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TOP SCHOLARSHIP

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Scholarship 2019
Agricultural and Horticultural Science

2.00 p.m. Friday 8 November 2019
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: SUSTAINABLE PRIMARY PRODUCTION AND CLIMATE CHANGE

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PLANNING

Use this space to plan your answer to Question One:

How contribute to NZ GHG emissions (Dairy)
~~4~~ 49%, 25%, 3 ~~bt~~ CO_2 eq / 6 million

How contribute - 13.5% ↑ 1990

GWP/ - N_2O
- CO_2
- CH_4
How produced.

Effects - ~~Productivity~~ ↑
- temp, wind, drought, rainfall
- flood, cyclone

Impacts to ~~system~~:

Implications - water ~~quality~~ / Ag productivity
- refugees
- LU changes / cost
- pest / diseases
- cultivars

regulations

Impacts: - regulations
- ~~changing LU~~
- drought.

Challenges:
- remaining productive
- new technologies not available yet (future mit - breeding, vaccine

Begin your answer to Question One here:

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Agriculture contributes 49% of New Zealands global emissions while dairy alone contributes 25% of those emissions. Between 1990 and 2017 greenhouse gas emissions increased by 13.5% through increased intensification, and synthetic ~~fertisi~~ fertilise usage. A single dairy cow emits approximatly 2.74 t CO_2 eq / year, while a sheep emits on average ~~around~~ 0.42 t CO_2 eq / year. With a national dairy herd of 6 million and sheep flock of 27 million this leads to considerable annual ~~agri~~ agricultural greenhouse gas emissions. Furthermore, emissions are also produced through transport and processing, with Fonterra emitting 1.17 million t ~~CO~~ CO_2 eq / year.

Methane (CH_4) is ~~typically~~ produced in the rumen of ruminant animals such as cows ~~am~~ by the methanogens, and then emitting when animals belch (95% of CH_4 emissions). Methane has a global warming potential ~~of~~ that is 28 times higher and CH_4 remains in the atmosphere for around 12 years. Arother significant greenhouse gas produced by agriculture is nitrous oxide (N_2O). Nitrous oxide is produced when urine patches as well as nitrogen fertiliser is broken down

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by microbes in the soil. Nitrous oxide however has a global warming potential 280 times higher than CO_2 and remains in the atmosphere for a century. CO_2 (carbon dioxide) is largely produced through transport and processing, ~~however~~ rather than on farm, lower ~~CO_2~~ Carbon dioxide (CO_2) remains in the atmosphere for up to 1000 years.

The greenhouse gases produced and their increasing concentration in the earths atmosphere are resulting in significant ~~forecast~~ climatic changes expected by the end of the 21st century. Even under a low greenhouse gas emissions scenario (under paris agreement) NZ annual temperatures are expected to rise by 0.8°C by 2090 however this figure could be as high as 3.5°C in a high emissions scenario. Rainfall is also expected to change ~~across the regions~~, varying in effect across different regions. For example in the ~~West~~ West Coast of the South Island annual rainfall is predicted to increase by 5-10% by 2090, however in other regions for example the wairarapa annual rainfall is expected to decrease by 2.5 - 5% in this time. In regions such as the Wairarapa this rainfall

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decrease coupled with increased temperatures will increase the frequency of drough events. From a dairy producers perspective droughts have significant adverse effects, not only do production costs increase through higher demand for supplement feeds which must be outsourced but the water requirements will also increase. Daing farming systems already have high water requirments, however environmental concens could result in more regulated water taxation in the future. This threat alongside the potential decrease in rainfall resulting from climate change could result in severe negative implications to daing production systems as cost of productions would rise will supply would decrease, ultimately decreasing profitability. Alongside the temperature increase, exotic pests and diseases could potentially become more prevalent while new weeds are likely to thrive in the new climate. This could also increase costs through having to experiment with new drenches, vaccines and pesticides. Associated costs through changing on farm cultivar species to suit the new environment could also negatively influence daing productivity.

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Regulatory and legaslative requirements are also likely to increase as the government becomes more concerned about reducing emissions. For example some new regulations suggest expanding riparian buffer zones to 5m each side of the waterway. This would significantly reduce effective land area decreasing profitability. While the 'sustainable dairying, water accord' has already resulted in 26,000 km of waterways being fenced on dairy properties, stock exclusion rules regarding stock exclusion from drains could become even more strict in the future thus increasing costs to meet new regulations.

