**Developing future apple varieties – unit plan**

**Overview**

In this unit, students investigate trends and drivers in the development of new apple varieties and what may be possible and preferable apple attributes in the future.

**Purpose**

This unit will help students to explore the influences currently driving the development of new apple varieties and encourage critical thinking about possible and preferable future scenarios.

**Background**

The [Breeding red-fleshed apples](https://www.sciencelearn.org.nz/resources/839-breeding-red-fleshed-apples-introduction) resources presents a case study of the current development of a potential new apple variety that has red flesh. The story also explores the wider context of how apples are currently bred and commercialised in New Zealand as well as the potential that new and emerging genetic techniques and information have for speeding up plant breeding and developing innovative new apple varieties in the future.

The breadth of information presented in our resources will help students to understand the existing situation, trends and drivers influencing new variety development and what is realistically possible in the future. Exploring this broad context will allow students to make informed and realistic predictions about possible future scenarios and to critique the possible impacts and desirability of various predictions.

***Suggestions for a scenario***

Breeding a new apple variety currently can take up to 25–30 years, so today’s breeders need to predict the attributes consumers will want in the future. Your task is to investigate the trends in apple breeding, changing consumer demand and factors that are driving these, in order to present a proposal to the apple-breeding team for a new apple variety to be commercialised in 25 years time.

***Where's the biotechnology?***

Plant breeding is 1 of the oldest forms of biotechnology. Selective breeding is used to create new fruit varieties with improved attributes that will meet changing consumer needs and lifestyles. Breeding new varieties of apples and pears takes many years. Since the discovery of DNA, advances in knowledge and capability in genetics are increasingly being applied to plant breeding, providing potential to increase speed and efficiency of the breeding process as well as fruit quality and to better meet the needs of consumers and the environment in the future.

**Curriculum focus**

***Technology (level 7/8) – Brief development***

Justify the nature of an intended outcome in relation to the context and the issue to be resolved. Justify specifications in terms of key stakeholder and wider community considerations.

***Technology (level 7/8) – Technological products***

Understand the concepts and processes employed in materials development and evaluation and the implications of these for design, development, maintenance and disposal of technological products.

***Technology (level 7/8) – Characteristics of technology***

Understand the implications of technology as intervention by design and how interventions have consequences, known and unknown, intended and unintended.

***Science (level 7/8) – NOS Participating and contributing***

Use relevant information to develop a coherent understanding of socio-scientific issues that concern them, to identify possible responses at both personal and societal levels.

***Science (level 8) – Living world***

Understand how humans manipulate the transfer of genetic information from 1 generation to the next and make informed judgements about the social, ethical and biological implications relating to this manipulation.

***Focus of skill and strategy***

This unit provides an opportunity for students to engage with a current technological development in New Zealand. The focus of student learning is on developing their understanding of factors that influence the development of new technologies, critical thinking about potential impacts on different groups of people and understanding that people have the power and the responsibility to control how and what technologies develop in the future for the benefit of society.

Students will apply their knowledge to developing and presenting a conceptual idea for a future apple variety and justify the feasibility of their proposal with research evidence of trends and drivers and consumer feedback.

**Health and safety**

Students need to be made aware of ethical and privacy issues in carrying out research using interviews and surveys.

**Useful links**

**Red apples for consumer health**

Plant & Food Research explains how they screen for the red flesh gene.

[www.plantandfood.co.nz/growingfutures/case-studies/red-apples-consumer-health](http://www.plantandfood.co.nz/growingfutures/case-studies/red-apples-consumer-health)

**Sensory and consumer science**

Find out how sensory and consumer science is used at Plant & Food Research for predicting consumer preferences.

[www.plantandfood.co.nz/page/our-research/food-innovation/research-platforms/sensory-consumer-science/](http://www.plantandfood.co.nz/page/our-research/food-innovation/research-platforms/sensory-consumer-science/)

**Plant & Food Research’s views on genetic modification**

Plant & Food Research outlines its views on genetic modification.

[www.plantandfood.co.nz/page/about-us/our-views-on-gm/](http://www.plantandfood.co.nz/page/about-us/our-views-on-gm/)

**Trends in food consumption**

Learn more about trends and drivers in food consumption in these Royal Society papers.

