

A contribution to Singapore's food future

Linking food security,
animal welfare,
and animal product based diets

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This briefing provides a summary of links between higher animal welfare and food security, highlighting that the former does not have to compromise and in a number of ways can enhance the latter, if a broader view of security is taken. It then considers the implications of diets high in animal products from food security perspectives.

These are complex topics and reform cannot happen overnight. I hope that this briefing contributes to the start of a longer dialogue between politicians, relevant ministries, the animal welfare community, health advocates, environmental organisations, and broader society. Hopefully the briefing sets out a structure for further investigation, deliberation, and subsequently adoption of measures that will be of benefit to Singapore and its citizens.

The briefing proceeds by defining the terms food security and animal welfare before drawing links between the two concepts. It then considers the food security implications of meat and dairy consumption more broadly. The letter concludes with suggestions.

I look forward to working with Singaporean authorities and industry on the issues raised.

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Food security, animal welfare, meat/ dairy consumption

Defining food security

The concept of food security is complex and has evolved over time. The main components are:

- Consistent Availability – broadly this refers to the total food available to meet dietary needs and food preferences for a population to have an active and healthy life. Consistency refers to the absence of transitory, chronic, or seasonal unavailability
- Access – broadly this refers to the ability of households to obtain food through direct production or economic exchange
- Utilisation – refers to the metabolism of food by individuals, including nutrition, sanitation, food safety, and other health aspects

For Singapore, the AVA addresses each of these areas in its Food Security Roadmap. It has been successful thus far and the Economist Intelligence Unit (EIU) now ranks Singapore as 5th on the Global Food Security Index¹ up from 16th previously.

Defining farm animal welfare

Farm animal welfare relates to the standards used in rearing animals for their meat or other produce. Standards include methods for housing, breeding, transporting, and slaughtering animals.

The UK model for farm animal welfare standards has broad traction internationally. It is based on the following five freedoms:

- Freedom from hunger or thirst
- Freedom from discomfort
- Freedom from pain, injury or disease
- Freedom to express (most) normal behaviour
- Freedom from fear and distress

UK regulation is informed by the Farm Animal Welfare Committee, which is described at: <https://www.gov.uk/government/groups/farm-animal-welfare-committee-fawc> .

There are other standards for farm animal welfare that sometimes compete. For example, Sharia law also provides slaughter standards that can conflict with modern interpretations of humane slaughter.

The AVA references OIE, the World Organisation for Animal Health, in some of its documents. OIE also maintains standards for Animal Welfare. However, the organisation has not yet developed a full set of standards and where it has, these tend to be a base line only and not in line with leading international practices.

¹ Written up on the AVA site at http://www.ava.gov.sg/files/avavision/Issue1_2015/food-bites-singapores-success-stories.html The index itself is at <http://foodsecurityindex.eiu.com/Country/Details#Singapore>

Introduction

The briefing sets out the links under the following headings. It aims to cite Singapore examples where possible.

1. Farm animal welfare and financial costs
2. Externalities of industrial livestock – environment, health, moral
3. Supply of higher animal welfare product to Singapore
4. Food security and animal protein

The first section covers direct production costs, noting that animal welfare does not always increase costs; highlights that regulation and caterer policies are creating more space for producers with business models based on higher welfare standards; notes that the AVA's remit already includes meeting food preferences even if there are cost implications; and notes that direct production costs provide an incomplete picture of total costs of intensive livestock production.

The second section addresses these further elements of total cost that are typically not internalised in intensive production systems. The arguments are presented qualitatively. Nevertheless, when fully factored in, they may reverse the argument that intensive livestock production reduces costs.

The third section sketches a likely evolution of demand and hence supply of higher animal welfare products in Asia from which Singapore could source.

The fourth section takes a different perspective and addresses problems inherent in meat consumption beyond animal welfare issues. It references UN statements that it is not possible to solve current environmental challenges without a significant reduction in meat and dairy consumption. It also references government sources in Australia, the UK, and the USA that find health risks associated with high consumption of meat.

A genuine attempt at establishing food security should address unhealthy and unsustainable levels of meat consumption in addition to animal welfare standards.

1. Farm animal welfare and financial costs

A key concern over higher animal welfare standards is that there are significant associated financial costs. On this view if Singapore were to insist on higher standards, its caterers and supermarkets would have to pay more and so consumers would have to foot the bill.

