



Murdoch
UNIVERSITY

HARNESSING FOOD TRENDS AND AGRI-INNOVATION FOR PROFIT

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Traditional to Advanced Farming



Source: ExploreYala.com



Source: Japan Times, 24 Aug 2014



Source: Urbangardensweb.com, 18 Oct 2015

...the next 20 mins...

- What's driving the change?
- What benefits do these plant factories provide over traditional farming methods?
- What proportion of food is currently being produced in plant factories? Which cities lead the trend?
- Why and how should Peel get involved?

Change Drivers: Increased Demand for healthy, fresh and quality...

- Growing urbanisation leading to increased demand for safe, healthy, fresh and quality products

Welcome to Simple Truth®!

Here, you'll learn all about our Organic, Natural and Free from 101+ foods and ingredients.

Simple Truth® and Simple Truth Organic® make it easy to eat better with a full line of honest, easy to understand and affordable choices...available exclusively at the Kroger Co. Family of Stores.

Product selection may vary by store.



Source: SimpleTruth.com

Change Drivers: Production Benefits

TRADITIONAL FARMING



5.2 BILLION
POUNDS OF PESTICIDES
USED WORLDWIDE
OF THE PESTICIDE CLASSES, HERBICIDES ARE
THE MOST WIDELY USED IN ALL U.S. SECTORS.

<http://www.commodorebooks.org/2013/pesticides>



0.1% EFFICIENCY
OF APPLIED PESTICIDES REACH THE TARGET
PESTS, LEAVING THE REST OF THE PESTICIDES
(99.9%) TO IMPACT THE ENVIRONMENT.

<http://www.commodorebooks.org/2013/pesticides>

TRADITIONAL FARMING



80% SOIL
ARABLE LAND ALREADY
IN USE



50% OF CROPS
PLANTED ARE
NOT HARVESTED

TRADITIONAL FARMING



70% GLOBAL
FRESH WATER USED
FOR SOIL-BASED FARMING
50-80% OF WHICH IS LOST TO
EVAPORATION AND RUNOFF



1500 MILES
ON AVERAGE, FOOD TRAVELS FROM
1500 TO 2500 MILES ON ITS WAY TO
OUR PLATE.

<http://www.mlb.org/blog/foodways/food-ways-mlb>

VERTICAL FARMING



0% PESTICIDES
ARCHITECTED TO KEEP CRITTERS OUT, THE
CONTAINED AND CONTROLLED ENVIRONMENT
ALLEVIATES THE NEED FOR TOXIC AND COSTLY
PESTICIDES AND HERBICIDES

Dr. Dickson Despender, The Vertical Farm

VERTICAL FARMING



0% SOIL
1 ACRE = 10 TO 20 ACRES
VERTICAL
FARM = SOIL-BASED TRADITIONAL
FARM DEPENDING ON CROP



90% OF CROPS
PLANTED ARE
HARVESTED

VERTICAL FARMING



70-95% LESS
FRESH WATER USED
FOR VERTICAL FARMING
UTILIZING THE AQUAPONICS OR
AEROPONICS METHOD OF FARMING



LOCAL
VERTICAL FARMING
REDUCES THE NEED FOR LONG-DISTANCE
TRANSPORT DIMINISHING THE USE OF
FOSSIL FUEL AND ENSURING QUALITY

Crops	Yield in VF due to Tech (tons/ha)	Field Yield (tons/ha)	Factor increase due to Tech
Carrots	58	30	1,9
Radish	23	15	1,5
Potatoes	150	28	5,4
Tomatoes	155	45	3,4
Pepper	133	30	4,4
Strawberry	69	30	2,3
Peas	9	6	1,5
Cabbage	67	50	1,3
Lettuce	37	25	1,5
Spinach	22	12	1,8
Total (average)	71	28	2,5

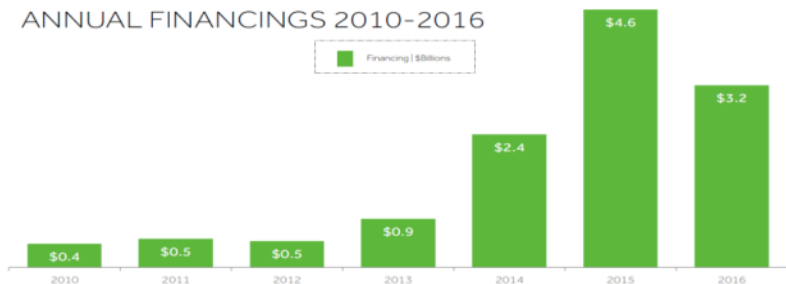
Source: Banerjee, C. & Adenauer, L. 2014.



