

No part of the candidate's evidence in this exemplar material may be presented in an external assessment for the purpose of gaining an NZQA qualification or award.

SUPERVISOR'S USE ONLY

S

93105A



931051

Draw a cross through the box (X) if you have NOT written in this booklet

☐

+

## SCHOLARSHIP EXEMPLAR



Mana Tohu Mātauranga o Aotearoa  
New Zealand Qualifications Authority

### Scholarship 2023 Agricultural and Horticultural Science

Time allowed: Three hours  
Total score: 24

#### ANSWER BOOKLET

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Write your answers in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–23 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (XXXXXX). This area may be cut off when the booklet is marked.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

# QUESTION ONE: Reducing greenhouse gases in New Zealand's primary sector

Primary production system: Dairy

## PLANNING

Methane - Ruminants

Nitrates -  $\text{N}_2\text{O}$ , volatilization of nitrate from pee/wine.  
- too concentrated to be abs. by plants.

~~CO<sub>2</sub>~~  $\text{CO}_2$  - Fonterra coal burner -

- Govt invest 100M to replace.  
- transportation

- Cannot have no. emissions

- Science always changing - less certainty to invest.

- Science is. seemed vaccine to  $\text{CH}_4$  by over 90% is ~~at~~ to come out soon

- ~~around~~ ~~hardback~~ Difficult to ~~invest~~ a lot as commodity.

- costs - Ravensdown W-protein.

- Compliance to Govt. Carbon credits/tax to offset.

- Most dairy farms running at deficit.  
BE price is \$8.50 but milk is around 7 ~~ish~~. + commodity = high volatility.



## Question 1 -Dairy

The dairy industry in NZ is one of our largest single export earners, with 35% of export revenue coming from dairy alone. However, dairy also contributes to 48% of agricultural green house gas (GHG) emissions. These come from the production of mainly methane and nitrates, alongside other emissions that arise after the farm gate in things such as transport, and processing. As a country we need to manage these emissions to remain sustainable in the future as a country that relies upon trade, and more importantly, trading on a clean, green image. However, managing these emissions comes with costs, and requires farmers to be open minded to change to navigate through the challenges of mitigating GHG emissions.

Methane is produced from dairy cows in their rumination process, where ruminants in their rumens break down and digest the plant material they eat (more specifically the cellulose), and as a by product, create methane, whilst is released through burps and farts. Nitrates are released into our atmosphere through the excrements of dairy cows, mainly in their urine. Cows will eat plants which contain nitrates, which is passed through their system and released mainly in their urine. This urine is very concentrated in nitrates and urea (a nitrogen containing compound), and is too concentrated to be absorbed by plants. This results in volatilization of urea into ammonia which acts as a base for reactions with nitrates, resulting in nitrous oxide being released into our atmosphere. This release of nitrous into our atmosphere is compounded when nitrogen containing fertiliser is being used on farm as it increases the nitrogen content in plants, resulting in more release from cows. It is important to note that whilst nitrous release occurs naturally and is a key part of the nitrogen cycle, our dairy is still harmful due to the concentration of animals, as well as the extra input of man made nitrates (through fertilisers) being added to the cycle.

Whilst methane and nitrous oxides are short term GHG's, they still have a very substantial effect on our environment, with warming potentials of 75x and 300x that of carbon dioxide. Furthermore, methane will eventually turn into carbon dioxide in our atmosphere.

Carbon dioxide produced from the dairy industry is largely produced from the processing and distribution of dairy for our exports. As fresh milk has a short shelf life, we export mostly milk solids, which is mainly milk powder, however, we do export cheese and other milk products. The production of milk solids involves the use of boilers by Fonterra, our largest dairy exporter, exporting over 80% of the dairy that leaves NZ. The boilers are used to dry the milk at high temperatures. For cost effectiveness, coal boilers are used, however, the burning of coal results in release of CO<sub>2</sub>. Once again, adding carbon that was previously locked away underground, back into the carbon cycle. From a distribution perspective, the shipping of our dairy to overseas markets also requires the burning of fossil fuels and causes release of CO<sub>2</sub>.

Why should we care about this?

The mitigation of GHG is extremely important for our country's economy. NZ is a member of the Paris accord, which has resulted in NZ having targets for GHG emissions that must be met, with the consequence being the purchase of overseas carbon credits from their emission schemes, which currently is predicted to be between \$4-23bn depending on prices (NZ treasury report). Furthermore, not meeting our goals will taint our clean green image that we trade on, decreasing our ability to trade in the future. Overall, it is clear that we must reduce emissions and that GOVT and consumers will expect this from our producers, but, this comes with many challenges and costs.