While it is estimated that current if all current good practices were implemented greenhouse gas emissions could be decreased by 10%, new technologies and innovations will be required in order to meet the targets laid out in protocols such the Paris Agreement and Kyoto Protocols. However, these new technologies also have challenges. For example breeding low emitting animals is considered to be one strategy to mitigate emissions however

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is ~~projected~~ to decrease ~~or~~ CH_4 emissions by only 5%. While taking at least 20 years to breed the low emitting trait though the NZ dairy herd. Other ways of minimising the impacts of greenhouse gas emissions and thus the impacts on dairy production is through a methane inhibitor. ~~[illegible]~~ This is currently being developed in Germany ~~[illegible]~~ an is expected to decrease CH_4 emissions by 30%. however the logistic feasability of implementing this ~~in [illegible]~~ may restrict its effectiveness in NZ ~~as~~ as it has been developed for the feedlot systems in europe and ~~therefore~~ also may not be readily available in NZ for a number of years.

~~[illegible]~~, ~~[illegible]~~ While NZ emissions per capita are the 5th highest in the OECD (18 t CO_2 eq/person (year)), 90% of new zealands agricultural greenhouse gas emissions are associated with consumption internationally due to high export nature of ~~the~~ New Zealand primary production. It is therefore more accurate to compare emission intensity across countries, and this comparison could positively benefit the NZ dairy industry. NZ emits 0.87 kg CO_2 eq/kg milk solid produced, which to a global average of can be compared

continued on pg 21

QUESTION TWO: CONSUMER PERSPECTIVES WITHIN THE GLOBAL ECONOMY

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PLANNING

Use this space to plan your answer to Question Two:

consumer trends dairy

- grass fed antibiotic free
- Sustainably produced
- bobby calves ⇒ new generation beef 8-12 mnth.
- ~~global exports~~ Cha marketing emotive
- Clean green NZ
- milk bottles
- online - Alibaba Tmal 15m Yangtze River

Happy cow company

value add
- lactoferrin
- manuka
- cream cheese.

S+B + wool

- Taste pure Nature
- emissions friendly (4x ↓ than domestic UK)

75% millenials by 2030.
82% stop buying from company if unethical

sustainable alternative Allbirds / Icebreaker.
ethically produced

VF corp. — vans North Face.
- $10m/year 10 yr supply contract with also relates to rights to use NZ story imagery in marketing

- Anchor recycling bottles Shampoo
- LRC: Recyclable material 100% in 5yrs

Begin your answer to Question Two here:

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By 2030 75 i. of the global workforce will be made up of those in the 'millenial' generation. These consumers are not only more ethically, ~~minded and~~ environmentally and socially responsible than the generations who came before them but are also demanding more and more tracability and transparency into where their products come for. ~~These for:~~ The changing dynamic of the workforce and their perspectives are driving innovation across the New Zealand primary production systems in order to ensure future sustainability for the industry.

Globally, consumers are becoming more aware of their own personal environmental footprint as well as where their foods come from. This is increasing global demand for New Zealand primary products due to our uniquely grass fed, free range, hormone/antibiotic free system., This is largly due to the stark juxtaposition between NZ farming systems and country of origin farming system especially in countries such as the USA and China where feed lots are prevalent. However capatilising on the ~~nature~~ unique nature of New Zealands primary production systems is crucial in order to increase awarness and demand

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This has driven innovation in the marketing of New Zealand primary products especially red meat. In 2018 the origin brand 'Taste Pure Nature' was launched in order to differentiate ~~the~~ NZ red meat producers and tell the NZ story on a global stage. This is anticipated to be as succesful as the 'True Aussie' campaign implemented by Australia which has allowed for ~~increased~~ a premiumisation of their red meat products ✓

NZ ~~dairy~~ dairy producers have also innovated through production and marketing to better meet the demands of the 21st century conscious consumer. 82% of consumers surveyed in 2016 said they would stop purchasing from a company if said company was found to be unethical and unenvironmentally friendly. This is driving companies such as Anchor to become more socially responsible, and they have recently started a new initiative to recycle their lightproof bottles. This involves a partnership with a ~~hospit~~ company which provide mini shampoo/conditioner bottles to the ~~New Z~~ hospitality industry, ~~who~~ who now manufacture a range of those bottles made of 100% ~~light~~ recycled lightproof milk bottles.

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Fonterra has also started a new initiative to help urban consumers gain appreciation and trust in the dairy industry. This month that have been running a programe called 'open gates' where dairy farmers will literally open their gates to ~~urbans~~ allow consumers to come on farm and see what farmers are actually doing in terms of environmental sustainability and animal welfare. This initiative allignd with modern consumer values of traceability and transparency right back to ~~a farms~~ an on farm level.

