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OUTSTANDING SCHOLARSHIP EXEMPLAR



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

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Scholarship 2020 Agricultural and Horticultural Science

2.00 p.m. Monday 16 November 2020
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.

Answer ALL questions from Question Booklet 93105Q.

Start planning your answers to Questions One, Two and Three on pages 2, 8 and 14 respectively.

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.

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

QUESTION ONE: The future sustainability of primary production

PLANNING

dairy

Hareid's environmental risk management authority
New Zealand Act 1991
Substance 8

$\frac{2}{3}$ near unmanageable, $\frac{1}{3}$

100% 147% 2002-2016

79 CO₂-e 56 CO₂-e red
-up 24% 1000 up 55% 1000
24% 1000 net

David Parker birth right

comprehensive & proposed - transpacific partnership
\$26 million Kaitiaki } only ratification by NZ/Japan
\$86 million Dairy

Aus vs. China
- 1/3 exports
- 50% beef tariff
- 4 real exporters

US vs. world
Quotas - 7 million
\$ 1%, 12.7%

Brazil

- common agricultural policy
- \$6 billion, 40% budget

1994 - subsidies, 40% income requires

ag-research - low-allergy milk
HNE research

B
PSA - 50%
\$530 million

Scion-pine trees

85% 4000000000 AUS cotton

9% 1000000

23% methanol

1 & 8 million

1000

PSA

Begin your answer to Question One here:

New Zealand is a country largely dependent on our primary industries with our largest export commodity, dairy, alone accounting for \$17 billion of our GDP in 2018. We as a nation pride ourselves on the quality of our produce, and the reputation which New Zealand cattle products have in global markets. The future of New Zealand's economy will undoubtedly continue to have cattle farming as a key component, but must not be wary of the ~~impt~~ wider implications. Churning out profits is one thing, but to balance ^{intensive} production with maintaining the beauty and cleanliness of our landscape is another. Overall, whilst there are certainly challenges to overcome, emerging technologies, ~~or~~ innovations and effective policy ensure that the future of New Zealand's cattle farming operations will likely be a sustainable. //

Since the era of 'Rogernomics' in the 1980s and removal of all agricultural export subsidies, New Zealand farmers have become productive ~~to~~ cattle cultivators and produce products which are competitive on world markets. It is telling that from 1990-2016, dairy export volume increased 4-fold, with dairy prices rising 17% in the same period. As 90% of our total dairy production is exported, New Zealand farmers are largely dependent on global commodity prices for their

prosperity. Whilst all ^{dairy prices} ~~they~~ have been trending upwards over the past few decades, New Zealand is vulnerable to sudden downturns when ~~dairy prices~~ milk solid prices reached a historic low in 2018. There is certainly some volatility in the market and no guarantees on prices, however given rising ^{global} population and rapidly growing markets (especially China where most of our dairy exports go), the economic future of cattle farming in New Zealand appears sound. Work towards ^{free} trade agreements, too, are beneficial to New Zealand cattle/dairy farmers, and increase the competitiveness of New Zealand products relative to domestic substitutes.

~~The evidence that NZ is still~~ The Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) currently in the works would see a \$86 million ^{annual} reduction in the tariffs imposed on NZ exports. This includes Japan completely removing tariffs on cheese, & Indonesia removing tariffs on liquid milk over a 16 year time-frame. Should NZ negotiate effective trade deals, the economic future for NZ cattle farms would appear to be sustainable. However, it is notable that on the world stage, New Zealand's influence is still rather limited as a small economy. The previous TPP, for example, was only ratified by NZ & Japan, with NZ helpless in the face of the USA refusing to agree to the deal. One might say that New Zealand is in a submissive position to its larger trade powers, and lack

the means to negotiate the most favorable trade conditions. Especially in the current climate where ~~protectionism~~ populist leaders are employing protectionism to guarantee domestic interests, we must be wary of the economic viability of NZ cattle farming in the long-run. Nonetheless, ~~as with countries like Britain opening their markets~~ Despite these threats, NZ's dairy industry is still likely to prosper ^{economically} in the long-run due to growing global demand trends, and the reputation and market power of a company like Fonterra.

