Lesson 5: The rise of dairy = Environmental Factors.

<table>
<tr><td>Starter</td><td>Have the 20 terms below written up on the board. Get students to write a short definition in groups without using their notes. Then construct 4 sentences using all the words. Go over it as a class and get some sentences as feedback to check understanding of terms.

Terms: Trough | In-calf | Riparian planting | Rotary dairy shed | Herringbone dairy shed | Backing gate | Milked out | Pen | Milk vat | Milk tanker | Effluent | Effluent ponds | Effluent sprayer | Feed-pad | Tractor | Silage | Silage wagon | Hay | Calf | Raceways.</td></tr>
<tr><td>Activity</td><td>Where is dairy located?

In pairs, students work as consultants who have been employed to provide a recommendation about investing in a dairy farm in New Zealand. In this activity students will need to interpret a range of resources about New Zealand to complete the “recommendation table”.

Their decisions around appropriate regions will be guided by the information on ‘consultant guidelines’ and resource analysis.

The Consultant recommendation table has the format shown below. Students write each of the regions on Post-it notes so they can shift the regions/notes around. It is important that students record why they place each region in a category, or why they decide to shift them to a different category.

Print copies of the Consultant recommendation table as A3 documents and have extra Post-it notes available.

<table>
<tr><th colspan="3">Dairy Farming Locations</th></tr>
<tr><td>Not ideal conditions</td><td>Environmental adaptation and investment is required.</td><td>Ideal conditions</td></tr>
</table>

Hand out the information in Set A Natural resources first. Provide Set B Cultural/infrastructure resources once students have worked their way through Set A.

Encourage students to think about what adaptions can be used to modify the environment. The main ones are ditches, irrigation, adding minerals and fertilisers to the soil and different crops/cultivars (for different regional temperatures).

<table>
<tr><th>Set A: Natural</th><th>Set B: Cultural</th></tr>
<tr><td>- Consultant Guidelines
- Landforms Map
- Soils Map
- Rainfall Map</td><td>- Infrastructure Resources</td></tr>
</table>
</td></tr>
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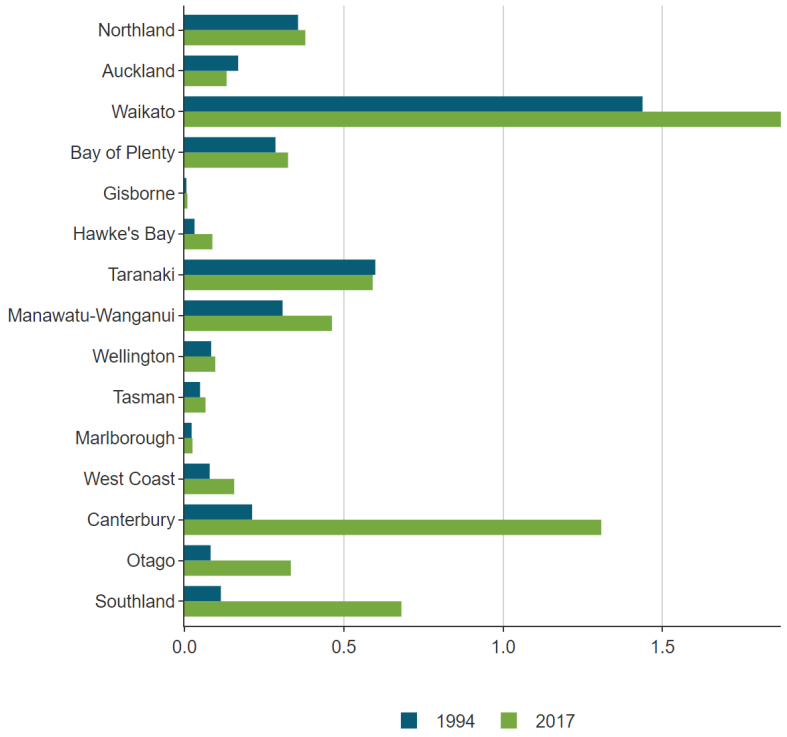
	Extension: Use the Seasonal variations and climate graphs – slides. It has climate information on seven New Zealand cities. Good grass growth needs around 80ml/ month so students can determine which time of year each region would struggle to produce grass and for how many months. They can then order the regions from longest growing seasons to shortest and discuss how climate change may affect the viability of some farms. **Or** For those students that finish early, they can go online and look up dairy farms for sale. They should aim for two in each of their recommended regions. Get them to note the cow numbers, infrastructure (shed type, irrigation), if cropping is involved and what the landscape looks like. Then they can select their top pick and do a mini write up on why they chose that one. **Teaching notes and answers are provided below.** StatsNZ has an interactive map that shows dairy cow numbers in New Zealand. A snapshot has also been provided in the teaching notes.
Close	Students categorise which environmental factors are constraining and which ones can be changed/adapted. Remind them that although we can adapt some of the environmental conditions, this can be expensive in terms of money and the environment as a whole. **Environmental Constraints:** sunshine, landforms, temperature, soils, rainfall **Environmental Adaptions:** rainfall, soil moisture, small scale contouring (ditches, levelling paddocks etc), soil fertility.