This view rests on a number of assumptions that do not hold.

1.1 Some production systems, such as group housing for pig production, can result in lower overall costs in their own right

The best evidence for this comes from industry. Murphy-Brown, a division of the livestock company Smithfield, had a large conversion from stalls to group housing, a higher welfare method for pregnant sows. General Manager Keith Allen said:

“Our production records validate improvements for any metric you can compare, pigs born, pigs weaned, etc. The company farm production records rank better than most contract growers with stall gestation. Sow mortality is neutral when compared to traditional stall operations in the system. Fighting is less than we expected. Although we anticipated higher feed consumption in gestation, it also has remained neutral.”²

Evidence from The Humane Society of the United States³ shows group housing systems for breeding sows in the United States have a range of associated costs at the level of cost per piglet. Some of these cost estimates are lower than conventional industrial breeding methods.

So far there are no completed Asian studies to assess whether the findings hold in markets with different cost structures, however, there are studies in their initial stages in Vietnam.

In other categories the findings have indicated higher costs. The evidence for egg production in the EU is that there is currently a premium of around 20% to 30% per egg for higher welfare standards eggs, however, this is fast declining.

Note that there are different standards for eggs. The conventional industrial system confines hens in cages. The next level is cage-free or barn raised hens, where the hens can move and socialise, but are not free to go outside. The highest standard gives laying hens the freedom to range outside. The concept 'Free-Range' implies they can roam outside, however, there is no standard or certification backing this concept, so its use as a label on packaging is essentially meaningless. It is believed that the Singapore listed egg company, Chews Group, which supplies 8% of local eggs, uses a system that does not involve individual cages (i.e. barn raised).

1.2 A second assumption that higher animal welfare would make producers uncompetitive does not hold

² <http://www.thepigsite.com/swinenews/39247/sow-group-housing-conversion-answers-animal-welfare-concerns/>

³ http://animalstudiesrepository.org/hsus_reps_impacts_on_animals/29/

In fact, where the market moves to higher animal welfare standards, this just becomes a requirement for doing business. Consequently producers do not suffer for providing higher welfare standards. The opposite can apply as producers can lose customers if they do not match higher grade sourcing policies.

This is increasingly the experience in developed markets such as the US, EU, Australia, and Canada. Over the past few years, many of the leading restaurants and supermarkets have implemented policies that phase out the use of gestation crates. This has given space for regulators to phase out the use of gestation crates, as has happened in 2014 in Canada. As a result, producers are following their customers and regulations to move to higher welfare standards in order to maintain their competitive position.

1.3 A third assumption is that if there are higher costs this could not be justified on higher welfare grounds alone. This is not an absolute, but rather a question of degree

The definition of food security highlights that food must meet food preferences. Meat and dairy consumption is itself a question of preference, rather than nutrition - its costs in terms of health and the environment are considered in section 4.

It is equally valid to pay increased costs, should they arise, to meet the preference for higher welfare food. The question of whether a cost premium is appropriate for animal welfare standards is one of degree rather than an absolute requirement to have no increase in costs.

This is similar to other food security areas, such as food safety. The level of checking ensures a minimisation rather than a complete removal of risks.

The AVA already incorporates animal welfare into its Food Security Roadmap as part of its supporting strategies and linked to affordability⁴. It is notable in this regard that as part of ensuring continuity of supply of animals for the Muslim ritual of Korban, the AVA has made efforts to diversify supply and train handlers on various aspects including welfare⁵.

1.4 The direct financial costs of animal welfare are not the only cost factor in the link between animal welfare and secure food supplies

See section 2.

⁴ http://app.ava.gov.sg/data/Publications/ListOfPublications/ava_vision_issues3-4_2013/food-security-roadmap.html

⁵ http://www.ava.gov.sg/files/avavision/Issue1_2015/animal-agenda-healthy-animals-from-more-sources.html

2. Externalities of industrial livestock – environment, health, moral

This section sets out examples of how intensified industrial livestock production can involve significant environmental, health, and social costs. These are often externalised by producers, but are a price that has to be paid at some point. These issues can relate to broader questions of security than food security.

2.1 Industrial livestock systems carry significant environmental costs that are often not paid by the producer

The environmental factors for livestock production include pollution issues in dealing with animal wastes, the environmental footprint of the animal feed, and various climate change factors.

