Rural Water Commission of Victoria
590 Orrong Road, Armadale, Victoria, Australia, 3143

Designing Paddocks on an Irrigated Dairy Farm

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Land forming and laser grading were first carried out on the northern plains of Victoria, but the practice is now spreading to other areas. This photo shows David Drummond's dairy farm at Eskdale in the Mitta Mitta Valley.

Dairy farmers wishing to landform and laser grade areas of their property should consider their whole farm layout so that future development work can be integrated with current work. The first step is to obtain a survey plan and examine the layout options, remembering that there are many factors peculiar to a dairy farm to be considered. On any dairy farm the cows have to walk to the dairy and back again twice a day, but on an irrigated farm they will probably have to cross a channel or drain to get there. So designing irrigation bays and paddocks with good dairy access is not as simple as might first be imagined. The number of paddocks, their size and shape, and their location with respect to the dairy sheds, all affect the operation of the farm. The factors which influence decisions concerning paddocks are listed below.

1. Paddock Numbers

Dairy advisory officers suggest that a grazing rotation of 20-21 days will promote good pasture growth and utilization. Farmers should therefore aim at having at least 20 paddocks, allowing one paddock per day (i.e. two feeds). Some farmers prefer to have 25-30 paddocks for easier and more flexible grazing management. Portable electric fences can be used to subdivide paddocks to offer cows separate day and night feeds of pasture and to increase or decrease the basic 20-paddock rotation according to pasture growth conditions.

2. Water Budget, to Calculate the Paddock Size

Dairy advisory officers consider that the most efficient use of water is to apply it to the area under perennial pasture since it is this area which determines the stocking rate. In most years it is safe to budget on 160% of water right for this. If sales of more than 60% of water right are permitted then the extra water can be used for annual pasture, lucerne and summer fodder crops, giving flexibility to use the water to its maximum.

The relevant water requirements are:

Perennial pasture, 10 ML per hectare per year
Annual pasture, 2-4 ML per hectare per year
Lucerne pasture, 4-14 ML per hectare per year
Summer fodder crops, 6-8 ML per hectare per year.

Examples are given in Table 1 to show how optimum paddock size can be calculated for a particular farm.

Table 1: Calculation of Optimum Paddock Size

	Dairy Farm No.			
	No. 1	No. 2	No. 3	Your Farm
Total Area of Farm	40 ha	45 ha	100 ha	ha
10% area lost to trees, buildings, lanes, channels, etc	4 ha	5 ha	10 ha	ha
Effective Pasture Area	36 ha	40 ha	90 ha	ha
Water Right	160 ML	160 ML	220 ML	ML
Sales Water 60% (see Notes below)	96 ML	96 ML	132 ML	ML
Drainage Diversion	—	—	50 ML	ML
Groundwater	—	100 ML	100 ML	ML
Turkey's Nest (rainfall only)	—	—	—	—
Transfer Sales from runoff block	—	45 ML	100 ML	ML
Total Water	256 ML	401 ML	602 ML	ML
Divide by 10 (water requirement per hectare)	÷10	÷10	÷10	÷10
Total Area of Perennial Pasture	25.6 ha	40 ha	60.2 ha	ha
Divide by 20 (number of paddocks)	÷20	÷20	÷20	÷20
Size of each Perennial Pasture Paddock	1.3 ha	2 ha	3.0 ha	ha
Cow numbers (approx.)	80	125	180	

Notes:

a. If the farm has autumn calvers, there needs to be less perennial pasture and more annual pasture.

b. In some years it would be quite safe to allocate 80% of sales water to perennial pasture, but in years of low sales the total area irrigated would have to be reduced.

c. Farmers with optimistic ideas of future sales allocations may elect to choose a higher percentage than 60% of water right.

d. Stocking rates depend on the area of perennial pasture and the calving pattern. For spring calving herds, typical stocking rates vary from 3 to 3.5 milking cows per hectare of perennial pasture. Some farmers successfully manage 4-5 milking cows per hectare of perennial pasture but with this stocking rate feed supplements are necessary.

3. Bay Area

As fences usually run along check banks, there must be 1, 2 or 3 bays to a paddock; there cannot be 1½ or 2½ bays to a paddock. It is preferable to have 1 bay per paddock and it is desirable that bays should be of uniform area as this makes watering easier.