<http://rstb.royalsocietypublishing.org/search?fulltext=food+consumption+trends&sortspec=date&submit=Submit&andorexactfulltext=phrase>

| **Suggested learning intentions** | **Suggested learning experiences** | **Possible teaching/assessment activities** |
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| **Introduction** |
| Develop awareness and thinking about how foods may change in the future and how this may impact on society. | Introduce the story of the red-fleshed apple. Start by showing an [image](https://www.sciencelearn.org.nz/images/944-red-fleshed-apple) of the red-fleshed apple and posing some questions, for example: * What would you think about eating an apple that was red all the way through?
* What might it taste like?
* Why would you develop an apple like this?
* What could the benefits be?

Students read the article [Why breed a red-fleshed apple?](https://www.sciencelearn.org.nz/resources/841-why-breed-a-red-fleshed-apple) and view the video clip [Potential health benefits of red-fleshed apples](https://www.sciencelearn.org.nz/videos/423-potential-health-benefits-of-red-fleshed-apples).Discuss and record their ideas on the trends (how what happens now differs from the past) and drivers (what is causing the changes) behind this new apple, whether this a desirable fruit for the future and why. What other variations of an apple may be possible or preferable in the future?[**Values continuum activity**](#values)**:** In groups of 3, students negotiate placement of descriptions of fruit possibilities for the future onto a continuum from most preferable to least preferable. Groups compare their continuum with another group, discuss reasons for differences and reconsider their own continuum and whether they would make changes based on discussion.  | Class discussion.Read article and view video.Record ideas about possible future fruit and desirability. Values continuum.  |
| **Introduce the scenario** |
| Develop understanding of the long-term nature of apple breeding, the challenges this presents for breeders meeting future consumer and society demands and the potential future impact of new genetic techniques and information. Develop understanding of apple attributes and how these are tested and defined.Develop understanding about factors that influence changes in the fruit we eat – trends and drivers. | **Scenario:** Apple breeders are constantly thinking about new ideas for the future. New apple varieties currently can take up to 25–30 years to breed and launch in the market place. This means breeders need to predict what future consumers will want many years ahead and have many new varieties in the pipeline at a time. You’ve been asked to develop a proposal for the next new apple variety for the breeding programme. You’ll need to investigate current trends and drivers and possible and preferable futures in apple breeding to understand what might be feasible and likely to satisfy consumer demand/acceptance in 25–30 years time. Your proposal will need supporting evidence to convince the breeding team that your concept is worthy of investment.Have students read articles (could be shared within a group): * [Why breed a red-fleshed apple?](https://www.sciencelearn.org.nz/resources/841-why-breed-a-red-fleshed-apple)
* [Breeding a new apple cultivar](https://www.sciencelearn.org.nz/resources/844-breeding-a-new-apple-cultivar)
* [Commercialising a new apple variety](https://www.sciencelearn.org.nz/resources/854-commercialising-a-new-apple-variety)
* [Genetic information and apple breeding](https://www.sciencelearn.org.nz/resources/847-genetic-information-and-apple-breeding)