Agriculture is unique in that it is an industry that is, currently, impossible for no carbon to be emitted. Unlike transport where electric cars can be used, animals such as dairy cows will always have emissions and produce GHG's. The question is how can we minimise these animal related emissions, as well as find other areas to reduce our emissions.



In terms of the animal related emissions (Methane and nitrous), the key lies in the science. However, the science is always changing, and sometimes not ready to be used. Whilst currently, there are methods of reducing emissions such as animal husbandry, feed selection, or housing of the cows indoors to manage urine, these all not only require large investment, but also, the science and figures around these methods is always changing depending on new research. In the words of farmer and investor Mark Erikson, 'we must have certainty to invest'. This means that without certainty of one method being actually useful or useful to any substantial extent, most farmers will not be willing to invest into this, in fear of it being proven to not be useful in the future. Things such as feed selection require investment in sowing of the crop onto pasture, caring for the crop etc. whilst housing of dairy cows require sheds and waste systems to be built.

Some of the leading farmers may be willing to invest, and some already have done so in these methods, however, for the majority of farmers this is not possible due to the volatility of dairy, high interest rates, and the already high costs. Dairy is more or less a commodity, which is even more apparently due to the kill steps we do to process it for exports (such as boiling to reduce down to solids). A commodity such as dairy is much more susceptible to price fluctuations and has resulted in dairy prices always being volatile. This, once again, results in less certainty for dairy farmers. Our high inflation rates at 5.6% as of september 2023, which result in high interest rates, mean that even if farmers are willing to invest, another barrier is the 'price of money'. Either farmers will need to have liquidity, or be prepared to pay the high price of debt servicing with high interest, both of which are unreasonable for the average dairy farmer. Lastly, the rising costs in NZ, such as labour. The current break even price for a kilo of milk solids is around \$8.50, whilst the actual price fluctuates around \$7.50, resulting in most dairy farmers making a deficit. Subsequently under this pressure, investment in things that can help mitigate GHG is difficult. There is a silver lining as a seaweed vaccine that can be given to cows is nearly at the end of its development. This vaccine uses red seaweed, which can reduce methane emissions from dairy cows by over 80% reportedly.

The other area that can be considered for GHG reductions are the processing and distribution of dairy. The GOVT has allocated over \$100m for fonterra to replace its coal boilers into electric ones. This investment shows that the GOVT is willing to help the industry in the right areas in reducing GHG's. In terms of distribution, the fuel used for shipping dairy products could be replaced with biogenic fuel, however, this does come with extra costs. This has already been done by other industries such as Mark Erikson, who chose to ship his apples to Europe using biogenic fuel rather than normal fuel.

In conclusion, whilst the dairy industry is one of our largest earners, it is also one of our largest producers of GHG's. In the current economic environment, it is difficult for farmers to invest in the new technologies and methods for GHG reduction. This requires GOVT incentives and potential subsidies to happen in the short term. However, we have seen through the likes of the Fonterra boiler, that we can indeed reduce GHG beyond the farm gate, and infact is a more practical area to focus on. Making the processing of dairy more green, alongside the distribution is definitely important going into the future.

## QUESTION TWO: Growing New Zealand's agri-food exports

Primary production system:

Apples.

### PLANNING

Planned in resource book.



## Question 2 - apples

The export of apples from NZ has played a substantial role in helping the increase of NZ agricultural trade of the past decade. We have done this through differentiation of our product through various methods as well as better farming to increase yield. There is definite potential for more growth into the future of this industry.

Over the past decade, apples have seen significant growth in our export market. This was helped greatly by the free trade agreement signed with China, which allowed us to trade tariff free (tariff was phased out over 7 years), meaning better price for our apples overseas, and better returns for us. This increased our volume traded with our largest export market, China, and thus our export earnings.

However, China did not give us a free pass. Instead of tariffs, they posed technical barriers to trade upon us such as strict regulations on our insect pests. These pressures from China alongside pressures from other markets have helped drive our producers and exporters to work more with grower good organisations such as Apple and Pear NZ, in order to differentiate our products on the global market, as well as be more productive on farm.