The flow rate per bay should be adequate to enable the bay to be irrigated in eight hours at the most. This usually requires the full flow of the channel onto one bay at a time. Where the bays are larger than 3 ha or the soil is very permeable or small flows only are available, advice should be sought from the Rural Water Commission and Department of Agriculture and Rural Affairs.

4. Bay Length

Natural boundaries may limit bay length but where possible bays should be no shorter than 300 m and no longer than 500 m.

If bays are shorter than 300 m it is likely that the farmer will spend more money than he really should in crossings, outlets, laneways and drains. Generally speaking, it is cheaper to move the soil than to have short bays. Moving soil is only a small part (10%-30%) of the total cost of a re-layout of land.

Bays longer than 500 m may cause problems with cow access, since the paddocks must be very long and narrow. Diagrams D, E and F illustrate ways of overcoming this problem.

Drainage of surplus surface water from long bays is very slow unless the slope is at least 0.15% (1 in 650). If the soil is very permeable, however, the water may not reach the end of the bay at all. Advice on the suitability of soil can be obtained from the Rural Water Commission and Department of Agriculture and Rural Affairs.

5. Bay Width

If the bay area and bay length have already been decided the width is easily obtained by simple calculation.

$$\text{Width (m)} = \frac{\text{Bay area (ha)} \times 10\,000}{\text{Bay length (m)}}$$

e.g. 2 ha bays, 400 m long

$$\text{Width} = \frac{2 \times 10\,000}{400} = 50\text{ m}$$

5.1 Minimum Width

To achieve uniform grading with laser controlled equipment 30 m is the absolute minimum width (except in unusual circumstances); if possible 40 m should be taken as the minimum width.

5.2 Maximum Width

For design purposes, slope affects the width. The steeper the slope the narrower the bay should be.

Recommended maximum widths for perennial pasture bays are:
90 m for slopes of 0.13%-0.15% (1 in 750 to 1 in 650)
70 m for slopes of 0.15%-0.20% (1 in 650 to 1 in 500)
60 m for slopes of 0.20%-0.50% (1 in 500 to 1 in 200)
30-40 m for slopes of 0.50%-1.00% (1 in 200 to 1 in 100)

These widths may be reduced where conditions are difficult or the operator is inexperienced.

The first watering is the worst for spreading, owing to lack of cover vegetation. The bay must be cultivated or cross-harrowed after grading and before irrigating to achieve a good spread of water.

6. Cow Access

This is one of the most important aspects of paddock planning on a dairy farm. Cows go to the dairy twice a day and the route they take must be considered carefully.

Cows have a good sense of direction, and they do not like making U-turns. They know where the dairy is and they don't like having to walk away from it before turning to walk towards it. Paddocks should therefore be planned so that the cows always walk more or less directly towards the dairy.

There are many different plans possible and the diagrams overleaf give some of the options. In these diagrams the area shown covers eight paddocks each of 2 hectares, giving a total area in each case of 16 hectares.

7. Fencing

It is desirable to put fences on check banks, although, because of cow access, other options may be required. Fences are also needed to keep animals out of channels (see "8. Stock Water" below).

Electric fencing is a cheap and effective form of internal fencing on dairy farms. It gives farmers the flexibility to change their paddock sizes when necessary to adjust to the inevitable changes in herd size. Advice on electric fencing can be obtained from the Department of Agriculture and Rural Affairs.

8. Stock Water

Traditionally farm channels have been used for stock watering. The inherent disadvantages with this practice are the promotion of weed growth, damage to channels caused by stock, the build-up of liver fluke snails and possible animal health problems caused by stale or contaminated water. The installation of stock troughs provides a more reliable source of water of better quality, as well as enabling farm channels to be fenced to exclude animals. It is important to have stock troughs of the right size and in the right location. Pipelines feeding the troughs must be of adequate size. Advice should be sought from the Department of Agriculture and Rural Affairs.

9. Farmers' Personal Preferences

Every farmer has his own preferences, and has every right to them. Calving paddocks and paddocks for sick animals all vary according to the individual farmer's choice.

10. Trees

The location of trees should be considered in the paddock planning stage. Every paddock should have some shade and in most areas of Victoria good wind protection is needed for some months of the year. Officers of the Department of Conservation, Forests and Lands will give advice on tree-planting on dairy farms.