Of these, industrialisation significantly exacerbates the local pollution issues. Through driving increased demand for animal proteins industrialisation also increases the overall demands of food on the environment – the footprint – and climate change factors. Meat’s resource footprint is a broader issue with animal protein than the specific link between animal welfare, industrial production systems, and food security and is covered in section 4 below.

The main pollution issues for air, soil, and water are from the direct wastes of animals. This includes primarily excrement as well as animal carcasses that cannot be used in production, and remnants from animals after slaughter. These in turn produce local air, soil, and water pollution. Greenhouse gas emissions are also a component of pollution (cows farting), however this is covered under climate change below.

In smallholdings, where subsistence farmers grow fruit and vegetables alongside livestock, the animal wastes produces manure that can be helpful. However, the concentration of animals in industrial production facilities creates significant quantities of excrement that cannot necessarily be effectively utilised or absorbed in neighbouring arable farms.

The slurry from industrial livestock is sometimes left in large polluted tailing ponds. In some cases it is sprayed into the air, causing health problems in local areas. In other cases it is spread thickly in local agriculture.

In many cases, assisted by rain, the excrement drains into water courses, streams, and rivers and then to the sea. This in turn causes problems with freshwater and marine ecosystems, such as algal blooms and associated dead-zones.

The dead-zones and pollution can undermine other agricultural and fishing production in local areas or further downstream and in some cases over large parts of the ocean.

Where the pollution undermines downstream agriculture, this can directly reduce food security. For example, the benefits of upstream livestock production may be more than offset by the losses in seafood production from an ocean dead-zone that it causes downstream.

Or putting this another way: how can Singapore gain diversification benefits from sourcing livestock production in an area if this jeopardises the production or safety of sourcing for current contracts of products from nearby or downstream locations?

2.2 Industrial livestock systems carry significant health costs that are often not paid by the producer

There are multiple health issues associated with animal product production and consumption. Some are more frequent in intensified production systems and are considered in this section, while some relate to meat and poultry consumption in itself and independent of the production system. The latter are considered in section 4.

Industrial systems have some positive biosecurity features as they isolate herds from some avian and insect disease vectors. However, there are a number of countervailing health problems.

2.2.1 *Increased prevalence of pathogens harmful to humans on products for human consumption*

The high density of food animals in close confinement systems creates a breeding ground for bacteria. This leads to an increased presence of food borne pathogens such as salmonella, listeria, and campylobacter. This creates major food safety issues with particular risks for the elderly. Of these nontyphoidal salmonella accounts for the most significant number in Singapore and has shown a marked increase over the last decade according to a 2012 NUS study⁶. Salmonella is associated more with intensive livestock systems than more traditional methods, with poultry as the most common cause in humans.

2.2.2 *Confined spaces act as a breeding ground for viruses and diseases that can cross over into humans*

There are a number of factors that affect the likelihood that a disease can cross over from animals into humans and go on to affect the human population. The faster the evolution of viruses, the greater the likelihood that a pandemic causing strain will emerge. Industrial farming, with close confinement of large numbers of animals creates conditions where virus evolution can occur. Component parts of the 2009 H1N1 swine flu were linked to factory farms in the US.⁷

Various strands of avian flu and swine flu, H1, H2, H5, H7 and H9 families pose potential risks that may be increased through the dense crowding of animals and birds in close confinement systems.

⁶ Overview of foodborne outbreaks in last decade in Singapore: Alarming increase in nontyphoidal salmonellosis by Turkay Kondakci and Hyun-Gyun Yuk from the Food Science and Technology Programme, NUS
https://www.academia.edu/3275866/Overview_of_foodborne_outbreaks_in_last_decade_in_Singapore_Alarming_increase_in_nontyphoidal_salmonellosis

⁷ See for example this paper by Humane Society International, which summarise the science and quotes statements from the Centre for Disease Control
http://www.humanesociety.org/news/news/2009/04/swine_flu_virus_origin_1998_042909.html

2.2.3 *The high levels of animal diseases and pathogens leads to significant prophylactic use of antibiotics, increasing the prevalence of antibiotic resistant bacteria in animals and humans, and so decreasing the effectiveness of antibiotics in human populations*

As noted, the issue of close confinement of food animals creates a breeding ground for bacteria. As bacteria are so prevalent, current industry practice for close confinement systems is to give all the animals antibiotics as a preventative measure, rather than as a treatment. This also promotes the growth of the animals. As a consequence in many countries food animal antibiotic use is higher than human antibiotic use. For example, in the US, food animals consume about 80% of total antibiotics.