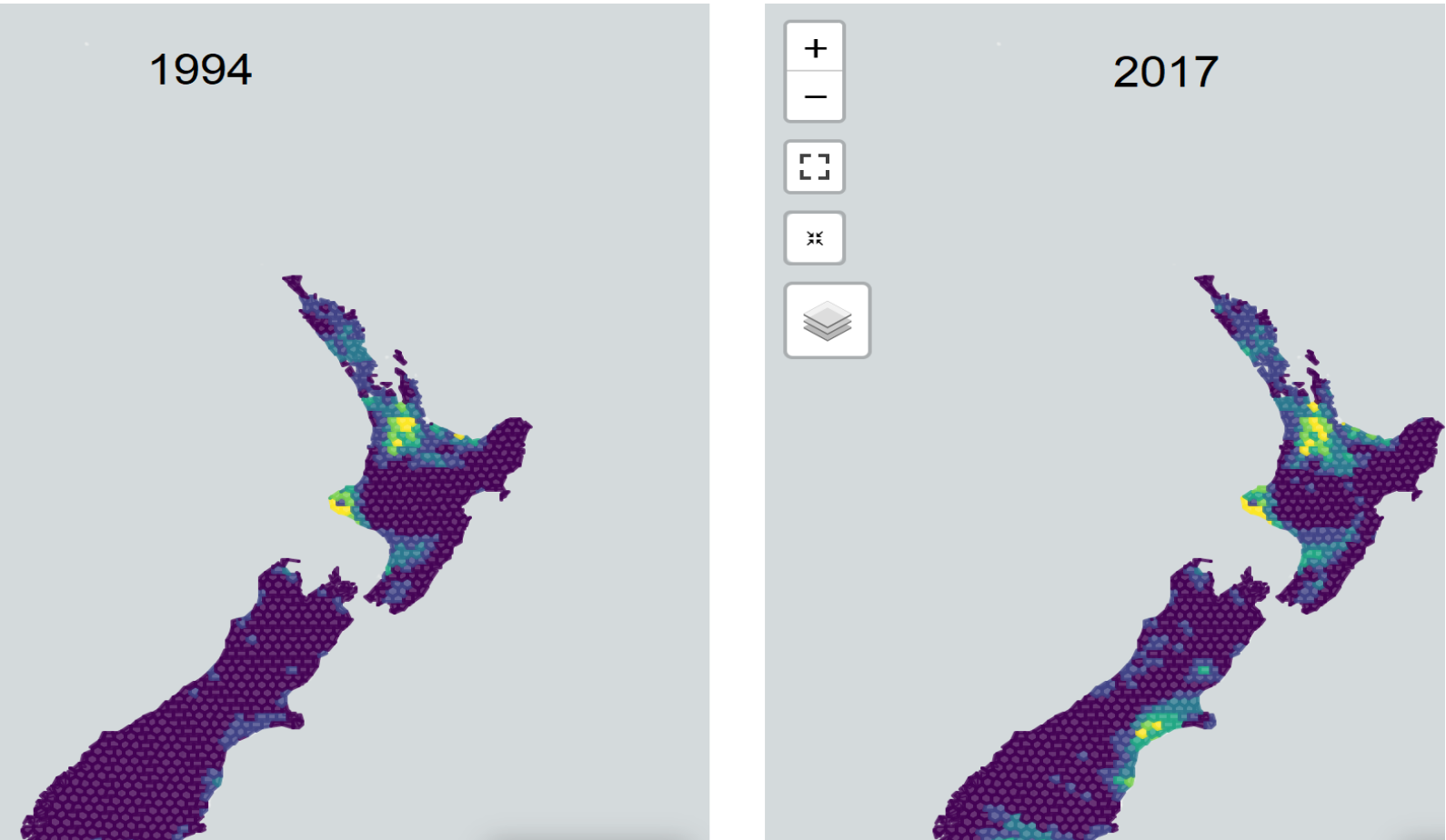
Recommended reading:

Otherwise Fine article by the New Zealand Geographic, which discusses the impact of climate change on farm systems and food availability.

Livestock Numbers It is recommended that students compare the map below to the 'land type' map.

Dairy cattle numbers, 1994–2017
Millions by region





Factors include…

Land type: Flat plains to rolling hills are suitable land for dairying and is the major determinant of where dairying is located in New Zealand. Rainfall constraints can be overcome with irrigation if there is a water source nearby. The use of different cultivators, crops and stored feed can help with low or high temperatures. Mineral or nutrient deficiencies can be overcome by adding minerals and fertilisers. Due to New Zealand's size and shape, history of settlement on plains and wetlands, and advances in refrigeration; most dairy farms are close enough to factories to drop off milk within a 24 hour period. There are debates if these innovations are sustainable in the long term but they help explain the spatial distribution of dairying in New Zealand.