The area where the trees are to be planted should be deep ripped, graded and check-banked. Trees are best planted in a ripped track where water infiltration and retention is improved. Native trees will require only two or three irrigations during the first season to aid establishment.

Metric Measurements

1 hectare (ha) = 100 m x 100 m
= 10 000 square metres (m^2)
= approx. 2.5 acres

1 megalitre (ML) = 1 million litres
= 1000 cubic metres (m^3)

1 ML of water covers 1 hectare to a depth of 100 mm

A channel crossing giving top access to the bay (see Diagram B overleaf)

Rural Water Commission
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Designs for Paddocks

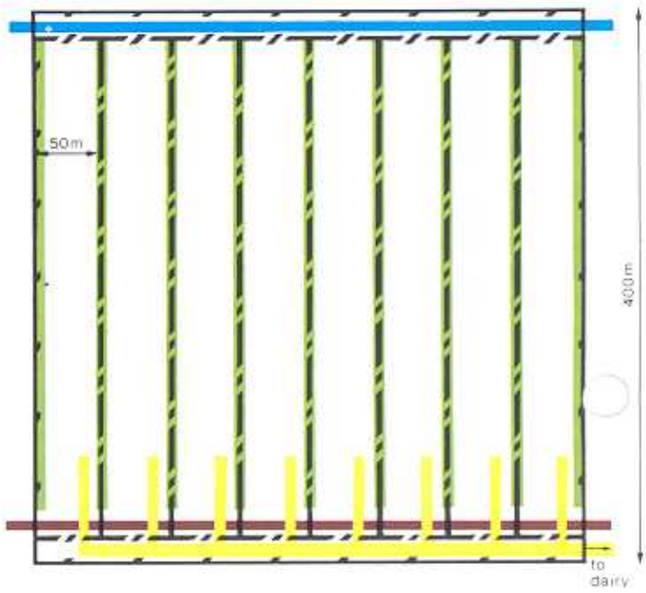
In each of the following diagrams, the total area is 16 ha and the area of each paddock is 2 ha. For simplicity, gates have not been marked. Where a fence crosses a lane it is to be assumed that there is a gate.

Lane
Channel
Drain
Check bank
Internal fence
Boundary fence

1: Bottom Access

This is the cheapest possible plan, as drain crossings are cheaper than channel crossings. With this plan it is easy to fence out the channel. Drains must be well constructed and maintained, and it is important to prevent the lower end of the paddock from becoming boggy.

Diagram A: Bottom access



2: Top Access

Top access inevitably means that the cattle must cross the channel to get to the dairy. There are two ways of providing for this: channel crossings or pipe outlets.

Diagram B: Top access–channel crossings

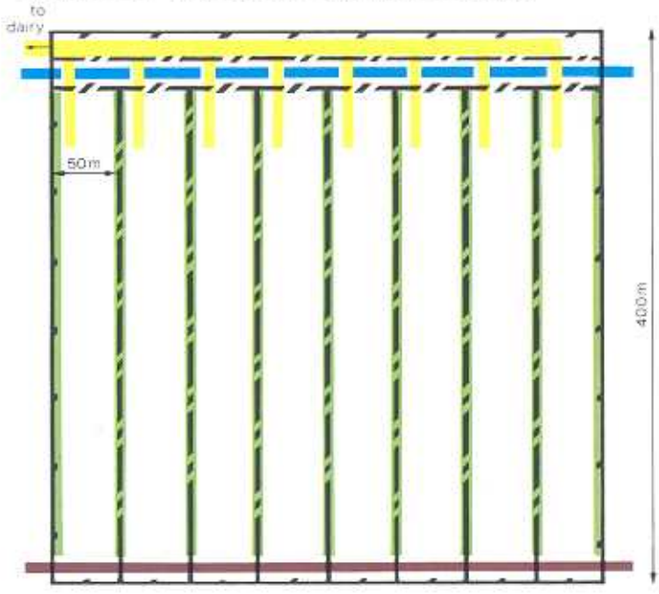


Diagram B shows channel crossings for every paddock. This is expensive, and makes channel maintenance difficult.

Making one channel crossing for every two paddocks gives a slightly inferior access, but some farmers find it a satisfactory way to reduce costs.

The pipes must be 600 mm in diameter and the crossing at least 6 m wide.