Over the past decade, as a country we have seen great productivity gains in our apple industry. Whilst the global average yield of apples is 35 tonnes per hectare, the New Zealand average is 68 tonnes per hectare. This being nearly double the global average is a reflection of our innovative farming practices such as selection of rootstocks, and precise farm management practices such as timing of pruning and laying of reflective mulch. Whilst this is extremely positive to see for us, and has played a large role in increasing our apple exports over the past decade, there is definite room for growth. This room for growth is demonstrated to us by our industry leaders. Cam Taylor is receiving a yield of over 90 tonnes per hectare, whilst grower Mark Erikson is receiving over 100 tonnes per hectare with his highest yield block producing 120 tonnes per hectare. These are a credit to their excellent farm management, constant need for innovation, and investment in their blocks. Mark Erikson says 'I spend a dollar to receive two'. Mark is constantly spending money to improve his farm, despite him being already one of the best growers in the country and the world. This means that other growers can do the same, and there is definite potential for further growth in terms of physical production.

Value adding to these agricultural commodities has been very apparent in the apple industry. Over the past decade, NZ as a whole has developed its brand as a clean, green, country, which makes our primary sectors products more desirable to markets such as Europe and China. Furthermore, NZ apples lead the way in terms of traceability and chemical residue levels. Through the addition of barcodes and recording of data all the way from the orchard to the market, a NZ apple can be traced all the way back to the orchard, which adds desirability to the product overseas, as customers can have a better understanding of the product, as well as more trust of the apple. Our chemical residue levels at practically zero (untraceable), completely undercut the minimum requirements in our markets, resulting in high trust, and desire for the apples and increasing their value as a healthy product. Whilst these factors and ways of increasing value all hold their individual benefits, the largest and most important benefit that these have is differentiation. No other country produces apples with near to no chemical residues, we have world class traceability, and we have developed a clean, green, well known image overseas. By differentiating ourselves and this commodity we sell overseas, through not just one thing, but many smaller factors, we have become less of a commodity and more of a premium good.

Growers have taken adding value a step further through creating a personal connection with the buyers. Cam Taylor brands his company with his last name as it is personal, and markets Taylor Corp with pictures of himself and his father who owned the company before him. When Taylor Corp interacts with buyers, it is Cam himself that talks to them, in fact, when buyers come to visit, they stay in Cam's house with his family. This personal connection differentiates them even more, and makes buyers prepared to pay more for his apples.

There is still definite potential to grow and change in terms of our adding of value. This involves getting closer to the customer. Developing more personal connections to the buyer, and understanding what they want in an apple. As we shift to export to different markets, we also must shift our value added areas to align with what each market cares about. This will allow us to maximise our price in the respective markets.



Agri-food technology is a game changer, in particular artificial intelligence. Taylor Corp's packhouse is almost fully automated by robots and AI. Whilst this does not create a new product, it adds a new edge that we have over competitors. Due to the AI packhouse, Cam and confidently say that when the apple reaches the consumer, the only two people that have touched that apple is the consumer and the person who picked the fruit. Other technologies such as improved coolstores and keep fresh chemicals have also meant fresher apples going to market. Agri-food technology is one of the areas of highest potential for growth, and we have just seen the tip of the iceberg. Technologies to keep our fruit fresher, or give other desirable traits can be extremely important into the future. Use of AI being adopted more around our country both in the packhouse, but also in the orchard such as robotic pickers. In an extreme case, Mark Erikson thinks that one day we may be eating apples from a pill rather than a fruit. Whilst this may only occur in the distant future, this insight from Mark shows the importance of changing technology and the effects it can have on our apple exports. By far the most important part of agri-food technology that is likely to come, and that is likely to have the biggest impact on our exports is the allowance and use of genetic engineering. Ian Proudfoot from KPMG says that 'it is time to have an adult conversation on GE'. Currently our GE laws are that of 1996, and we are left with much stigma around GE. However, the positivity that GE can bring to our exports, such as apples is huge in terms of the traits we can target, disease resistance etc. Furthermore, the technology such CRISP is already very well developed, the only thing stopping it is the laws in NZ. Therefore, the change that comes with GE will be significant and also very rapid. The value it could add to our apple exports and primary exports as a whole is significant.

Overall, over the last ten years, New Zealand has stepped up as an industry leader in the apple exports through our extremely positive yields, adding of value to become a premium product and subsequently achieve higher prices, and use of technologies. These have helped our apple exports grow in size, however, all three of these aspects have major room for improvement. This improvement is being lead through our leading producers, who constantly display the room for improvements. By keeping up with market requirements, improving farm practices for yields, and keeping up with and using the ever changing technologies, in particular GE, we can continue to see these gains into the future.

### QUESTION THREE: Primary production profitability and rising costs

Primary production system (1): Kinifruit

Primary production system (2): Dairy

#### PLANNING

a) option.