A February 2015 study, *Global Trends in Antimicrobial Use in Food Animals*⁸, projected a 67% increase in antimicrobial use between 2010 and 2030 due to the increase in meat consumption. The study finds pigs use the most antimicrobials on average at 172 milligrammes per kilogramme of meat. Chicken follow close behind at 148 mg per kg and cattle are lower at 45 mg per kg.

The huge use of antibiotics has led to a significant increase in the prevalence of antibiotic resistance in bacteria. The resistance traits can transfer between bacteria, raising the prospect that diseases that pose significant risks to humans, such as tuberculosis, will no longer be treatable with antibiotics.

US authorities have become so alarmed that last year the White House released a set of new strategies to deal with the emergence of antibiotic resistance.⁹

2.3 Industrial livestock systems carry significant moral costs that are borne by the consuming economy

A further cost of industrial livestock is the moral cost. Is it possible for society to reach its full harmonious potential when large numbers of sentient beings are bred to a life of abject misery and brutal suffering purely to satisfy momentary tastes? There are practical as well as moral considerations here.

Singapore has achieved dramatic progress in material prosperity in the 50 years since its birth as an independent country. While it needs to work to maintain its resilience, the next phase of evolution for Singapore is surely in the cultural and moral spheres. This presents a further reason to invest in farm animal welfare: to advance Singapore's progress towards a harmonious society.

⁸ <http://www.pnas.org/content/early/2015/03/18/1503141112.abstract>

⁹ <http://www.businessinsider.sg/obama-action-on-antibiotic-resistant-bacteria-2014-9/#.VQed5ma8o4Q>

3. Supply of higher animal welfare product to Singapore

One concern with restricting suppliers on the basis of higher welfare standards is that this may significantly limit the breadth of suppliers to Singapore, potentially lowering supplier diversity and resilience.

This briefing does not cover statistics on the levels of consumption or supply of higher animal welfare product globally or in Singapore. However, trends in multinational corporation (MNC) purchasing patterns and regulation make it clear that global production, and likely regional production, are increasing for higher animal welfare products. This should create a growing pool of suppliers from diverse regions that Singapore can tap.

Clearly a first step is to confirm the animal welfare standards at local production facilities – for example, local egg producer Chews Group uses a barn system. However, as local agriculture accounts for so little of Singapore's animal product consumption, the more important question is the standards used for imported animal products.

Singapore has extremely long food supply chains that include geographies such as North America, the EU, and Australia, that adopt higher animal welfare standards as a matter of public policy. As an example of the distance animal products travel, the AVA's website mentions Korban sheep and goats from Australia and Canada¹⁰ and frozen meats from Poland and Denmark¹¹. As there is significant demand for higher welfare standards in these regions, some of which codified in regulations, there will be higher welfare product available in Singapore's global food sourcing regions.

In addition, some Asian suppliers will already have higher standards. In some cases this may be to target domestic/ regional buyers with higher welfare requirements. It will also be to supply customers in higher welfare standard regions where either regulations prohibit purchase of low welfare standard products or where caterers/ supermarkets have sourcing policies that require high standard products in their home markets.

Demand for, and so production of, higher welfare product within Asia can only be expected to grow. MNCs will increasingly demand higher welfare products in Asia as they turn the sourcing standards in higher welfare geographies into global commitments covering Asian countries. In addition Asian regional caterers are likely to adopt higher welfare sourcing policies in line with their brands and reputation. We have seen the first part of this trend in Singapore with Marina Bay Sands and a number of other leading brands taking shark fin off the menu and Singapore Airlines banning shark fin from cargo flights.

In summary, there should be enough variety of higher welfare suppliers for Singapore to begin to tighten welfare standards with no noticeable reduction in supplier diversity. It may already be the case that Singapore is sourcing higher welfare product without realising it as this was not a purchasing feature – for example, if regulations in the producing country are set at a higher standard, with Singapore choosing the product on different factors.