Diagram C: Top access–pipe outlets

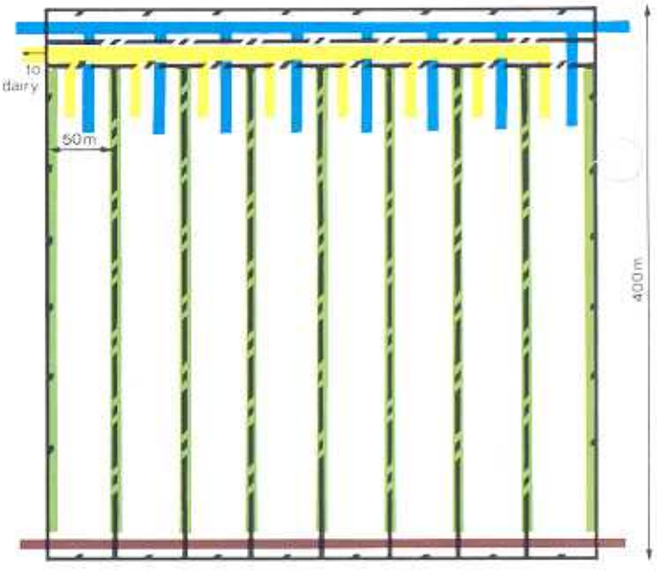


Diagram C shows bay outlet pipes under the laneway used by the cows. This is often the cheapest and easiest design when access to the top of the bay is required. It reduces structures, utilizes smaller pipes and provides good access. A good channel head is required for this system.

3: Long Narrow Paddocks – Top or Bottom Access

If paddocks are too long and narrow, poor utilization of the ..sture results, because the paddock becomes a lane and ..e pasture is trodden down before it can be grazed.

If the bays are long, and resultant paddocks are too narrow, a central subdivision of the bays could solve the problem. Diagrams D, E and F indicate possible solutions.

Diagram D indicates one option – to divide each long bay into two paddocks, using a temporary fence. This gives flexibility in grazing, but requires more labour to adjust the fence.

Diagram E shows a plan which requires less channel crossings but takes more land for laneways. The fence can remain in a permanent position.

Diagram F shows a raised lane across the middle of the bays with pipes under the lane to allow water to flow through.

In order for this option to work there must be at least 100 mm difference in the bay levels across the laneway.

Instead of pipes, concrete flood ways could be used.