$\uparrow$  Quant.  $\rightarrow$  can't flood market, but always increasing market.  
 $\rightarrow$  technology  
 $\rightarrow$  Continuity?  
 $\uparrow$  price  $\rightarrow$  scarcity  
 $\rightarrow$  FTA - India - Achit conds - loan - Hal 4  
 $\rightarrow$  SPE - Zespri.  $\rightarrow$  PVR. - G3.  $\rightarrow$   $\uparrow$  \$ of  
 $\rightarrow$  labour  $\rightarrow$  killstep.  
 $\downarrow$  costs,  $\rightarrow$  interest - hard to innovate  
 $\rightarrow$  change early - avoid compliance

b) viability  $\rightarrow$  Dairy is not doing well  
 $\rightarrow$  are reliant on China = shift to India.  
 $\rightarrow$  ageing pop.  
 $\rightarrow$  youth unemployment, 21%  
 $\rightarrow$  CC - big producer Cattle.  
 $\rightarrow$  Kinifruit good SPE.

Both  
 $\rightarrow$   $\uparrow$  demand



### Question 3 - kiwifruit and dairy

With NZ inflation as 5.6% as of Sep 2023 and labour costs, borrowing costs, fuel costs, all increasing substantially, this is placing immense pressure on farmers. There are three ways that farmers can remain viable through these increasing costs; increasing quantity sold, increasing price, or decreasing the costs. I will at the ways that these can be achieved for our kiwifruit and dairy exports, and discuss the viability of these industries going into the future.

In terms of increase quantity, for the kiwifruit exports we largely look to the use of technology and farm management practices, which can help increase the yield of kiwifruit per hectare, however, our kiwi fruits go through a single point of entry (SPE), which is Zespri. Zespri is a grower owned and voted organisation which exports all of our kiwi fruit, most of which is G3 gold kiwi fruit to China. The quantity that we export is controlled in order to maintain a controlled price and maximise returns for growers, therefore, we cannot mindlessly increase the quantity of kiwi fruit, in order to not flood the market and result in the price dropping. This idea of flooding the market is especially important for lesser differentiated commodities such as milk solids that we export. Therefore, we also mustn't mindlessly increase quantity of dairy as to not flood the market and reduce the price which is already very volatile. Furthermore for the dairy industry, more exports may result in more GHG emissions which can cause negative affects in other areas of the industry. However the world population is increasing rapidly and therefore, we can afford to increase production over time. Increases in quantity produced should be done in a controlled way that follows the market demands and matches that of consumer demand in order to maximise returns to the growers and for our exports.

In terms of increasing price, differentiation and creating scarcity is the key. Zespri has done this very well over the years as they have maintained the SPE status and are able to control the supply going into the market to maximise the price they get in market. Also, the gold kiwifruit that Zespri grows was developed by them and they legally hold the plant variety rights of the kiwi fruit (PVR), and thus are the only ones in the world who can legally grow gold kiwifruit. This scarcity that Zespri has created has resulted in high demand for their fruit in overseas markets, and has helped them become a premium product and differentiate themselves from other kiwifruit, which allows them to sell for more in market. The dairy sector of exports is slightly different. Whilst Fonterra can leverage the New Zealand brand to become a more premium product, the dairy sector is still more of a commodity. Unlike fruit, milk has many killsteps involved where we boil it etc. to become the milk powder, which is resulted from the short shelf life, resulting in the inability to sell it as a fresh product. Whilst the kiwifruit and other fruit we sell can be argued to be a living thing that is eaten by the consumer, this is not possible with milk. Therefore, in terms of increasing the price of our milk through practices on our end, there is lesser potential for growth into the future.

For both these products, we export largely into China to the point that now we are over reliant on China, which now is becoming more of an issue as China has a rapidly ageing population, a declining economy, and high youth unemployment at 21% (Bob Wallace). This has started to open our eyes to the possibility of shifting to other markets such as India, which now has the largest population in the world. Currently, our 87% of our dairy traded is tariffed at 10% or more (DCANZ), meaning that if we were to get more free trade agreements, we could get higher prices overseas. KPMG has put FTA's as 2nd most important for our export earning into the future. Furthermore, opening up more markets for free trade could allow us to increase quantity of kiwifruit and dairy further without flooding markets and sacrificing price (which due to our high costs we cannot afford to do).