The social and environmental viability of cattle farming go hand in hand, as one is likely to lead to the other. From 2002-2016, the area used for cattle farming increased by 47%. Whilst this represents a greater output and economic market power, we must also consider the environmental impacts. Some of this land will have been repurposed from sheep (given the loss of subsidizing in 1984 and reduced profitability), however much of this will have also been land cleared for the purpose of agriculture. Trees ~~serve~~ play a vital role in the uptake of CO₂ from the atmosphere, and expanding production of cattle has significant detrimental environmental impacts. It is somewhat telling that from 1990 to 2018, NZ's ^{gross} greenhouse gas emissions increased 17% to 79 ~~million~~ million tonnes carbon dioxide equivalent metric

tonnes ($\text{CO}_2\text{-e}$), while ~~net~~^{net} greenhouse gas emissions increased by 57% to 55.5 million $\text{CO}_2\text{-e}$. Not only do larger cattle heads produce more air pollutants, but the loss of trees and heavy vegetation result in less CO_2 being absorbed and stored back in the earth. b

As it currently stands, 24% of our gross pollution is from ~~methane~~^{methane} cattle methane alone. ~~the~~ Over a 20 year period, methane will trap up to 84 times more heat than CO_2 , so is a large contributor to ~~greenhouse~~ global warming. As long as New Zealand's ~~export~~ cattle-farming operations grow, the environmental pollution will continue to worsen. The picture is rather bleak, ^{as it stands} however emerging technologies ~~present~~ present potential for a sustainable future. Seaweed cattle feeds have been found to reduce cattle methane production, as has ~~high~~ High Metabolizable Energy (HME) ryegrass, said to reduce cow methane emissions by 23%. These innovations present the key to an environmentally sustainable future, however must come with appropriate research and public policy to ensure effective implementation. HME ryegrass is a GMO, and has been approved by the Environmental Risk Management Authority (ERMA) for testing in NZ. Very soon, we will need to confront the legislative issues of adopting GMOs and other new and controversial technology into our farming processes. Whilst not

all will welcome changes, they are necessary to ensure the future environmental viability of NZ cattle farming. h

With cattle farming also comes the issue of water pollution. Effluent run-off can cause eutrophication in our waterways, eroding both the environment and health of our ~~people~~ population. A Greenpeace survey found that $\frac{2}{3}$ of NZ waterways are unsuitable, while ~~the rest~~ $\frac{1}{3}$ are polluted beyond repair. This is an unfortunate by-product of cattle farming, and hampers all individuals. Minister for the environment David Parker describes how "clean water" is a birthright, and how all Kiwis should be able to go down to the local river and have a dip. The balance between preserving natural beauty for all to enjoy and the economic ~~benefit~~ ^{livelihood} is certainly a precarious one, however it seems clear which ~~one~~ one the people prefer. In a 2018 survey by ~~the~~ Game and Hunting New Zealand, 82% of respondents believed that ~~that~~ there should be more stringent water pollution measures. This percentage was even greater than those who voted to address rising house prices or child policy as a primary government ~~concern~~ ^{water} concern. Reducing ^{water} pollution can be costly to farmers, especially considering how the use of Riparian buffer zones around waterways results in a lesser area of productive grazing.

QUESTION TWO: Global trade disruptions/changes

PLANNING

CPTPP

good business
tariffs ↓

Brexit

1984 subsidies from EU
return to free trade with Britain

China vs US

- global uncertainty
& hostility

China vs Australia

BUT sustainability

CAP

protectionism BAD
for isolated NZ

Moral vs pragmatic response

Begin your answer to Question Two here:

ASSESSOR'S
USE ONLY

In recent years, the global political climate has ~~was~~ been one marked by uncertainty and volatility. ~~Especially~~ Especially revolving around the populist leaders of Boris Johnson and Donald Trump, we have seen an attempt to leave the EU and a trade war with China to protect domestic interests. For a country like New Zealand, there are both threats and opportunities from this turmoil. In a similar vein, there are both ~~threats~~ difficulties and opportunities in New Zealand ^{itself} forming political agreements with other countries. Ultimately, trade is inextricably tied to politics, and ~~the~~ both cattle farming and kiwifruit cultivation are affected.

Free trade, and especially ~~the~~

1 The CPTPP, ~~are~~ ^{are} agreements which presents significant potential for a New Zealand, as ~~they have~~ ^{they have} a direct impact in increasing access to global markets and removing barriers to trade. Under the CPTPP, NZ is expected to see an ^{annual} reduction ~~of~~ of \$26 million in kiwifruit tariffs, effective immediately on ratification. Similarly, the dairy industry is expected to see an \$86 million reduction, with ~~the~~ Japanese cheese tariffs and Indonesian liquid milk tariffs being removed completely over 16 years. Clearly, there are significant economic benefits to be had, which present significant potential. The dairy and kiwifruit industries already generate \$17 billion and \$1.8 billion in export revenue respectively, with the

Free trade agreements likely to further ~~the~~ trade activity. A reduction in tariffs likely sees NZ products more competitive relative to domestic or other imported substitutes, which ~~rather~~ increases demand for them over time. While free trade agreements are beneficial on paper, they may not necessarily materialise. The USA, for example, refused to ratify the old TPP, ~~at~~ leaving the entire agreement null and void. ~~Only~~ NZ is only a relatively small power on the global stage, so direct global ~~agreements~~ political agreements which are mutually beneficial may be ~~hard~~ ^{hard} to come by. Nonetheless, there is significant opportunity available to seize.

