Part 6: Research and technology

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Historically Australia has valued research into science and technology, positioning Australian agriculture as a world leader in many areas. As research funding becomes more difficult to secure, and the best scientists are lured overseas it is becoming clear how easily we can lose our advantage. Australian agriculture must continue to develop innovative approaches to production, processing and marketing in order to preserve our reputation for quality and efficiency.

In this section you will examine the effects of science and technology on agricultural production, by looking at some examples from the dairy industry. You will then investigate the influence of scientific and technological changes on your farm case study product.

This part contributes towards an understanding of Outcome H3.3 from the Agriculture Stage 6 HSC Course. The syllabus can be found on the Board of Studies, NSW website at http://www.boardofstudies.nsw.edu.au
Past dairy innovations

Look at the data provided about Australian dairy industry changes in the following three graphs.

Figure 6.1: The number of dairy farms in Australia.

Figure 6.2: The number of dairy cows in Australia.
Figure 6.3: The quantity of milk produced in Australia.

1 Outline what has happened to the number of dairy farms from 1970 to 2000.

2 Outline what has happened to the number of dairy cows from 1950 to 2000.

3 Outline what has happened to the quantity of milk produced in Australia per year from 1950 to 2000.

4 Summarise the information provided by the three graphs.

Check your answers.
Increasing productivity

The reason that milk production has increased despite reduced numbers of farms and milking cows is that technological changes have allowed an increased level of productivity per cow, and per farm.

Until the 1880s dairying was a small, localised industry. Shortly after this time there were technological innovations that allowed expansion of the industry including:

- The introduction of the centrifugal cream separator in 1881 led to the establishment of a central butter factory in Sydney in 1883.
- An improvement of the road and rail system in the early 1880’s assisted in more efficient product transport.
- 1883 – Refrigeration allowed the development of butter and cheese export markets.
- 1892 – American Babcock tester was used to measure fat content of milk more accurately.

In 1900 most dairy herds contained about 20 hand milked cows. The first milking machines were introduced at this time, but their use did not become widespread until 1938 when electricity became generally available to farms.
In 1914 the first batch pasteuriser was installed in an Australian factory, although it was not made compulsory to pasteurise milk until after World War II. This process made milk more hygienic and improved demand from the domestic market.

World War II stimulated an increased level of research, leading to advances in farm management, pasture improvement, herd testing, quality control and manufacturing methods. State governments funded most of this research. In 1926 the Council for Scientific and Industrial Research (CSIR) was established, providing an organised federal approach to agricultural research. Relevant focus areas included animal pests and diseases, plant pests and diseases, and animal nutrition. There were some significant early discoveries related to cattle health. In 1940 a division of industrial chemistry was established, with dairy products as one of the focus areas.

In November 1944 the first Australian calf conceived by Artificial Insemination (AI) was born. By 1958 AI was in widespread use throughout the Australian dairy industry, resulting in rapid productivity gains.

The Tetra Pak milk carton was first introduced in 1958, and in 1970 plastic milk containers were introduced as a packaging option. These have slowly replaced glass milk bottles.

Figure 6.5: Packaging innovations have changed the way milk is presented to the consumer.

In the 1960s there was a change to a bulk milk supply system, which meant that the task of cream separation now became a factory process. Before this time cream separation was a task performed at the farm, requiring a lot of time and effort by the farmer.
The first Australian UHT (Ultra High Temperature) processing operation was installed in 1964. UHT treated products can be stored without refrigeration for up to 9 months. This had implications for the transport and storage of milk and milk products.

In 1970 the government decided to limit the expansion of the dairy industry, and provided funding to encourage non-profitable dairy farmers out of the industry.

In 1973 Britain entered the European Community (EC) and limited the importation of Australian milk products. Just prior to this 78% of Australian butter exports were going to Britain, so there was a significant impact on the Australian dairy herd, which fell from 4 million to 2.4 million in 1988. Development of new markets, particularly in Asia and the Middle East, have allowed the industry to slowly recover. These changes can be seen in figures 6.2 and 6.3.