¹⁰ http://app.ava.gov.sg/data/Publications/ListOfPublications/ava_vision_issues3-4_2013/animal-agenda-korban.html

¹¹ http://www.ava.gov.sg/files/avavision/issues3-4_2013/food-security-frozen-meat.html

4. Food security and animal protein

This letter has so far focused on animal welfare and food security. Arguably the current and growing rate of production of animal products is itself one of the biggest threats to long term food security. This is primarily due to the environmental implications of animal product consumption, though there are also health implications.

As Singapore has a well-educated population and very little livestock production to lobby in opposition, the country is well positioned to act on meat reduction. This is likely to work in tandem with trends in consumer preferences that show a growing shift to plant-based diets in some developed economies. In fact, these trends present investment opportunities that Singapore is already taking advantage of.

This section presents evidence on the links between health and environmental issues of meat consumption and production then considers consumer demand for plant-based alternatives.

4.1 Health effects of meat consumption

There is a great deal of literature on the links between diet and health. However, the complexity of the issues and industry funded studies with potential for bias create confusion. To quickly identify useful points with strong evidence backing, this section provides brief highlights of the scientific basis for national diet guidelines in three countries with strong meat industry lobbies. It therefore likely captures only minimum levels of risk associated with high levels of meat consumption.

A number of countries have guidelines with recommended daily maximums for red meat consumption. Bodies in Australia and the UK both set the level in relation to their populations at around 500 grammes per week¹², which is equivalent to around 70 grammes per day or 26 kilogrammes per year.

In compiling the Australian Dietary Guidelines (2013) the National Health and Medical Research Council conducted a scientific review. Findings included:

- Consumption of fresh red meat is associated with increased risk of lung cancer
- Consumption of fresh red meat is associated with risk of renal cancer
- Consumption of (greater than, at least 100-120g/d) fresh red meat is associated with an increased risk of colorectal cancer

The UK's recommendations are based on studies of iron availability. They also conclude there are risks associated with red meat consumption.

In the US, where the livestock lobby has historically challenged any attempt to create guidelines for maximum meat consumption, the current version of dietary guidelines is in public consultation. The

¹² See the UK guidelines at <https://www.gov.uk/government/publications/sacn-iron-and-health-report> and Australia <https://www.nhmrc.gov.au/guidelines-publications/n55>

Dietary Guidelines Advisory Committee (DGGAC) states in its 2015 Scientific Report¹³ (my emphasis):

“The DGAC concurs with the conclusions of the NEL Dietary Patterns Systematic Review Project and *AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk* that strong and consistent evidence demonstrates that dietary patterns associated with decreased risk of CVD are characterized by higher consumption of vegetables, fruits, whole grains, low-fat dairy, and seafood, and ***lower consumption of red and processed meat***, and lower intakes of refined grains, and sugar-sweetened foods and beverages relative to less healthy patterns.”

The DGAC’s findings are particularly notable as, for the first time, they provide recommendations on the basis of the environment (see next section).

I have not had time to source a full set of evidence on poultry. However, there are studies linking poultry to health risks. This is partly due to the negative implications of diets with high fat content, which is not necessarily reduced through switching to chicken.

There may still be links with cancer. One study, Consumption of Meat and Dairy and Lymphoma Risk in the European Prospective Investigation into Cancer and Nutrition,¹⁴ found that consumption of poultry was related to an increase in B-cell lymphomas.

I have not been able to isolate the Singapore consumption of red meats. The AVA provides 2012 statistics for meat consumption of 323,000 tonnes, however, this includes chicken and duck alongside beef, mutton, and pork. On the basis of Singapore’s 2012 population of 5.31¹⁵ this is 61 kilogrammes per person per year or 167 grammes per person per day. This statistic conflicts with a *Guardian* published statistic that dates from 2002 that puts Singapore’s meat consumption at 71.1 kilogrammes per person per year¹⁶.