Diagram D: Long bays – temporary fence

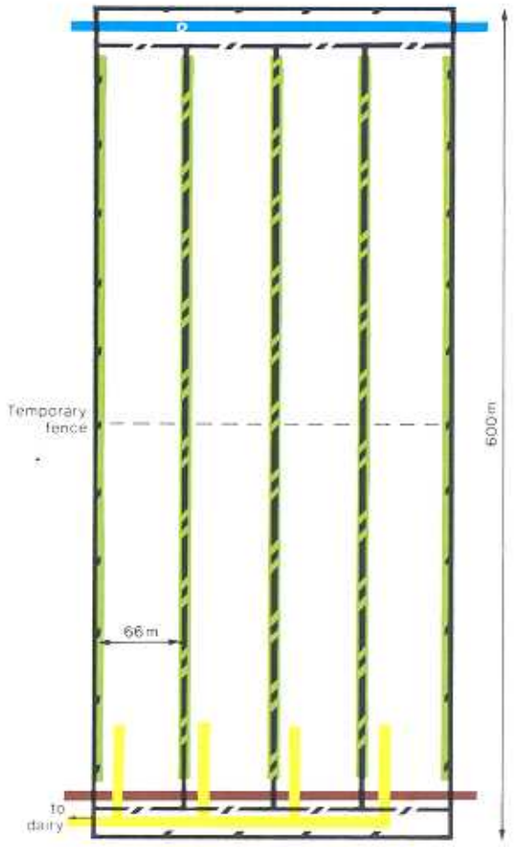


Diagram E: Long bays – prong lanes

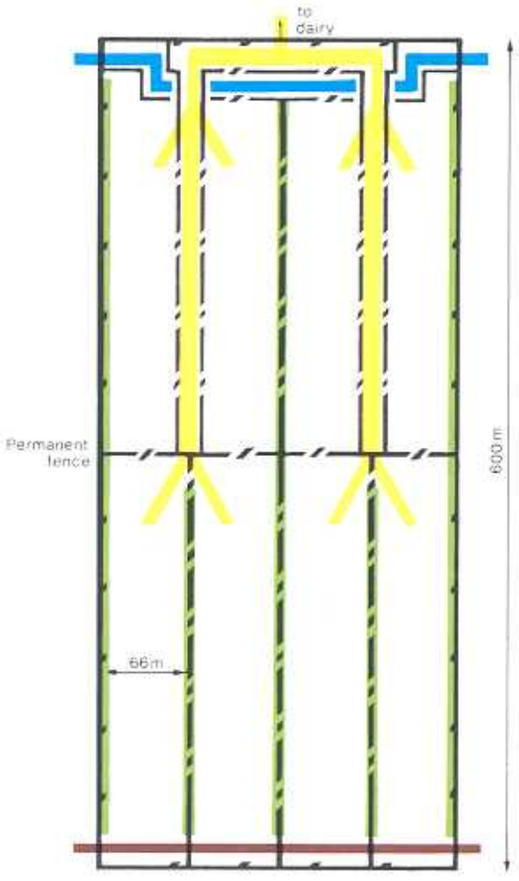


Diagram F: Long bays – central laneway

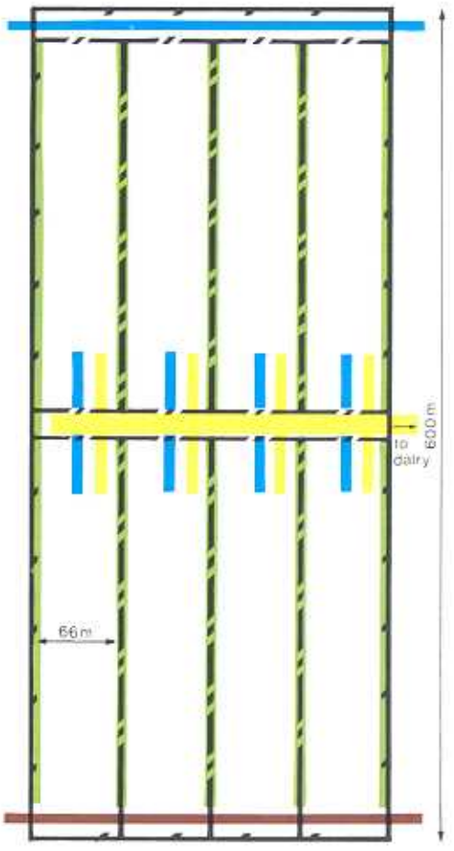
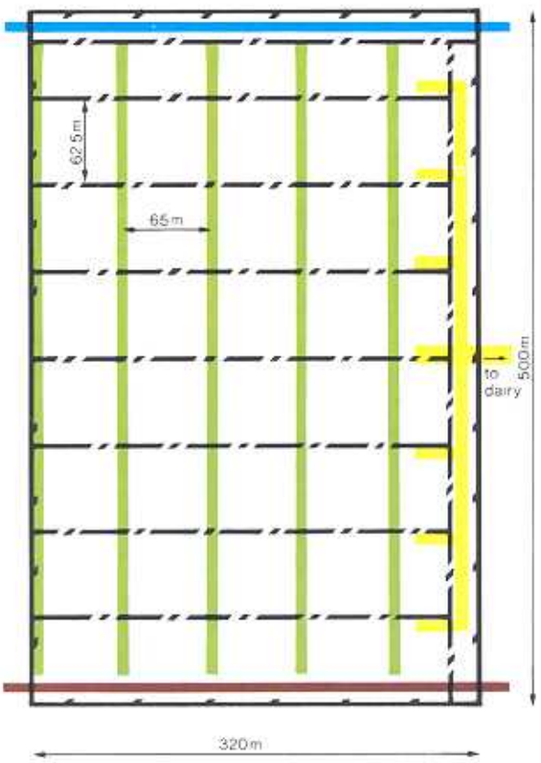