~~Microdairy~~ On a smaller scale microdairy companies are also meeting consumer demands for sustainably and responsibly produced products. Lewis Road Creamery already make some of their milk bottles using recycled plastic and ~~ha~~ are the first dairy company within NZ to commit to achieving ~~100%~~ a target of using milk bottles made of 100% recycled materials within the next 5 years. The Happy Cow milk company - a microdairy company - have also innovated their production system. While Happy Cow Milk co only supply a small volume of product locally, this aligns with ~~trend~~ increasing trends to ~~eat~~ consumer products produced seasonally and locally. Happy Cow milk co.

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have also employed emotive changes to their practices, through the development of portable milking sheds which can be taken ~~on~~ in paddocks and allow for calves to be left on cows. This alleviates one of the most contensious issues surrounding the current daing system which is of keey concern to ~~environmental activists~~ animal welfare activists. It is likely that in the future the practice of slaughtering bobby calves ~~with~~ at 4 days old will be phased out amidst the ethical concerns regarding the practice. ~~This~~ This threat to the industry has driven innovation in production with 'new generation beef' a potential solution the issue of Bobby calves. This is being researched currently at Massey University and involves a ~~cross breed~~ cross breeding between Kiwicross and Hereford and raising these bobby calves to 8-12 months ~~before~~ ~~This new beef product~~ before slaughter. Not only would this be more ethically responsible but it would also decrease the environmental impact of beef production. This is because when calves are raised for one year rather than two, they don't winter twice, and can also utilise the spring

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pasture flush. As they are less heavy there is also less soil compaction and erosion which in turn increases soil carbon reducing emissions. This new generation beef product would also suit the health conscious consumer as the younger animals at slaughter result in ~~lower f~~ leaner meat, however the higher % collagen content retains tenderness. This is because collagen is soluble and dissolves in cooking meaning high fat content isn't required to maintain meat tenderness.

Ultimately it is the consumer who controls and dictates what occurs on farm & and off farm, ~~as~~ in order to remain relavent a in the changing dynamic of the 21st century especially as consumers ~~become~~ trends relating to primary products change, producers must adapt to meet these demands

QUESTION THREE: CHANGES IN LAND USE IN NEW ZEALAND

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PLANNING

Use this space to plan your answer to Question Three:

Q 2 primary production systems.

S+B, Dairy implications LU changes 20 years

S+B	Dairy
social - Forestry conversion - Urban spread Population increase. -	- increased wealth. - growing rural urban divide mental health
Economic Forestry returns	Dairy — subsidies removed / land increase — canterbury — Technology — wealth/exports to commodities
Environmental sequestration	forestry — decline market returns, political, conversion back, social employment S+B — urbanisation spread — conflict, prices, pop growth

Begin your answer to Question Three here:

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Sheep and beef farming operations have dominated the New Zealand landscape for the past 150 years, and have become central to not only New Zealands economy but also ~~the~~ to ~~its~~ our national identity. However, in the past 20 years economic, social and environmental factors have driven changes in land use away from Sheep and beef farming systems, ~~away from~~ ~~this and towards a number~~ with significant increases in dairy farming systems.

~~In the~~ Between 2002 and 2016 the area of land under dairy farming systems increased by 42%. This increase was driven by ~~the~~ a ~~decrease~~ decline in the relative profitability in sheep and beef farming operations following the removal of subsidies in the 1980's in conjunction with an increase in profitability and exports of dairy. Since 1990 dairy exports have increased by ~~4 times~~ ~~while~~ a factor of four while the milk prices have increased by 17%. Initially ~~this~~ the favourable economic returns ~~for~~ from dairy as opposed to sheep and beef operations drove the land use change. However, technological advancements and ~~relatio~~ foreign relations

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and free trade agreements have increased the significance of NZ dairy exports and opened up new markets such as China. ~~the~~ ~~dairy~~ Dairy products now constitue 75% of New Zealands export wealth while ~~of~~ more than 90% of New Zealand dairy products are exported. Technology has also driven marked land use changes in specific regions for example in Canterbury between 2002 and 2016 dairy land increased by 155% with a 255,000 ha converted during this time, ~~through the advancements~~ This ~~conversion~~ land use only became possible in the canterbury region through advancements in irrigation allowing for the high water requirements of dairy to be sustained, as the regions historically low annual rainfall previously was unable to sustain this. This increase in dairy farming operations has impacted the Canterbury region through increased wealth ~~following~~ flowing into the rural communities, and increased employment as well as related services benefiting. This social and economic implication has also therefore been observed on a national scale, and has ~~benefited~~ the increased the wealth of provincial NZ. As a whole dairying contributes $8 billion to New Zealands GDP 11