Costs in dairy production have continued to rise, while the sale price for milk has fallen. This has resulted in a cost-price squeeze. Farmers have had to become more efficient or leave the industry. Innovations in general use which have improved efficiency include:

• milking shed designs that allow more cows to be milked more quickly using less labour, for example herringbone and rotary

![Figure 6.6: This rotary dairy can milk 48 cows at a time with only one operator. (Photograph – LMP)](image)

• development and use of new pasture species cultivars, for example, cultivars of white clover, lucerne and rye that improve cow nutrition, leading to increased productivity

• widespread use of artificial insemination to improve the genetic quality of the milking herd
• oestrus synchronisation used to ensure the even, year round supply of milk
• herd performance recording that permits decisions on herd composition and breeding to be made using objective information

Figure 6.7: AI is now the standard method used in the dairy industry. Semen can be purchased from the best bulls in the world to improve production characteristics in the replacement heifers. (Photograph – LMP)

• better disease control, for example, an increase in the understanding of mastitis prevention and control practices
• use of pasture management techniques such as strip grazing to maximise productive capacity of the pasture.

Research the history of your case study product. Use your research to answer the questions in Exercise 6.1.

Information sources include:
• the Internet – try entering your case study product name in a search engine, use a specialist agricultural list site such as AgNet (http://www.agnet.com.au/) or ask a direct question on Questionpoint (http://www.questionpoint.org/).
• books – check the agriculture (630) and history (994) sections in a library
• representative bodies.
Breeding values

Before the use of AI became common a farmer was restricted in the choice of a male animal to mate with the females in the herd. Cattle herds require only about 2 or 3 bulls to every 100 cows for effective insemination of the herd. Because fewer males are needed than females it is usual to concentrate on the genetic value of the bull, purchasing an animal that will improve his daughters, and so slowly improve the genetic merit of the herd when they are used as replacements. In order to avoid breeding a bull with his daughters and to continue the herd improvement, it is necessary to purchase a replacement bull every few years. Generally the choice of bull has been an economic one, with a farmer purchasing the best animal within their budget.

A physical bull is now rarely used in the Australian dairy industry, and AI has become a common option in other animal industries as well. With a wide range of available sires from all over the world the problem of which sire to select becomes an issue. The appearance of an animal can be altered by being raised and kept under different conditions, and may not indicate true genetic merit, so looking at a picture, or even the actual animal is not a good indicator. What the farmer needs is a means of comparing the genetic worth of potential sires. In Australia the major animal breeding industries have systems in place to gather objective information about animals to assist with making breeding decisions.

Estimated breeding values

In the beef cattle industry objective information from over 1600 Australian beef cattle herds is routinely collected and processed to be presented as an estimated breeding value (EBV). Breedplan is the international scheme that records and evaluates EBV data for most beef breeds. Computer software called BreedObject has been developed in Australia that allows farmers to weight EBVs to reflect their individual breeding goals. The BreedObject software then produces a ranked list of bulls that best meet these goals.

If you have Internet access you can look at a simplified web site version of BreedObject on the Meat and Livestock Australia website at http://www.mla.com.au. Follow the prompts to find out the current best bull to use for a selected breeding objective.

The major objective of beef cattle EBVs is to produce the biggest, most meaty animals in the shortest time, so the characteristics that are measured and reported reflect this.
Some of the EBVs used are:

- **birthweight (BWd) (kilograms)** – a higher birthweight can result in calving difficulties, so bulls that produce lower birthweight calves are often selected for insemination of untried heifers

- **growth measured at 200 days (200d), 400 days (400d) and 600 days (600d) (kilograms)** – a producer can select the age which is most relevant to their market goals

- **mature weight (MW) (kilograms)** – the weight of a 5 year old cow after weaning a calf, this indicates the maintenance requirements of the cow so a lower value is better

- **milking ability of the daughters (Milk) (kilograms)** – this predicts the additional calf weaning weight due to the milk production of the mother, and is most important if the calves are marketed at this age

- **scrotal size (SS) (centimetres)** – an indicator of male fertility, a bigger scrotal circumference also indicates better fertility and earlier puberty in the offspring

- **days to calving (DC) (days)** – an indicator of female fertility, a negative number indicates a reduced the time the female is ‘empty’ and thus unproductive

- **rump fat (RF) (millimetres)** – low or negative values indicate leaner meat

- **eye muscle area (EMA) (square centimetres)** – a more positive value indicates better muscling

- **intramuscular fat (IMF) (percentage)** – for some markets a high value is desirable, indicating marbling in the meat

- **retail beef yield (RBY) (percentage)** – higher values indicate offspring with a higher meat percentage

- **calving ease (percentage)** – this is calculated for the calves sired by the bull (CEd) and also for the calves produced by his daughters (CE), it is based on the level of intervention at the birth as well as birthweight and gestation length data with a more positive value indicating easier calving.

