Results from a survey of farms, with either no supplement or about 2 t DM/ha supplement; 1998-2002:
- Inputs: - Extra 2 t DM imported/ha
  - Extra 40 kg N applied per ha
  - Extra 0.27 cows/ha and 10 days in milk
- Outputs:- Extra 45 kg MS/cow and 196 kg MS/ha
  - Equivalent to about 80 to 90 kg extra MS/t extra DM
  - Little extra profit
- Similar to recent experimental results for systems

Genetic Feed Demand; A Genetic Discription of a Cow

- Uses Breeding Values for yields of milk and solids, and for liveweight to estimate "genetic feed demand" for optimum profit
- "Optimum profit" calibrated against experimental data for cows with Breeding Values

	BVs			GFDemand
	Milk	Milksolids	LW	(t DM/cow)
HF	900	55	56	4.7
J	-100	23	-44	4.0

Use of Genetic Information for Management Purposes: eg:- Genetic live weight targets



Health in the Dairy Herd

- National Control Programmes for TB, Brucellosis and Leptospirosis
- Average SCC now 210,000 cells/ml, up since 2000
- Annual replacement rate about 22% of the herd; 6 to 10 % not pregnant; 5 % diseases and deaths
- Many preventatives given through the herd's water (eg:- Magnesium; bloat - preventative)
- Mastitits, lameness and infertility main problems