It is notable that the indicator for which Singapore had the lowest absolute score in the Economist Intelligence Unit’s Food Security Index is Dietary availability of vegetal iron.¹⁷

4.2 Environmental implications of meat consumption

The environmental footprint of livestock includes direct pollution, the resource footprint, and climate change impacts. Of these, the climate change impacts are extremely significant in terms of security defined broadly as well as food security, given that climate change is expected to make it harder to grow food. In fact, Singapore has already experienced this challenge with the occurrence of plankton blooms

¹³ <http://www.health.gov/dietaryguidelines/2015-scientific-report/>

¹⁴ <http://www.ncbi.nlm.nih.gov/pubmed/20473877>

¹⁵ <http://www.straitstimes.com/news/singapore/more-singapore-stories/story/singapore-population-now-547-million-slowest-growth-10-y>

¹⁶ <http://www.theguardian.com/environment/datablog/2009/sep/02/meat-consumption-per-capita-climate-change>

¹⁷ <http://foodsecurityindex.eiu.com/Country/Details#Singapore>

destroying local fish stocks viewed as increasingly likely in light of climate change.¹⁸

This section highlights the increased resource footprint of animal products, the effect of livestock production on climate change, and the effects of climate change on food security. Pollution issues are more acute for industrial production systems and are considered above.

The conclusion is clearly expressed by the UN, in its 2010 report *Assessing the Environmental Impacts of Consumption and Production – Priority Products and Materials*¹⁹. The report observes (page 79) that “animal products, both meat and dairy, in general require more resources and cause higher emissions than plant-based alternatives.”

It then states the following on page 82 in its future outlook (my emphasis):

“Impacts from agriculture are expected to increase substantially due to population growth, increasing consumption of animal products. ... **A substantial reduction of impacts would only be possible with a substantial worldwide diet change, away from animal products.**”

4.2.1 Diets with higher animal product consumption have higher resource footprints

Due to the inefficiency of digestion and the conversion of plants into animal fats and proteins, food consumption via animals requires significantly more land, water, and crops than would be required to obtain the same level of nutrients via a plant based diet.

Water

Beef is particularly water intensive, however, pork and poultry also use significantly more resources. According to Water Footprint Network figures based on a study by Mekonnen and Hoekstra²⁰, beef requires 15,414 litres per kilogramme, while vegetables only require 322 litres per kilogramme and pulses 4,055 litres per kilogramme. The table below extracts some figures provided at the referenced link showing for various food products their water footprint required on average to obtain a certain level of nutrition.

	Litre/kg	Litre/kcal	Litre/gramme protein
Vegetables	322	1.34	26
Cereals	1,644	0.51	21
Pulses	4,055	1.19	19
Eggs	3,265	2.29	29
Chicken meat	4,325	3	34
Pig meat	5,988	2.15	57
Sheep/goat meat	8,763	4.25	63
Bovine meat	15,415	10.19	112

¹⁸ <http://www.straitstimes.com/news/singapore/environment/story/vivian-balakrishnan-plankton-blooms-recurring-problem-20150308>

¹⁹ <http://www.unep.fr/scp/publications/details.asp?id=DTI/1262/PA>

²⁰ <http://www.waterfootprint.org/?page=files/Animal-products>

It is clear from the table that a meal combining vegetables, cereals and pulses can provide significantly more calories and protein for a given level of water than any of the animal products.

Beef requires 8 times more water per calorie than vegetables and 6 times more water per gramme of protein than pulses. The ratios are 1.6 times and 3 times respectively for pig meat and 3 times and 3 times respectively for sheep/ goat meat.

For poultry the ratios are different depending on whether eggs or meat is eaten. For eggs the ratios are 1.7 times more water per gramme of calorie than vegetables and 1.5 times more water per gramme of protein than pulses. For chicken meat the ratios are 2.2 and 1.8 times respectively.

Land

Land is sometimes converted directly to make space for livestock production, such as in Brazil's cattle ranches. Land is also converted to grow feed, particularly for industrial farming based on use of crops for feed. A significant example is the conversion of Amazonian rainforest to soy production for use as pig feed.

Crops

Crops can be used to feed humans or animals or used to form biofuels. The UN report previously cited states that around half of crops are fed to animals, rather than humans. The proportion fed to animals varies significantly by country and is higher in the US, where industrial livestock production is higher.

4.2.2 Diets with higher animal product consumption have a higher contribution to climate change causing emissions

The impacts of livestock on climate change are significant. The FAO's 2013 report *Tackling Climate Change Through Livestock* covers emissions in detail²¹. Livestock's contribution to climate change represents 14.5% of total emissions. This is significant enough that there is no way to tackle climate change overall without addressing the emissions from this sector.