Not all the EBV values are collected for every breed. The EBVs for the different characteristics are quoted as a number plus or minus from a base amount. The accuracy of each EBV is usually indicated by a % underneath. Accuracy increases as the bull fathers more offspring, more data is collected, and a more accurate picture of his genetic merit is built up. Below 75% is regarded as low accuracy, while above 90% is considered high.
<table>
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<th>BWd</th>
<th>200d</th>
<th>400d</th>
<th>600d</th>
<th>MW</th>
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</table>

Figure 6.8: Example bull EBVs.

Use the example bull EBVs in figure 6.8 to select the best bull to match each of the following scenarios.

1. A bull to breed with a small heifer that may have calving difficulties – calf will not be used as a replacement in the herd.
2. A dairy farm with a market for dairy x beef calves at 200 days.
3. A stud cattle breeder wishing to increase scrotal size of the bulls without losing calving ease.
4. A bull for mating with a commercial herd of cross bred cows to produce well muscled yearlings.
5. A bull to use in a vealer enterprise, where the calves are sold before weaning at about 200 days – some females are kept as replacements.

Check your answers.

**Australian breeding values**

The dairy industry equivalent of an EBV is the Australian breeding value (ABV). It has been estimated that the improvement to the dairy herd due to ABVs, since 1982, has a value of approximately $20 billion to dairy farmers. ABVs for bulls are published so that purchasers of bull semen can compare the statistics, and select the best match for a cow.
ABVs measure a wide variety of characteristics. Data of particular commercial interest to the dairy industry includes milk yield, milking speed, mastitis resistance and calving ease. Of course, these important dairy characteristics cannot be measured on a bull directly, so these characteristics are provided for a bull by measuring the performance of his daughters. The more daughters that a bull has, the more accurate and reliable his ABV figures will be.

New ABVs are added to the list as needed. A recent ABV addition is daughter fertility, which measures the differences between bulls for the percentage of their daughters pregnant by 6 weeks after the start of mating. A higher number indicates that farmers will not be unnecessarily feeding and caring for ‘empty’ cows. As the figure is new many bulls do not have data for this feature, but this will be slowly added as it becomes available increasing the usefulness and reliability of the figure.

The Australian Dairy Herd Improvement Scheme (ADHIS) uses ABVs to develop an Australian Profit Ranking (APR) for dairy bulls. The APR uses a formula based on ABVs for protein and fat in the milk, milk quantity, milking speed, cell count, cow survival, temperament, liveweight and daughter fertility to produce a ranked list of the bulls that produce the most profitable daughters.

The bull description in figure 6.9 is for Donor, a bull that came second in the May 2003 APR rankings and one of the most popular Australian Holstein bulls.

1 Evaluate the ABVs of Donor compared to the Holstein breed averages in figure 6.10.

______________________________________________________
______________________________________________________
______________________________________________________
______________________________________________________
______________________________________________________
______________________________________________________
______________________________________________________
______________________________________________________

Check your answer.
Bull ABVs  Holstein - May 2003
Name: ELITE MOUNTAIN DONOR IMP (E.T)
Bull ID: DONOR
NASIS ID: 29FFP65
Herdbook ID: AUS668474
Defect Codes: TV
Date of Birth: 26-Apr-1994

**Pedigree**

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<tr>
<td>A00007170</td>
<td>HOLUSAM00002020049</td>
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</tbody>
</table>

**Production ABVs**

- **APR**: 147
- **Reliability APR**: 96 %
- **ASI**: 122
- **Protein**: 38 kg
- **Fat**: 31 kg
- **Milk**: 1056 litres
- **Protein %**: 0.18
- **Fat %**: -0.2
- **Reliability (production)**: 99 %
- **Records in Progress**: 25 %
- **AUS Daughters**: 6583
- **AUS Herds**: 1184
- **Herd with most daughters**: 61
- **Herd with 2nd most**: 55
- **Country with daughters**: 2