In terms of decreasing costs, currently our labour costs and are very high as a result of low labour availability. Ways producers of kiwifruit and milk can combat this is through the implementation of technology into packhouses and other production processes. Cam Taylor has 2 machines that grade the apples and check for defects using AI. Each of these machines replaces 60 workers, which is



very substantial, especially with today's labour costs. It is likely that machines like these will become more and more common in all industries including where it is possible in the processing of dairy, as they will have short payback periods (Cam Taylor's machine have a pay back period of 5 years), and due to artificial intelligence, will improve each day. Furthermore, productivity gains will be seen from these as they can work throughout the night, don't call in sick, don't need a lunch break etc. Producers must innovate in order to combat the rising costs of production, however, this is once again difficult due to the high interest rates. However, it is clear through industry leaders such as Cam Taylor that it is possible for these to be done and for the return on investment to be worth it. Another cost that has become prevalent and will only rise into the future is that of offsetting GHG and other climate related compliance costs. Due to things such as the Paris accord, these are inevitable, and the only and best thing producers can do is to change early. Dairy farmers need to be completely up to date with how they can best manage their farm emissions, and be prepared to change and take in the advice of their grower good organisations. Producers and exporters such as Fonterra also need to invest where possible in sustainable processes. Kiwifruit growers feel these affects less, but can still act early to mitigate or minimise costs related to these areas. Getting these done early rather than later by listening to the GOVT signals of future change helps them avoid the costs to come and remain profitable.

Overall, for the kiwifruit industry, their SPE, Zespri, allows them to control price through quantity, and allows for optimal returns for their products. Zespri has also differentiated itself through its PVR of G3 and sungold variety. Into the future, to manage costs, the kiwifruit sector should look towards the direction of technology and automation in parts of its production to avoid the high labour costs of today. Kiwifruit is likely to remain viable and profitable into the future judging by its good returns, SPE, differentiated product, and room for improvement in terms of technology.

For the dairy industry, the current operating environment is not so favourable. Because of the difficulty to differentiate dairy as a premium product due to its kill steps involved in its production, it has failed to keep up with the increasing costs. Due to its high rate of GHG outputs, it has also be subject to the increasing sustainability related compliance costs that are only increasing each year. In terms of managing costs, dairy must look to decrease their costs in areas such as switching to electric boilers to avoid climate related costs in the future. For dairy, it is extremely important to carefully increase the quantity as a response to the market demand. Most importantly for dairy, opening up new markets with free trade agreements such as India allows us to increase our quantity more. Whilst dairy is currently unfavourable, there is definit hope that it can become more viable into the future.

In conclusion, through the lens of kiwifruit and dairy sectors, producers can look to either increase their quantity, increase price sold, or decrease costs. For the kiwifruit sector, there is great promise judging by today's operating environment, however, the dairy industry will likely need to see some major change. Overall, both industries will require forward thinking minds that can change quickly with the market in order to stay viable into the future.



## Scholarship

**Subject:** Agricultural and Horticultural Science

**Standard:** 93105

**Total score:** 17

Q	Score	Marker commentary
1	4	<p>The candidate, for the dairy production system:</p> <ul style="list-style-type: none"> <li>• identified the relevant greenhouse gases (GHGs) – methane, nitrous oxide, and carbon dioxide – significant in the dairy system and across the different parts of the system</li> <li>• provided a sound discussion of the sources of the three GHGs, but the answer did not fully discuss the costs and challenges of GHG / carbon mitigation</li> <li>• mentioned the importance of the Paris Accord and the issues of not meeting our emission targets, along with the costs associated with research and investment and cost to farmers.</li> </ul>
2	6	<p>The candidate, for apples:</p> <ul style="list-style-type: none"> <li>• provided a detailed discussion of the growth of export value that has been achieved over the past decade. This included the role that trade relations and FTAs played in the industry's growth, particularly with China, and how meeting consumer demands, particularly around sustainable goods, are important both now and into the future</li> <li>• provided a strong discussion on product differentiation along with increased productivity and yields, and production of value-added goods</li> <li>• wrote about potential for future growth with personal connection to customers and the growing use of technology and AI, along with the potential for GE in the future.</li> </ul>
3	7	<p>The candidate in relation to kiwifruit:</p> <ul style="list-style-type: none"> <li>• perceptively discussed for both kiwifruit and milk, the options producers have, in order to maintain profitability and the future viability of the product and its production</li> <li>• included the options for Kiwifruit growers adopting new technologies that not only raise productivity but also can reduce costs like labour</li> <li>• discussed the future viability in the export markets, control of prices and quantity, and the role of new varieties.</li> </ul> <p>The candidate in relation to milk production:</p> <ul style="list-style-type: none"> <li>• has written about the difficulties producers face with a hard-to-differentiate commodity with growing cost pressures around GHG mitigation with respect to milk production</li> <li>• included limitations on future price growth due to the processed nature of the exported milk products</li> <li>• discussed how the growing costs associated with GHG mitigation and sustainability compliance are unfavourable for its future viability and that there is a need for changes to occur.</li> </ul>