Rainfall/irrigation: Pastures require water and nutrients to grow, and lactating dairy cows require a large amount of pasture (approximately 100kg of fresh pasture per day per cow). Water helps dissolve nutrients which makes them accessible to plants. It is also a large component of all cell bodies and is also used within plants to transport nutrients for growth.

Due to New Zealand's temperate climate, pasture species grow throughout New Zealand. This makes rainfall the big determinant of where dairy farming was located in the past. With irrigation and advances in irrigation technology, areas considered too dry have been converted to dairy as long as there is a source of water. Other sources of water are rivers, lakes, irrigation ponds and aquifers. Some areas that have adequate rainfall are also putting in irrigation systems to ensure feed security. Global warming may make it a more popular option unless alternative farming practices are developed and adopted.

Soil/soil fertility: New Zealand soils (and much of the world's soils) are lacking in readily available phosphorus. Phosphorus is one of the three major nutrients required for plant growth. In 2019, 154 thousand tonnes of phosphorus was sold in New Zealand. Approximately 80% of New Zealand's phosphorus comes from Western Sahara, which has been occupied by Morocco since 1975. Geopolitical tensions around phosphorus is an interesting topic and many New Zealanders are unaware of our dependency on this nutrient for our agricultural production. The alternative to importing phosphorus is cultivating specific microbial populations within the soil. These microbes help make the phosphorus in the soil accessible to plants. It can be difficult to ensure adequate populations of these microbes as changes to their environment can disrupt their numbers and they are in competition with other microbes for space and resources.

Fertilizers can be applied to provide specific nutrients such as nitrogen (N) and phosphorus which boost plant growth, but they can be expensive and have a high environmental footprint in its production. Urea is a form of N that is readily available to the plant so it can boost plant growth and is relatively cheap. Farmers consider urea as a form of supplementary feed, due to the large increase in pasture growth that can occur under the correct conditions. However, over application can cause N leaching, or N can be released as nitrous-oxide (a greenhouse gas) due to specific soil microbes processing the urea In addition N fertilisers cannot be applied during excessively wet, cold, dry or hot conditions. Some water is required to dissolve urea, but too much will cause

leaching. Soil temperature also affects plant activity which will reduce the utilisation of urea if it is too cold.

The alternative to nitrogen fertilisers is the integration of legumes like clover. Legumes convert nitrogen from the atmosphere into the soil making it available to plant growth. The negative consequence of this has been feeding cows nitrogen rich diets, resulting in their urine having very high concentrations of nitrogen and being a major source of nitrogen leaching.

Sunshine: Sunshine is used by pasture plants such as ryegrass and clover to carry out photosynthesis and grow. Sunshine also impacts temperature which in turn affects plants uptake of nutrients and biological processes. Sunshine hours for an area is considered fixed as it is largely dependent on latitude. This in turn affects if you have a short growing season or a long growing season and overall feed security.

Sunlight also impacts cow behaviour. The light produced sets an internal body clock which tells humans and animals when to sleep and when to wake. This internal body clock, driven by the sun, is important to maintaining the daily activity of a dairy cow. They are driven to have their largest meal at dusk and a smaller meal at dawn. The reason for this may either be to avoid eating during full daylight when predators may be lurking or because the nutritional value of the grass is greater at dusk than it is during the day due to the accumulation of sugar produced from photosynthesis.

Temperature: The regional temperatures will impact how much pasture is grown and resulting stock numbers. Extreme temperatures restrict a plant's ability to photosynthesise and grow.

Ryegrass is a commonly used pasture plant in NZ grazing systems and will be able to photosynthesise when the ambient temperature is between 5 and 18℃. In addition, the range of comfort of a dairy cow is between 5 and 20℃ so warm temperatures in summer not only restrict grass growth but milk production, particularly when dairy cows have to walk long distances to and from the milking shed. Temperatures also affect microbes in the soil, which also affect nutrient availability to plants and the utilisation of fertilisers which are applied to the soil.

Regional Environmental Factors

Region	Issue	Environmental Manipulation
Northland	Can be very dry during the summer	Make silage in spring and have crops that grow in hot conditions for summer feed. Excess crops can be harvested and stored for winter.
Waikato	Heavy soils	Heavy soils can have a large amount of clay or organic matter. Clay soils can stop water draining so makes the soil soft, wet and prone to flooding. A lot of the land used for dairy farming in the Waikato used to be wetlands. Traditionally ploughs have been used to break up the clay pan, and the use of ditches help with drainage. The gully systems that naturally occur in this region also help with water drainage and can be a big asset to farmers.
Canterbury	Very low rainfall	Uses surface water (lakes and rivers) and underground water to irrigate pastures.
West Coast	Very high rainfall. Poor soil fertility.	Uses a practice called ‘humping and hollowing’ where you contour the paddock into humps and hollows which allows for better drainage and to grow more grass on the humps. Building up organic matter and the use of fertiliser (natural and chemical) has been used for poor soil fertility.

Dunedin and Invercargill	Low temperatures, especially in winter, reduces the growth rate of ryegrass.	Makes silage in spring and crop feeding in winter (with crops that can handle the low temperatures.