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
<td>6583</td>
</tr>
<tr>
<td>NZL</td>
<td>1295</td>
</tr>
</tbody>
</table>

**Conformation ABVs**

- **Overall Type (scale 1 – 15)**: 0.7
- **Mammary System**: 0.6
- **Stature**: 0.8
- **Udder Texture**: 0.2
- **Bone Quality**: -0.2
- **Angularity**: 0.1
- **Muzzle Width**: 0.2
- **Body Length**: -0.1
- **Body Depth**: 0.2
- **Chest Width**: 0.1
- **Rump Length**: -0.3
- **Pin Width**: 0.3
- **Pin Set**: 0.8
- **Foot Angle**: 0.5
- **Rear Set**: -0.3

<table>
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<td>Fore Attachment 0.3</td>
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<tr>
<td></td>
<td>Rear Attachment Height -0.1</td>
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<tr>
<td></td>
<td>Rear Attachment Width 0.3</td>
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<td></td>
<td>Centre Ligament 0.4</td>
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<td></td>
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<td>Loin Strength N/A</td>
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<td>Reliability (conformation) 98 %</td>
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**Workability ABVs**

- **Milking Speed**: 95 %
- **Temperament**: 93 %
- **Likability**: 96 %
- **Reliability (workability)**: 99 %
- **AUS Daughters**: 1850
- **AUS Herds**: 509

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<tr>
<td>NZL</td>
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**Survival ABV**

- **ABV**: 5 %
- **Reliability (survival)**: 88 %

**Calving Ease ABV**

- **ABV**: 9 %
- **Reliability (calving ease)**: 96 %

**Cell Count ABV**

- **ABV**: 2 %
- **Reliability (cell count)**: 99 %

**Daughter Fertility ABV**

- **AUS Daughters**: 6579
- **AUS Herds**: 1182

<table>
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**Liveweight ABV**

- **ABV**: 21 kg
- **Reliability (liveweight)**: 97 %

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Figure 6.9: Bull description © ADHIS Pty. Ltd. May 2003. All rights reserved.
ABVs are released three times per year in February, May and August. For the most recent ABV release, refer to the ADHIS Website at http://www.adhis.com.au.

In the **Cattle production** module the issue of genetic diseases was discussed, and the particular problems that can arise through the widespread use of an AI sire. The ABV system tries to address this issue by publishing the results of any tests done on the bulls for genetic diseases. Notice that **Donor** has a defect code of TV. This code means that **Donor** has tested negative for the disease **Complex Vertebral Malformation (CVM)**.

CVM causes abortion or malformation and death of 25% of calves produced by crossing affected cows and affected bulls. It was first detected in 2000 in Denmark, and Danish scientists developed a DNA test in 2001. CVM was introduced to the Australian herd by the use in AI programs of the American bred bull *Penstate Ivanhoe Star*, and his son *Carlin-M Ivanhoe Bell*. It is estimated that now 11.8% of Australian Holstein cows are carriers of the disease.
2 Describe how dairy farmers can avoid CVM in their herds.

_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Check your answer.

If you are interested in finding out more about CVM there is a lot of information on the Internet. Try some of these websites:

http://www.altagenetics.com/English/WhatsNew/20010821CVMGene.htm
http://www.lr.dk/kvaeg/informationsserier/nyheder/CVM.pdf
http://www.selectsires.com/cvm_reprint.html
Continuing innovation

In order to continue as a successful industry it is important that research and development have a high priority. A research levy of approximately 0.12 cents per litre, based on the amount of milkfat produced, is collected from all Australian dairy farmers when they sell their milk. The Federal Government matches the contribution of the dairy farmers. This money goes to Dairy Australia (prior to July 2003 to the Dairy Research and Development Corporation (DRDC)) that distributes it to individuals and research organisations undertaking dairy research.

If you have Internet access you can look at the Dairy Australia web site at http://dairyaustralia.com.au/ and see information about their current research projects.