~~Similarly~~ Political agreements/disagreements between other nations, too, impact on New Zealand, and there is scope to capitalise. Prior to the UK joining the EU, they were New Zealand's main trading partner and purchased the majority of our dairy and cattle products. However, the Common agricultural policy (CAP) of the EU put an end to this, with large ^{and subsidies} tariff walls ~~designed~~ to raise internal European prosperity. At last count, the subsidy ~~came~~ ^{came} in at \$65 billion USD, representing 40% of the EU's entire budget.

Brexit and other instances of disagreement create scope for New Zealand to increase their own trade, and make up for some of the lost benefits. Without the ~~the~~ EU, Britain must look elsewhere to import primary produce as the ~~potential~~ ^{potential} lose the internal free trade and subsidy advantages provided by the

EU. There is potential for New Zealand to ~~rekindle~~ its historic ties with the UK, finding in them a partner for kiwifruit, and especially dairy, and reducing dependence on the Chinese & Australian markets.

Whilst there are opportunistic advantages for NZ to have from the disputes of others, the wider implications of ~~the global~~ a restricted global market are not beneficial for NZ. As a relatively isolated ~~the~~ nation, NZ relies on ^{international} trade for economic prosperity and sale of our primary output. Especially with China and the US's trade wars the entire 'tone' of global trade began to flip hostile and adverse to New Zealand's interests. If we consider both Fonterra and Zespri, they represent the dairy and kiwifruit industries in NZ respectively. Both co-operatives operate a 'single-entry model' where they supply global markets on behalf of all the farmers/growers in New Zealand. This leaves our primary industries especially vulnerable to ~~sanction~~ sanction, and any international dispute could have devastating consequences. As we saw recently ~~with~~ Australia, they endorsed ~~an~~ effort ~~to~~ in May to probe China and discover the true source of the Covid-19 outbreak. This created political tensions between the nations, with a 80% barley tariff and ~~ban~~ of ban of 4 Australian meat exporters quickly introduced. Should this have been NZ

instead of Australia, direct sanctions on Zespri or Fonterra would have had devastating impacts on our primary ~~industry~~ ^{industry} and all those who work in it.

In such a fragile global environment, then, political events may lead to moral and ethical questions of NZ's international relations. It is notable that NZ did not directly challenge China in the same way Australia did, choosing not to practice "foghorn diplomacy" and overt signalling of New Zealand's position on the matter. It is important to reiterate time and time again that NZ is a relatively small player in the global market who are dependent on its trading partners for economic prosperity. NZ is forced to navigate the tensions relationships and tensions between China, the US and Australia, ~~keeping~~ ^{maintaining} close ties to each nation without sparking retaliation from the others. This may ~~involve~~ involve leaving controversial issues untouched or signing less than favourable agreements to keep their parties happy. The ~~live~~ ^{live} export of cattle to China, for example, has not been ~~on a practice~~ ^{a practice} approved by the general public or animal rights activists. ~~Therefore,~~ ~~our~~ ~~reliance~~ ~~on~~ ~~our~~ ~~trading~~ ~~partners~~ ~~are~~ ~~reliance~~ ~~on~~ ~~our~~ ~~trading~~ ~~partners~~ ~~may~~ ~~supercede~~ ~~these~~ ~~ethical~~ ~~considerations,~~ ~~and~~ ~~also~~ ~~open~~ ~~the~~ ~~threat~~ ~~of~~ ~~exploitative~~ ~~and~~ ~~unfavourable~~ ~~trade~~ ~~conditions~~ ~~for~~ ~~NZ.~~ ~~||~~

Ultimately, global political events play a large role in the export and production of NZ primary output. ~~Two~~ Two important industries, cattle and kiwifruit are able to realise benefits from free trade agreements and new trading partners, however may also be hurt by the dominance of NZ's trading partners. Politically relations are increasingly complicated, and New Zealand must negotiate carefully through its agreements and relationships in order to guarantee long-term prosperity and the welfare of our primary industries. //