Diagram G: Side access



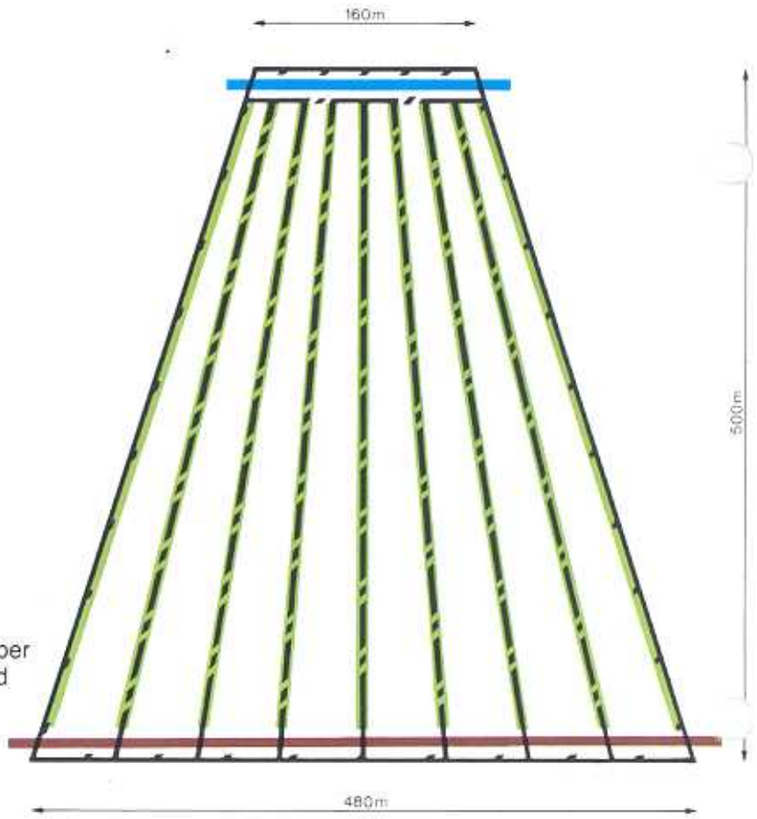
4: Cross Fencing

Diagram G shows fencing across the bays, with side access to the dairy. In some situations this kind of arrangement is unavoidable. It makes management a litti more difficult as the whole area must be treated as one unit.

Large terraces (greater than 100 mm) should be avoided in this situation and bay widths stretched to the maximum to reduce the number of bays.

Another problem is that cows often "walk the fence" causing pugging of the soil which in turn hinders movement of water onto and off the bay.

Diagram H: Fan-shaped area



5: Odd-Shaped Areas

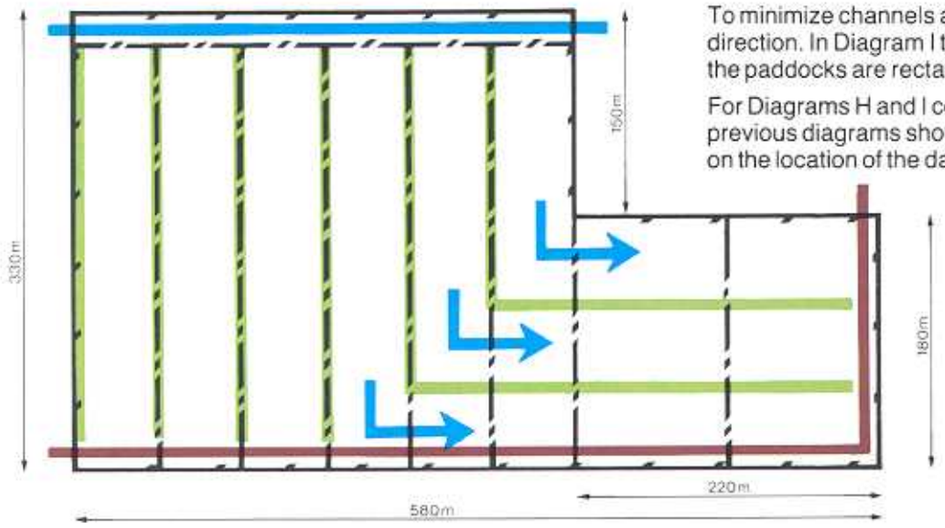
In small or odd-shaped paddocks it may be worth considering bays that are not rectangular.

Diagram H shows an enclosed piece of land, which is

160 m wide at the top
480 m wide at the bottom
500 m long

Such an area could be divided into 8 paddocks (1 bay per paddock) each paddock being 20 m wide at the top and 60 m wide at the bottom.

Diagram I: L-shaped area



To minimize channels and drains, bays can change direction. In Diagram I three bays turn at right angles, but the paddocks are rectangular.

For Diagrams H and I cow access is not shown. The previous diagrams show the options; the choice depends on the location of the dairy.