To support students in conceptualising and describing a new apple variety, complete the class activity [Investigating apple attributes](https://www.sciencelearn.org.nz/resources/883-investigating-apple-attributes).**Brainstorm:** Stimulate discussion about the existing situation. What are our apple eating habits? What do we like and expect in terms of eating and buying apples? Where do we buy from? How often do we eat/buy apples? When, how and why do we eat/buy them? How does this situation vary among different groups of people? What might the fuel situation be in 25–30 years time? How will this affect exports? Could there be significant weather/climate changes in the next 25–30 years? How will this affect what can be grown? With continued population growth, could there be significant food shortages or limited arable land – locally, nationally and globally? What impact could this have? Record ideas on the board. (See [examples of future thinking about apples](#future).)Have students in small groups sort ideas about the existing situation into 4 categories – personal, local, national and global – and record these.Assign each group 1 of the 4 categories and a colour to identify it, and invite them to colour-code the ideas on the board, adding in any extras from their list. Discuss differing ideas in categorising, or ideas that overlap.Use the brainstorm ideas as a starting point to summarise what the general trends are in apple consumption today: How does this situation compare with 50 years ago? What has changed and why?For homework, students could interview several people from different generations about their fruit consumption and experiences and identify similarities and differences from the existing situation on a Venn diagram. Discuss possible reasons for the differences. What has caused the changes/trends that currently exist (what are the drivers)? Discuss other issues that may drive changes in the future, for example, the fuel situation in 20–30 years – how could this affect exports? Weather/climate in 20–30 years – how could this affect what can be grown? Possible food shortages?Student groups record their ideas of trends and drivers.  | Present scenario.Students record key ideas on what drives the development of new apple varieties and how genetic techniques and information could impact on future developments. Complete worksheet.Class brainstorm – record on board.Group activity. Class discussion. Homework and follow-up activities.Class discussion. Group activity.  |
| **Developing knowledge and skill** |
| Develop awareness of current research and developments in plant breeding and how they have changed and could continue to change breeding processes and the fruit we eat in the future.Stimulate critical thinking about what is possible versus what is preferable in the future. | Small groups carry out research to inform the development of their proposal for the given scenario.Start by reading the articles viewing the embedded video clips in [Breeding red-fleshed apples](https://www.sciencelearn.org.nz/?search=true&query=+red+fleshed+apple). Students could do further research using the internet – see [useful links](#links). If possible, invite an orchardist as a guest speaker to provide an industry perspective on current trends and drivers. Get students to prepare specific questions first.Questions to guide research could include:* What are the trends and drivers influencing changes in this area (advances in biotechnology knowledge and capability, lifestyle changes, environmental concerns, sustainability)?
* What could be possible in the future?
* Are all possibilities beneficial and sustainable? Why/why not?
* What factors could constrain certain developments (ethical concerns, economic factors, legislation, increasing population, availability of land, fuel shortages, extreme weather patterns?
* What possible future scenarios are beneficial for society (preferable futures)?

 In groups, students discuss and summarise their findings about future possibilities in apple breeding in the future and what they consider preferable for society.  | Student research.Guest speaker.Group discussion and recording of ideas. |
| **Develop a proposal for a new apple variety for 2040** |
|  | Groups decide on and describe the [attributes](#attributes) of their future apple concept and prepare their proposal. They could organise a focus group to provide feedback on their idea (see student activity [Consumer research on future apples](https://www.sciencelearn.org.nz/resources/884-consumer-research-on-future-apples)). Analysis of the feedback may cause them to modify their idea and their supporting evidence.The proposal could be presented in a range of formats according to student choice or set by the teacher, such as digital story, PowerPoint, chart, eposter.Proposal to include:* brand name and image of the apple concept
* overall statement about the apple and the market need or opportunity it is targeting
* a list of the key attributes (see [Investigating apple attributes](https://www.sciencelearn.org.nz/resources/883-investigating-apple-attributes) activity)
* supporting evidence including some science background to justify its feasibility and likely public acceptability
* how the product is differentiated from others
* benefits and possible risks
* final summary.
 | Group discussion on a future apple concept. Consumer research activity.Group discussion of a presentation format.Group completion of proposal. |
| **Present the proposed brief** |
|  | Groups/individuals present their proposals to the class. If possible, invite an orchardist to provide feedback on the proposals. | Student groups present proposals. |
| **Conclusion/assessment** |
|  | Students can write an individual report presenting and justifying their ideas on preferable and feasible future changes in apple breeding. | Final report. |

**Values continuum**

Cut up and place these descriptions of fruit possibilities for the future onto a continuum from most preferable to least preferable.

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| **Slim-down apple** Great for people trying to lose weight. An apple variety containing compounds that help you feel full. These compounds have been identified in kiwifruit.  | **Super-sized apple**An apple variety bred to be larger than usual. Apple varieties are produced in many different sizes and shapes for ease of eating for different groups of people, convenience, different uses, novelty etc. | **Pest-buster apple** An apple variety with resistance to insects and pests, reducing the use of chemical sprays.  |
| **Sugar-rush apple**An apple variety bred for its high sugar content for people with energetic lifestyles.  | **Red-fleshed apple**A healthy apple variety with increased anthocyanin levels to protect against disease.  | **Rainbow apple**Apple varieties with many different flesh colours, including yellow, orange, purple. Aimed at encouraging more children to eat fruit.  |
| **Super-tasty apple**A sweet, firm and crunchy apple, similar to our most popular varieties.  | **Medi-apple**Apple breeding focusing on increasing levels of various micronutrients in an apple so we can improve health and eat less fruit. | **Long-lasting apple** An apple with a long shelf life so it retains good texture and flavour longer after purchase. |
| **Hardy apple** An apple tree with an added drought-resistant gene so it can be grown in more countries. | **Traveller apple**An apple that doesn’t bruise easily and has a long shelf life. Ideal for export overseas.  | **High-productivity apple**An apple tree bred to be more efficient and have more apples per branch, making apples cheaper.  |