Dairy Australia also conducts the annual Australian Grand Dairy Awards which includes a category for the most innovative new dairy product and supporting marketing campaign. The 2003 Award for Innovation went to Brownes Dairy Pty Ltd for Heart Plus™ milk. This is a low fat milk product with added marine omega-3 fats and vitamins B6, B12 and folate which are believed to be beneficial to the health of the heart.

If you have Internet access look at the Heart Plus™ web site at http://www1.heartplus.com.au/pages/healthprof.asp and at the most recent awards on the Dairy Australia web site.

The CSIRO, state departments of agriculture, universities and private companies also continue to conduct research into areas relevant to dairying.

Most agricultural industries in Australia have organisations conducting research to improve production, processing and marketing of the product. Identify one organization that conducts research on your case study product.

_________________________________________________________
Mastitis

A high cell count in milk downgrades quality. Counts above 400 000 cells per ml are unacceptable for most Australian export markets, and Australian dairy farmers aim at a count below 250 000 cells per ml, with many processors now paying a premium for milk under 150 000 cells per ml. High cell counts are caused by mastitis, a bacterial infection of the udder. It is a major problem in the dairy industry worldwide, costing an estimated $120 million annually in Australia alone.

Mastitis is caused by a number of different bacteria, most of which are common in the environment. These bacteria have to enter the interior of the udder past the natural body defences before the mastitis infection can develop. Some aspects of dairy production, such as high levels of milk production and some milking techniques, can make cows more susceptible to bacterial entry, but with continuing research and development of best practice milking techniques the problem can be significantly reduced.

Countdown Downunder is a program that has been funded by the DRDC that aims to bring down the levels of mastitis in Australian dairy herds. This program identifies best practice and educates farmers by:

- producing handbooks and information leaflets
- publishing articles in industry specific and local magazines and newspapers
- broadcasting items on local television programs
- running meetings, seminars and courses for dairy farmers
- establishing coordinators for each dairying region
- training local dairy advisors
- maintaining a web site.

Countdown Downunder also recognises the best performing farms with annual milk quality awards for the 5% of Australian farms with the lowest annual average bulk milk cell count.

The program has been judged very successful, with the percentage of herds under 400 000 cells per ml increased from 89% in 1998, when Countdown Downunder started, to 92% in 2000 when it was last assessed. The 2000 research also found that 76% of dairy farmers felt they had benefited from the program.

If you have Internet access you can visit the Countdown Downunder web site to see their latest initiatives at http://www.countdown.org.au/.
There is a recognised genetic component to mastitis, and in 1999 a breeding value indicating mastitis resistance was developed. The cell count ABV is the percentage change that can be expected in the incidence of mastitis in the daughters of the bull. Farmers can now produce replacement heifers that are resistant to mastitis by selecting bulls as sires with a strongly negative cell count ABV.

Outline the effect that the use of Donor (figure 6.9) as a sire is likely to have on the incidence of mastitis in a herd.

Check your answer.

Effective mastitis control relies on farmers using an IPM approach where a number of measures are used together.

**Testing**

Better and faster testing techniques and feedback can help farmers improve product quality more accurately and efficiently. In 2002 Professor Veal at Macquarie University developed rapid milk analysis technology that means bacterial counts can now be done in an hour rather than 72 hours. It also makes bacterial and cell count measurements much more accurate.

The usual method of measuring bacterial numbers involves a measured dilution of the sample placed in conditions favourable for bacteria to divide and grow. After 72 hours the bacterial colonies can be counted and the number of bacteria in the original sample is extrapolated from this result. The rapid analysis technology uses a technique called flow cytometry to directly count individually labelled bacteria.

The bacteria are stained with a fluorescent dye, and different groups or families of bacteria can be stained with different dyes for separate counting. The stained bacteria are passed at speeds of up to 50 000 cells per second past a laser which causes them to fluoresce and they are then detected.
Robotic milking

The cells in the udder of a cow slowly produce milk. After some time the udder cistern will fill up. Modern cows have been bred to have a large capacity, but as the udder fills the pressure builds and slows further milk production. The high pressure in the udder is uncomfortable for the cow, and can also make her more likely to get mastitis. Most farms milk twice daily, but some farms milk three times a day, and find that they can get extra production from their cows because there is less inhibition of further milk production. However, there is some question whether the additional production is worth the extra costs (such as labour, electricity, cleaning chemicals, water) involved in an extra milking session per day.