QUESTION THREE: The position of genetic modification in New Zealand's primary production sector

PLANNING

intro definition

disease resistance
favourable trait selection

consum
production
environmental

(apple)
(lemon fruit).

public perception
opportunities cost - 'GMO free' premium

regulation - capacity
ethics regarding animals

Begin your answer to Question Three here:

Genetic modification involves direct intervention by scientists in the genetic code of an organism in order to achieve more favourable traits. Contrary to selective breeding where ~~traits~~ desired traits are cultivated and picked over many generations of plants/animals, genetic modification can be done in a lab ~~and~~ in a far shorter time frame so long as the right genes can be isolated, and changed/inserted. Modern technologies like CRISPR make GM an incredibly straightforward process nowadays, with home GM kits now available for hobbyists. It is somewhat telling that millions of hectares of crops around the world are GM, representing about 15% of total production. The possibilities in terms of yield, variety and flavour ~~that~~ for GM ~~grows~~ crops are endless, but we must tread carefully given ^{negative} the public perception, ~~unavoidable~~ ^{unavoidable} consequences and increasing value in non-GM plants. //

The ability to quickly and precisely select for favourable traits is an immense advantage, and offers tangible benefits for all those who cultivate and consume primary output. In 2010, ^{the bacterium} ~~the~~ PSA was introduced into New Zealand and decimated our kiwifruit industry. It was estimated that 80% of the national crop was affected, resulting in a \$930 million loss in export revenue. GM allows us to engineer disease resistance in the crops, allowing the creation

of pesticides and insecticides by the plant itself. In Australia, GM cotton has been a great success, with crops needing 85% less insecticide. This helps protect yields and ^{lessens} vulnerability to disease, whilst also reducing the cost and health implications of using synthetic pesticides to ~~protect~~ protect our crop.

GM, too, can help us limit the environmental impacts of agriculture, with new plant strains showing promising signs in reducing methane emissions of ruminant animals. High Metabolisable Energy (HME) ryegrass not only promises a 90% reduction in water irrigation needs, but also leads to a 8% increase in nutritional value and 23% reduction in methane emissions. HME ryegrass is engineered to have a greater lipid content, which is toxic to the bacteria in animal ~~stomachs~~ stomachs which produce the methane as a bi-product of their respiration. With growing global populations and demand for food, GM crops present an environmentally sustainable way forward for the NZ primary production sector.

On the consumer side, GM allows for unprecedented choice and new varieties of produce. Traditional selective breeding programmes can take decades to result in the perfect consumer product, as was the case for NZ apple varieties such as Jazz and Pacific Rose. It takes up to 5 years for a single apple tree to flower, with selective breeding taking place over 5-6 generations. In the same time, CRISPR allows

for the insertion of foreign genes which reduce flowering time to 1 year. Ultimately, GM measurably shortens the time from development to market, giving consumers greater choice. Innovative products like 'snaples' or red kiwifruits ~~may take less time to be created~~ can be created in less time ~~and~~ with GM, and also give a novelty factor to consumers. Unique products justifiably ~~come~~ ^{come} with a premium, which may reap economic benefits for the cultivators in the first place. ||

Whilst GM presents innumerable opportunity, it also comes with challenges — most notably, public perception. The scientific consensus, as given by the ~~outgoing government~~ ^{science} ~~adviser~~, is that there are "no significant ecological or health concerns associated with the use of advanced genetic technologies". However, this has not come ~~and~~ without skepticism from the public and concerns about the side-effects. New Zealand currently operates on an extremely cautious GM ~~framework~~ ^{framework}, the Hazardous Substance and New Organisms Act 1996, introduced in the early stages of GM technology. Any GMOs used in NZ must go through a staged approval process ^{by the Environmental Risk Management Authority} — it is telling that only 3 ~~products~~ ^{products} are ~~only~~ allowed to be scientifically tested in NZ — Scion's hardy pine trees, and AgResearch's low-allergy milk & HMT ryegrass. Public consensus is similarly conservative, with upproven ~~fears~~ ^{fears} of the adverse health & environmental ~~implications~~ ^{implications} of using GM to 'play God' in nature. Whilst the "facts"

Whether GM is good or bad, it is a controversial issue, however

of the matter may point to a safe reality behind GM, public perception is a whole separate challenge which poses a hurdle to the introduction of GM.