The report does not contextualise livestock emissions by providing those from other forms of agriculture. Nevertheless, it is clear from its resource intensity that animal products also bring with them higher associated greenhouse gas emissions. This is partly due to the significant emissions required to grow feed for animals, such as from fertilizer use, and from the conversion of land, such as forests, to crop land to feed animals.

4.2.3 Climate change is a significant threat to food security

The link between climate change and food security is complex as there are positive as well as adverse consequences. However, the negatives are considered more significant. A full write up of the links is contained in Chapter 7 on Food Security and Food Production Systems of the Intergovernmental Panel on Climate Change's Fifth Assessment Report

²¹ <http://www.fao.org/news/story/en/item/197623/icode/>

Working II titled: Climate Change 2014: Impacts, Adaptation and Vulnerability²².

The main positive is that the presence of extra carbon dioxide in the atmosphere spurs plant growth. However, the increased climate variability poses significant challenges to farmers as it can destroy crops through floods and droughts, or simply through the wrong conditions at the wrong time.

As mentioned above, Singapore is itself experiencing these effects, with the incidents of plankton bloom such as the one that hit local fish farming expected to increase as climate change continues.²³

Climate change has implications for land availability. The warming of certain regions, such as the Siberian Tundra, could make new land available to agriculture. However, climate change also brings increased variability in the weather and reduces land availability in other areas, such as through salination from rising sea-levels (rice growing areas in the Mekong River Delta are particularly low-lying) and accelerating desertification. The IPCC's chapter on impacts in Asia²⁴ states:

"Sea level rise threatens coastal and deltaic rice production areas in Asia, such as those in Bangladesh and the Mekong River Delta (Wassmann et al., 2009b). For example, about 7% of Vietnam's agriculture land may be submerged due to 1-m sea level rise (Dasgupta et al., 2009). In Myanmar, saltwater intrusion due to sea level rise could also decrease rice yield (Wassmann et al., 2009b)."

The increase in temperatures will affect growing seasons. The Asia chapter also states:

"Wassmann et al. (2009a,b) concluded that, in terms of risks of increasing heat stress, there are parts of Asia where current temperatures are already approaching critical levels during the susceptible stages of the rice plant. These include Pakistan/ North India (October), South India (April/ August), East India/ Bangladesh (March-June), Myanmar/ Thailand/ Laos/ Cambodia (March-June), Vietnam (April/ August), Philippines (April/ June), Indonesia (August), and China (July/ August)."

Overall, climate change is expected to have a significant negative effect because farmers are unlikely to be able to adapt their growing methods in time to mitigate the risks or find advantages in the new weather patterns that climate change creates.

The sensible precautionary approach is to manage climate change and this includes reducing the consumption of foods that most contribute to climate change, such as animal products.

Aside from this, a deeper analysis of the resilience of Singapore's sourcing areas to assess resilience to the effects of climate change is indicated. The IPCC report notes that there are significant gaps in

²² <http://www.ipcc.ch/report/ar5/wg2/>

²³ <http://www.straitstimes.com/news/singapore/environment/story/vivian-balakrishnan-plankton-blooms-recurring-problem-20150308>

²⁴ <http://www.ipcc.ch/report/ar5/wg2/>

information, whether observations or projections, for food production in SE Asia in light of climate change.

4.3 Demand for plant based alternatives

Globally there is a growing market for vegetarian and vegan foods. According to a market report from Mintel released in 2014 "12% of global food and drink products launched in 2013 carried a vegetarian claim, up from 6% in 2009".

Hampton Creek, which counts Li Ka-shing as an investor²⁵ (and anecdotally Temasek, though a source was not available), and Beyond Meat, which has Bill Gates as an investor²⁶, are two companies that are trying to take this niche mainstream with eggless eggs and chicken-free chicken respectively. A worldwide move towards plant-based products offers significant opportunity. There are also Asian suppliers of mock meats.

This trend is firmly in place, with the experience of developed nations showing that as understanding of the many issues highlighted in this letter spreads through society there is a tendency for diets to shift away from animal products. In the UK 12% of the population now follow a vegetarian or vegan diet²⁷. In the US annual per capita consumption of meat has fallen significantly in the last few decades²⁸.