**Examples of future thinking about apples**

***Existing situation: what happens now and why?***

* Most consumers buy apples from the supermarket.
* Some are grown in New Zealand (Braeburn, Jazz, Pacific Rose, etc) but others are imported (e.g. Golden Delicious, Granny Smiths).
* Consumers want apples as a tasty, healthy and portable snack.
* A large percentage of New Zealand pip fruit is exported to overseas markets and is an important contribution to our export earnings.
* Apple breeders try to understand and meet consumer demands in different markets, as well as competing against different varieties overseas.

***Trends: how does this differ from the past and why?***

* Increasing consumption of high-calorie energy-dense foods, including fast foods, and decreasing energy expenditure related to leisure, work and transportation is leading to many diet-related diseases and associated costs to individuals and society.
* Consumers are more aware of nutrition-related diseases and the importance of fresh fruit and vegetables in a healthy diet.
* Consumers are increasingly interested in foods with additional health benefits.
* Many consumers are more educated and health information is more accessible, leading to increasing health awareness and subsequent demand for healthy foods as well as environmental and sustainability concerns.
* Growing consumer and industry awareness and concern over environmental and sustainability issues.
* Increasing numbers of women in employment and both parents working leading to busy lifestyles and increasing demand for convenience in foods they choose.
* Campaigns like 5+ a day, which encourage people to eat more fruit and vegetables.
* Rise in social media platforms and creative marketing.
* Consumers want value for money.

***Drivers: what is causing the changes and why?***

* Increasing urbanisation.
* Increasing demand for healthy, safe, convenient foods.
* Rise in supermarkets as opposed to smaller local suppliers of fresh food.
* Globalisation of food marketing and distribution.
* Advances in food processing and modern technology.
* Increasing production and availability of functional foods with health benefits.
* Global mass media.
* Increasing knowledge and capability in genetics offers potential for more abundant and economical food supply.
* There are still many public concerns about GM foods in relation to safety, environment and ethical issues.
* Government regulations control/constrain developments in GM foods to different degrees in different countries.
* Year-round availability of food.
* Demand for low levels of chemical residues in fruit, resulting in phasing out of harsh chemical use and using more acceptable orchard management techniques. (Apple futures)
* To sustain competitive advantage in export markets, New Zealand needs to continue to develop new and improved varieties.
* Germplasm from Kazakhstan has contributed new and diverse traits to the germplasm collection in New Zealand, making interesting new varieties possible.
* Global market research providing data on consumer needs and trends.
* Environmental and sustainability concerns, such as food miles and carbon costs of shipping overseas.
* Growing scientific knowledge and capability.
* Finding new export markets?

***Possible futures: What might happen in the future?***

* Different shapes, sizes, flesh and skin colours – for novelty, health, convenience.
* Increased health benefits in fruit through increasing information from genetic research (for example, nutritive value, protection from disease, satiety).
* Breeding of fruit with minimal chemical residues, higher yields and improved longevity/shelf life.
* Increasing application of genetic and genomic techniques to speed up and add efficiency to breeding programmes.
* GM apples? (If GM food becomes acceptable in New Zealand, what would make GM apples more acceptable?)

***Preferable futures: What do you want to happen in the future and why?***

* Higher consumption of fruit contributing to improvements in nutrition and health of general population.
* Fruit with increased health benefits.
* Fruit with increased protection against disease through higher percentage of compounds such as anthocyanins – plant and genetic research together with advances in breeding processes is making this possible.
* Competitive pricing of fruit through greater efficiencies in breeding and application of knowledge from genetic research.
* Fruit with improved shelf life.
* Fruit trees more adaptable to different climates and environments.
* Fruit grown with little or no use of chemicals.

**Possible future apple attributes**

* Size
* Sugar content
* Vitamin/mineral
* More fruit/tree
* Easier to harvest
* Grow in harsh conditions (hot/cold)
* Shelf life
* Insect-resistant or disease-resistant
* Fruit flavour
* Texture
* Firmness
* Storage and shelf life
* Tree productivity/structure
* Tolerance to cold/warm weather
* Medicinal apples