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However, the environmental implications of the increase in dairy have also been observed through increases in syntletic fertiliser usage and subsequently nitrate leaching as well as through emissions. Since 1990 syntletic fertiliser usage has increased by 650%. While nitrate leaching has increased by 29%. These issues help perpetuate the stigma and negative perception that ~~is withheld~~ surrounds dairy farming, as well as stimulating media backlash. 42% of New Tealanders withhold a negative view on dairy farming and amidst growing environmental concerns this figure is likely to increase. ~~There~~ As Climate change and its effects have become more publisised dairy producers are under ongoing scruting from the public, as dairy farming alone constitutes 1/4 of total greenhouse gas emissions. This scruting is resulting in ever increasing legislative and regulatory requirements which are subsequently increasing cost of production. ~~impressed~~ For example methane reduction targets under the Paris agreement of between 24-47%. reductions by 2050 will likely require up to 22% reductions in stocking rates thus markedly decreasing ~~return~~ profitability and returns (even ~~with~~ alongside relative genetic gain and increases in efficiency). The growing pressure on

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producers ~~As well as~~ especially those in the dairy sector is resulting in increased stress levels and mental health issues. Those living in rural communities are aproximately 24% more likely to comit suicide than their urban counterpart and are often unable to access help due to geographic isolated in conjunction with stigma surrounding asking for help. However, this has driven several new initiatives such as 'Farmstrong' and 'A Will to live' which are offering mental health support to those in rural areas. y

$ Between 2002 and 2016 Sheep and beef farmed land area has decreased by 19.8%. This has been driven by decreased profitability of sheep and beef farming operations as well as political ~~influences~~ and environmental influences ~~as well as population growth within New Zealand~~ to reduce greenhouse gas emissions through carbon sequestration in trees. Under the 1 billion trees programe it is ~~Sug~~ recomended that 1.3 - 2.8 ~~bill~~ million hectares of marginal sheep and beef land in NCw Zealand be converted to forestry by 2050, and this initiative requires planting rates of aproximatdy 100,000

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hectares per year. This change is driven through government incentives and grants under the One billion Trees programme as well as the possibility of a € in carbon credit income under the emissions trading scheme and less strict regulations surrounding foreign investment in forestry. In the past 12 months in the Wairarapa region alone 12 large sheep and beef properties have been sold and converted into pine forestry. This includes the particularly ~~sign~~ historically significant 1,006ha Hadleigh Station which was sold to Austrian aristocrisy and converted to forestry. Furthermore, in the past 3-4 months alone 18,000 ha of sheep and beef land in the Tararua & Wairarapa have also been converted. While intially this ~~conversion~~ results in increased employment through the conversion itself ultimatly it will detrimentally impact these regions. Not only are these ~~regions~~ sheep and beef farms engrained within the identity and history of these regions, but they also contribute to their local economies as many small rural areas and rural schools are supported by the wealth of local farms. Due to the nature of forestry employment will also decrease in the long term.

continued...

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

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QUESTION NUMBER

3. However, relative profitability of forestry is under the ETS ~~is~~ extremly favourable. In the land classes 6-7 returns from forestry are approximately 5 times higher than that of sheep and beef. This profitability is also forecast to increase considerably as the current carbon price cap of $25/t is expected to be removed in the next few years which could drive up the carbon price to at least $50/t and possibly $100/t or higher. This ~~relative~~ profitability through carbon credits relative to harvest itself could also ~~be~~ mean thinning and pruning of forests are minimal as a cost saving measure. This decreases the harvest value further and alongside the challenging topography of the sheep and beef properties typically being converted could result in some forests never being harvested reducing the ability for the land from being developed further in the future ~~Also as it is often~~ As much of this forestry conversion is occuring within regions across the East coast of the

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

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QUESTION NUMBER

3 North Island This could impact New Zealands ability to meet December lamb export markets in the future. The increase in forestry in these regions (which due to their drought prone nature and early weaning are often able to ~~meet~~ supply lambs in December) will hugely decrease stock numbers in these regions. Thus leaving a potential gap in NZ december lamb supply (where prices are significantly higher (≈$0.20/kg cw) ~~difference~~ than in January/February)

1 2.4. ~~Therefore~~ The emissions per unit of milk solid produced in NZ have also been decreasing by an average of 1% per year since 1990. Therefore the ~~relative~~ efficiency of NZ dairy ~~prod~~ emissions relative to other countries offers a potential positive opportunity for New Zealand dairy producers to differentiate themselves from competitors. ~~This~~ This however is challenged by the perception of 'dirty dairying' and the statistics which portray NZ dairy as particularly un-environmentally friendly

continued

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Write the question number(s) if applicable.

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QUESTION NUMBER

1 Marketing would also be required in order to capatalise on this relative efficiency and educate consumers about NZ dairy production, ~~however that is~~ ~~is unnecessary~~

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

QUESTION NUMBER

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