I do not have any statistics for Singapore, but my personal experience is that it is an easy city in which to consume a plant based diet. There are local chains of restaurants such as Veganberg and Real Food that cater to plant-based or vegetarian diets. In addition, there are many vegetarian Indian restaurants and Chinese vegetarian food stalls and restaurants. Lastly, many caterers with a broad array of dishes have plant-based, or at least vegetarian, options.

The presence of these caterers and these options indicates a strong local demand for plant-based foods. This may be due to of pure vegetarians or due to omnivores that enjoy plant-based food for some proportion of their meals.

There seems no reason why Singapore should not follow the trend towards reduced meat and dairy consumption. Perhaps the aging of the population will also play a role.

²⁵ <http://www.forbes.com/sites/ryanmac/2014/02/17/egg-replacing-startup-hampton-creek-foods-raises-23-million-from-asias-richest-man-and-yahoo-cofounder-jerry-yang/>

²⁶

²⁷ <http://www.mintel.com/press-centre/food-and-drink/number-of-global-vegetarian-food-and-drink-product-launches-doubles-between-2009-and-2013>

²⁸ <http://www.nasdaq.com/article/how-the-death-of-meat-could-impact-your-portfolio-cm435607#/ixzz3RdKxcF9j>

Suggestions

This briefing presents evidence that intensive industrial livestock practices and meat and dairy consumption in general pose risks to food security and pose broader security issues. This section presents suggestions to move forward.

1. Local production

Animal welfare

- Assess current animal welfare standards in respect of various international norms
- Broaden cost/ benefit analyses for local animal product production to include relevant environmental and social externalities
- Draw on the support of international civil society organisations in stakeholder dialogue to develop new standards, giving producers and regulators access to a significant pool of knowledge and expertise
- Take steps to encourage local livestock production to move to higher welfare methods, particularly when they invest in new facilities

Food resilience

- Assist local food producers in developing plans for increased resilience in light of predicted changes in the local climate
- Assist local food producers in tracing their supply chains to identify environmental and social risks to their supplies and implement risk mitigation plans to ensure the resilience of sourcing

2. Importers

Increase the evidence base for action through gathering information on:

- The production costs and implications of higher welfare methods
- The current levels of import of higher welfare products
- International regulations on animal welfare standards
- Sourcing policies used at multinational corporations
- Availability of higher welfare product for Singapore

Consider various ways to encourage adoption of higher welfare import standards, such as:

- Setting out clear definitions of standards
- Introducing labelling requirements for animal welfare
- Setting minimum standards

3. Meat consumption challenge

Increase the evidence base to inform a public policy position on meat reduction:

- Review the scientific evidence of health implications of animal product consumption and production

- Review the scientific evidence of environmental implications of livestock production
- Review current levels of meat and dairy consumption in Singapore and likely trends (particularly in the context of aging population)
- Assess consumer attitudes to livestock consumption and plant-based alternatives to determine effective interventions

With this evidence base, it should be possible to adopt a policy of intervention in line with scientific findings that reduces risk and potentially identifies opportunities for investment. The environmental risks in particular potentially create an even stronger case for intervention than the arguments used to justify high taxation on alcohol and tobacco.

Encourage lower consumption of meat and dairy:

- Introduce higher rate taxes on imports and at sale for animal products to reflect the negative health effects on the local population and the longer term environmental challenges Singapore will suffer
- Establish education programmes to encourage healthier, more sustainable diets with reduced animal product content. These should cover the health and environmental implications of meat, with information on diets to counter misunderstanding about sources of protein and micronutrients
- Increase the proportion of plant-based meals at government buildings, educational establishments, schools, and hospitals
- Promote reduction on certain days, such as Meatless Mondays or Veggie Thursday, which are encouraged in a growing number of cities around the World including Sao Paolo, Ghent, and Los Angeles

Encourage alternatives:

- Support local businesses/ caterers offering a high range of plant-based options, potentially with tax incentives
- Invest further in plant-based alternatives to animal proteins to capture the benefits of ongoing consumer trends

Food supplier resilience:

- Develop a deeper assessment programme for Singapore food suppliers to better understand i) the resilience of suppliers' inputs in light of predicted climate change effects ii) the intensity of their environmental footprints
- Apply this assessment to suppliers and work with them to improve resilience/ reduce environmental footprints
- Reduce exposure to suppliers that are unable or unwilling to improve risk management/ resource footprints