In a similar vein, ethics, too, must be addressed. When it comes to plants and crops, little consideration is made of these organisms as sentient beings. However when it comes to animals, GM may lead to ~~an~~ more concerns. The nightmare stories of KFC chickens in America being overly fattened to the point that they cannot stand up are real concerns, and the introduction of GM is able to start the normalisation of modifying nature. In search of better yields, better flavours, faster growth rates, scientists ~~have~~ ^{have} considerable scope to play with in genes. There are reasons why GE ^{human} embryos cannot be developed past a certain stage of life, and there are real ethical concerns with animals and agriculture, too. What we do not need to do is normalise a society in which animals and crops are engineered beyond recognition to serve the utilitarian purpose of nutrition for us, and profits for farmers.

Finally, GM offers a challenge of its opportunity cost — what would we lose with a move to GM? It is true that "once you allow GMO, you can't go back", and allowing genetic engineering would have irreversible consequences on NZ's primary industries. As a

nation, we have spent years cultivating a 'clean, green, image', and GMO would likely tarnish this image. As the third source notes, GM forces NZ to compete on raw productivity in international markets. On the contrary, a GM-free label would provide product differentiation, and likely command a premium on world agricultural markets. NZ is faced with a difficult choice between pragmatic & production, and natural & perceivedly 'premium' cultivation. Whilst science has not ~~not~~ shown adverse GM health effects, consumers, in the long-run, likely will value increasingly something 'natural', which would render the benefits of GM lesser than the associated costs & loss of benefits from 'natural' agriculture. h

Ultimately, GM provides endless opportunity, but also drawbacks which must be addressed. The ~~clear~~ practical value ^{of GM is} ~~clear~~ clear & proven, however public perception is a difficult notion to overcome. In the coming years, consumers will increasingly look for that natural, GMO-free product, & NZ faces a difficult choice as to whether GM is worth it. h

Extra space if required.

Write the question number(s) if applicable.

ASSESSOR'S
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1) land. While ~~some~~ ^{some} farmers will suffer economic damage, the preservation of NZ's natural beauty is an important social & environmental goal. Apart from being valued by many recreational users, we must also respect the spiritual connection which Maori have to the land and water, and ensure the preservation of our country.

Ultimately, the future of cattle and dairy farming ~~is~~ ^{is} rather bright, with significant economic potential. As a ~~developed~~ ^{developed} country, NZ is unique in its reliance on agriculture. However, our economy is likely to be well supported in the long-run, with the focus mainly on managing the trade-off with environmental and social factors. The government must play an active role in encouraging the development and implementation of new laws and technologies, which are necessary to achieve ~~truly~~ ^{truly} holistic long-term sustainability.

Extra space if required.
Write the question number(s) if applicable.

ASSESSOR'S
USE ONLY

QUESTION
NUMBER

Outstanding Scholarship Exemplar 2020

Subject	Agricultural and Horticultural Science		Standard	93105	Total score	20
Q	Grade score	Annotation				
1	07	<p>The candidate has articulated an insightful response to the question. Consideration of a wide range of relevant factors to the sustainability of dairying is evident with detailed discussion of aspects like the role of emerging technologies and innovation.</p> <p>All three sustainability aspects (economic, environmental and social) have been discussed with accurate and appropriate data and astute, perspective statements. Some 'clumsy' structuring or wording (e.g. 'cattle farming') was the reason for a 7 and not an 8 being awarded.</p>				
2	05	<p>The candidate has presented a relevant discussion or response using Kiwifruit and Dairy as their two contexts.</p> <p>Threats and opportunities that trade disruption presents to these two primary production systems have been discussed along with a consideration of New Zealand's position or strength or lack of within global trade.</p> <p>Vulnerabilities of New Zealand's primary production systems have also been effectively discussed along with the links between politics and trade.</p> <p>A good 'Scholarship' level response overall.</p>				
3	08	<p>The explanation of genetic modification (GM) and how it is carried out is coherent and clear.</p> <p>A balanced, considered discussion of the potential benefits or opportunities that GM presents to the kiwifruit industries is presented with the PSA outbreak and cotton used as examples in their justification. HME ryegrasses and their benefits to the livestock sector are also relevant and discussed from potential consumer benefits perspective.</p> <p>An insightful discussion includes the risks and challenges GM presents – society's often conservative position on this sort of innovation along with a general lack of knowledge, a degree of mistrust of science and the 'normalisation of nature'.</p> <p>In summary, a perceptive or insightful discussion of the opportunities that GM may offer or provide, and the challenges it presents to New Zealand's primary production systems and hence society as a whole.</p> <p>Well-structured, clearly discussed answer, with little superfluous material.</p>				