The Astronaut robotic milking system developed by Lely is an innovative unit that allows a cow to choose when she wants to be milked. Cows enter a milk alley through a one-way gate to a feeding area. The only exit is through the milking unit. When a cow enters the unit, the system uses an electronic collar to identify her. The teats are cleaned with brushes and the milking cups are automatically attached with sensing guides that contain stored information about the placement of teats for each cow. The milking system computer also stores production information for each cow.

After milking the cups detach and a teat spray is applied that will help prevent mastitis causing bacteria entering the teat canal. The cow then moves to an exiting area where she has access to concentrates before leaving by a one-way gate. Gates are manipulated by the computer so the cow either returns to the old pasture area, proceeds to a new pasture area or moves into a holding pen for human attention if there is a problem such as mastitis, or she is due for AI.
Identify advantages and disadvantages associated with a robotic milking system.

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

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____________________________________________________________________________________

Check your answer.

If you have Internet access find out more about the robotic milking system at http://www.lely.com/, see it in ‘action’ on a dairy farm via webcam at http://www.roboticdairy.com/ and read what the press have written at http://www.melbpc.org.au/pcupdate/2205/2205article3.htm and http://www.abc.net.au/rural/vic/milking.htm

Marketing innovations

It is becoming increasingly important to stimulate demand for a product by innovations in marketing. These innovations are sometimes promotional, for example advertising campaigns that emphasise the
nutritional benefits of a product such as Heart-Plus™ milk. There are many examples of these in television, radio, newspaper and magazine advertisements.

If you have Internet access you can view the current promotional campaign for milk at the Dairy Australia web site at http://dairyaustralia.com.au/

Sometimes innovative uses for a product are developed that open up new markets.

In 1999 a new product derived from milk was developed after years of research by Professor Eric Reynolds, head of the school of dental science at the University of Melbourne. This product, derived from cow milk protein, has been licensed to the manufacturer Bonlac Foods Limited and is sold under the trade name of Recaldent™.

The first stage of tooth decay is the loss of calcium and phosphate from the tooth enamel. Recaldent™ has the proven ability to prevent and even reverse this demineralisation, producing healthier teeth. It is currently marketed as a mint and a chewing gum in Europe, USA and Japan.

Select one of the dairy innovations described in this part and complete the following table.

<table>
<thead>
<tr>
<th>Dairy Innovation</th>
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<tbody>
<tr>
<td><strong>Name of innovation</strong></td>
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<tr>
<td><strong>Developer</strong></td>
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<tr>
<td><strong>What the innovation does</strong></td>
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<tr>
<td><strong>How the innovation affects production or marketing</strong></td>
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<tr>
<td><strong>Why the effect on production or marketing is important</strong></td>
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Check your answers.
Develop a list of scientific and technological innovations that have affected your case study product, then indicate whether they impact mostly on production (P) or marketing (M) of the product.

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If you have Internet access you can find innovations in your case study product by conducting a search or by looking at websites for that product. Look at the Rural Industries Research and Development Corporation at http://www.rirdc.gov.au/.
The Grains Research and Development Corporation at http://www.grdc.com.au/ contains articles on innovations in grain production and also publishes summaries of research projects including method and results.

Select two innovations – one that has impacted on production, and one that has affected marketing. Try to choose those innovations that are more recent.

Research the selected innovations and use the information you collect to complete the following table.
### Production innovation

<table>
<thead>
<tr>
<th>Name of innovation</th>
<th>Developer</th>
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<table>
<thead>
<tr>
<th>What the innovation does</th>
<th>How the innovation affects production</th>
<th>Why the effect on production is important</th>
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### Marketing innovation

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<th>Name of innovation</th>
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<tr>
<th>What the innovation does</th>
<th>How the innovation affects marketing</th>
<th>Why the effect on marketing is important</th>
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Turn to [Exercise 6.2](#) and use the information you have collected to write an HSC style extended response describing how scientific and technological innovations have impacted on production and marketing of your case study product.
Summary

- Production and marketing techniques in Australian agriculture have been changed as a result of scientific research and innovations in technology.
- Past changes to production and marketing have resulted in fundamental alterations to agricultural systems, affecting such things as labour requirements and farm size.
- Continuing research and development in agriculture means that future innovations will be available to further change production and marketing.

Figure 6.14: Holstein Friesian cow.
Past dairy innovations

1 There has been a significant decline in the number of dairy farms from 1970 to 2000. This decline was dramatic at first, but appears to be levelling out.

2 There has been a decline in the number of dairy cows from 1950 to 2000, although in 2000 there is a slight increase from 1990.

3 The quantity of milk produced during this time period has almost doubled. There is a dip in 1980, but otherwise quantity increases with time.

4 Milk quantity has significantly increased, while at the same time there has been a significant decrease in the number of dairy farms and the number of dairy cows.

Estimated breeding values

1 A has the most positive calving ease (direct) as well as the lowest birth weight.

2 B has the highest 200d value.

3 A has the biggest SS value, as well as good values for birth weight and calving ease.

4 B has the highest 400d and eye muscle area values.

5 The important EBVs in this scenario are:
   • the weight at 200 days – heavier weight will be more profitable
   • milking ability of the daughters – better milking daughters used as replacements will produce heavier calves in the future
   • mature weight – a herd of lighter weight cows will be cheaper to run.

B has the highest 200d, but C has the best MW and Milk and a moderately high 200d. On balance C may be the best choice, although the lower accuracy could be a problem.

Australian breeding values
1  *Donor* is second on the APR ranking and falls well within the top 1%. The high reliability of this figure means that his performance is particularly impressive. The Australian Selection Index (ASI) is based on milk protein and fat ABVs, and is similarly high. *Donor* has the highest protein ABV, but falls back a little on protein % although this ABV is still more than 1 standard deviation over the mean. Milk volume ABV is high, although not in the top 1% it is more than 2 standard deviations over the breed mean. Fat is also high at more than 1 standard deviation over the mean, although fat% is only just over the mean. Milking speed, temperament, likeability, survival and calving ease all fall into the top 1%. At 2% cell count is a moderate ABV, falling just above the mean. Daughter fertility with an ABV of 0 is on the mean, although this figure may change as it has a low reliability. The liveweight ABV of 21 kg is poor at more than 1 standard deviation over the mean.

Overall *Donor* ranks very well on most measures of production leading to a high APR ranking and his popularity as an AI sire.

2  Dairy farmers can avoid CVM in their herds by ensuring that cows with *Star* in their pedigree are not mated with bulls descended from *Star*, or by only using those bulls that have been DNA tested free from CVM.

**Continuing innovation**

**Mastitis**

*Donor* has a cell count ABV of 2%. This is a very small amount when the cell count ABVs range from 72 to –59, so it is unlikely that the use of *Donor* as a sire will have any noticeable effect, or else produce only a very small increase of mastitis in the herd.

**Robotic milking**

Advantages of the system include:
- reduced stress for the cow from less handling
- decreased period between milking times, which improves cow health and increases milk yield
- less workload for the dairy farm manager and more flexibility in working hours
- electronic identification allowing production records of individual animals to be easily kept
- some evidence that the incidence of mastitis is reduced.

Disadvantages of the system include:
• expense of the system, which is significantly higher than setting up a more traditional dairy
• difficulties in getting the system started – changing yard layouts and accustoming cows
• problems if the system malfunctions.

Marketing innovations

Some of the innovations you may have identified include:

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<td><strong>What the innovation does</strong></td>
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<tr>
<td><strong>How the innovation affects production or marketing</strong></td>
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<tr>
<td><strong>Why the effect on production or marketing is important</strong></td>
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<td>production or marketing is important</td>
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**Dairy Innovation**

<table>
<thead>
<tr>
<th>Name of innovation</th>
<th>Countdown Downunder</th>
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<tbody>
<tr>
<td>Developer</td>
<td>Dairy Research and Development Corporation (DRDC)</td>
</tr>
<tr>
<td>What the innovation does</td>
<td>Provides education by a variety of means to farmers on best practice to avoid mastitis. Also encourages good farms with milk quality awards.</td>
</tr>
<tr>
<td>How the innovation affects production or marketing</td>
<td>Promotion of the best milking practices means that more farmers are using these practices, which results in a lower incidence of mastitis and thus a lower milk cell count.</td>
</tr>
<tr>
<td>Why the effect on production or marketing is important</td>
<td>Lower mastitis incidence means less labour and veterinary chemical costs in treating mastitis infections. Lower milk cell counts mean that less milk is rejected which will cost the farmer money, and there are better milk marketing opportunities.</td>
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</table>

**Dairy Innovation**

<table>
<thead>
<tr>
<th>Name of innovation</th>
<th>Rapid analysis technology using flow cytometry</th>
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<tbody>
<tr>
<td>Developer</td>
<td>Professor Veal at Macquarie University</td>
</tr>
<tr>
<td>What the innovation does</td>
<td>Makes bacterial counts in milk faster and more accurately than conventional methods.</td>
</tr>
<tr>
<td>How the innovation affects production or marketing</td>
<td>Faster feedback helps farmers improve product quality more accurately and efficiently.</td>
</tr>
<tr>
<td>Why the effect on production or marketing is important</td>
<td>Faster identification of production problems means that they can be fixed more quickly, and less money is lost.</td>
</tr>
<tr>
<td>Dairy Innovation</td>
<td></td>
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<td>--------------------------------------</td>
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</tr>
<tr>
<td><strong>Name of innovation</strong></td>
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<tr>
<td>Astronaut robotic milking machine</td>
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<td><strong>Developer</strong></td>
<td></td>
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<tr>
<td>Lely</td>
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<tr>
<td><strong>What the innovation does</strong></td>
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<tr>
<td>The robotic machine milks the cows, and allows them to choose when they want to be milked.</td>
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<tr>
<td><strong>How the innovation affects production or marketing</strong></td>
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</tr>
<tr>
<td>The timing of labour in the dairy is less important as the routine task of milking is automated. Cows are able to choose their own milking schedule which has implications for the freedom and health of the animal. Production per cow may be increased as milking is likely to be more frequent.</td>
<td></td>
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<tr>
<td><strong>Why the effect on production or marketing is important</strong></td>
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<tr>
<td>A lot of the labour on the average dairy farm is involved in the twice daily milking. Dairy farmers must ensure they have labour available for this task 365 days per year. The robotic system frees up this labour for other tasks. Production increases per cow and improved health of the cow may improve income, although the cost of the system is still very high.</td>
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<table>
<thead>
<tr>
<th>Dairy Innovation</th>
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<tbody>
<tr>
<td><strong>Name of innovation</strong></td>
</tr>
<tr>
<td>Recaldent™</td>
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<tr>
<td><strong>Developer</strong></td>
</tr>
<tr>
<td>Professor Eric Reynolds, head of the school of dental science at the University of Melbourne</td>
</tr>
<tr>
<td><strong>What the innovation does</strong></td>
</tr>
<tr>
<td>When in contact with teeth the product prevents and reverses the demineralisation that leads to tooth decay.</td>
</tr>
<tr>
<td><strong>How the innovation affects production or marketing</strong></td>
</tr>
<tr>
<td>The product can be added to chewing gum and mints. The healthy nature of the product will help to provide marketing opportunities.</td>
</tr>
<tr>
<td><strong>Why the effect on production or marketing is important</strong></td>
</tr>
<tr>
<td>The product is derived from milk protein, so the use of it will increase demand for milk. The healthy nature of the product will assist marketing and so increase profits.</td>
</tr>
</tbody>
</table>
Exercises — Part 6

Exercises 6.1 to 6.2  Name: _________________________________

Exercise 6.1

Use your research of the history of your case study product to answer the following questions.

1  Outline how your case study product was produced before mechanisation was introduced.

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2  Describe an example of machinery that has reduced the labour requirements for the production of your case study product.

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3  Describe an example of innovation that has improved the quality of your case study product.

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__________________________________________________________________________
4 Describe an example of innovation that has altered the storage or handling of your case study product.

5 Evaluate the impact of one innovation on the agribusiness associated with your case study product.
Exercise 6.2

Describe how scientific and technological innovations have impacted on production and marketing of a product you have studied.