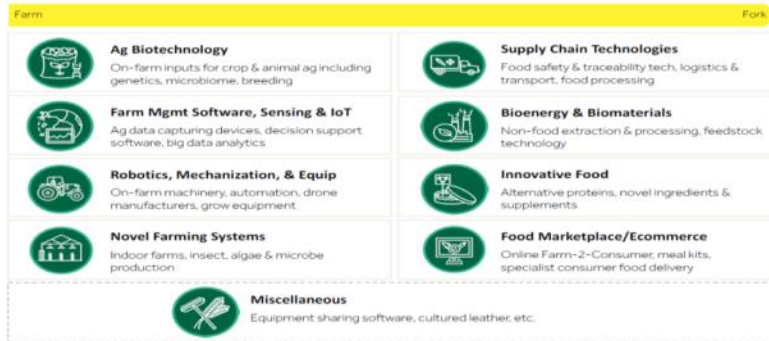
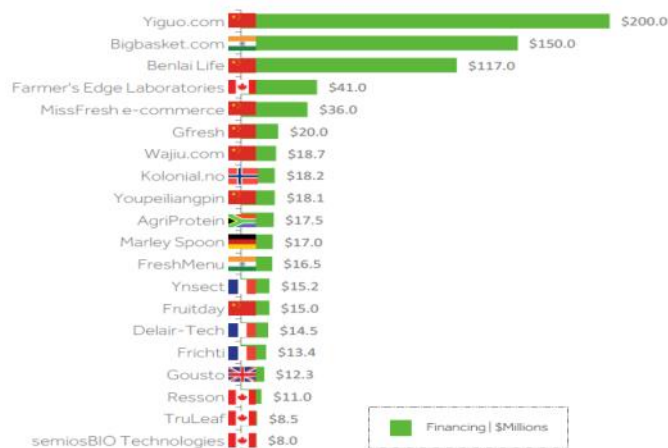
Association for
Vertical Farming
www.vertical-farming.net

Change Drivers: New Agribusiness & AgriTech Opportunities

ANNUAL FINANCINGS 2010-2016

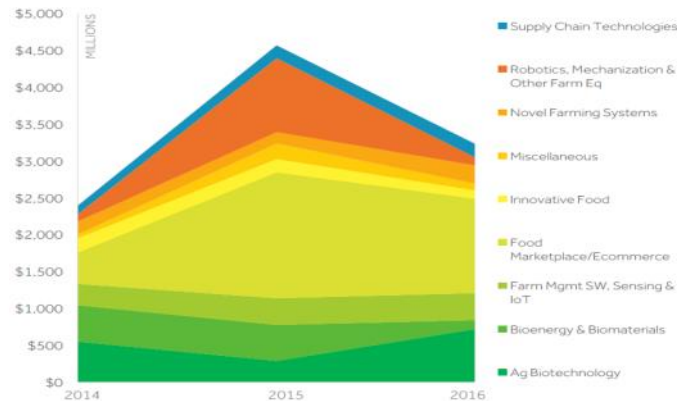


TOP 20 NON-U.S. DEALS



INVESTMENT BY CATEGORY 2014-2016

- Investment grew year-over-year in four categories: Ag Biotechnology (150% to \$719m), Farm Management Software, Sensing & IoT (3.7% to \$363m), Novel Farming Systems (63% to \$257m), and Supply Chain Technologies (3% to \$180m).
- As expected, Food Marketplace/E-commerce funding fell, but by less than expected (25% to \$1.3bn). The category was driven by five large deals totaling \$767 million. Deal activity only fell by three, indicating continued growth at the seed stage, however.
- Robotics, Mechanization & Other Hardware, which was dominated by drone technologies in 2015 (another arguably overheated sector), also experienced a pullback in 2016 as investors awaited more proof of the technology's efficacy in agriculture, or drone companies moved onto other industries.



Novel Farming Systems aka *Plant Factories*

- Growing crops in stacked layers (vertical farm), in controlled environments (indoor farm, greenhouse) with precise light, nutrients and temperatures [controlled environment agriculture CEA]
- Without soil –
 - Hydroponics (roots are submerged in nutrient solution providing the right chemical composition at the right time)
 - Aeroponics (earliest evidence is NASA in 1990s wanting to grow plants in space using air/mist and very little water)
 - Aquaponics (combines plant and fish in a closed loop system where nutrient rich waste from fish is used as a feed source for plants & the plants filter and purify the water acting as recycled water back to the fish pond)



- Uses simple design innovations for their vertical urban farms
 - 95% lesser water,
 - 10x more yield;
 - 75% less input,
 - \$0.05 of electricity per kg of vegetables
 - 40w of energy 12L per kg

Plant Factories

- Current state
 - In Japan, plant factories have grown from a mere 39 (2009) to 191 (2015)
 - Mostly producing leafy vegetables (lettuce being the most common)
 - Existing business models differentiate by *technology, distribution, marketing, income variation, and policy environment*
 - Further, *Infrastructure, energy consumption, supply chain and price* are fundamental barriers to overcome for urban farms to be viable
 - Energy efficiency continues to improve year-on-year e.g. LED

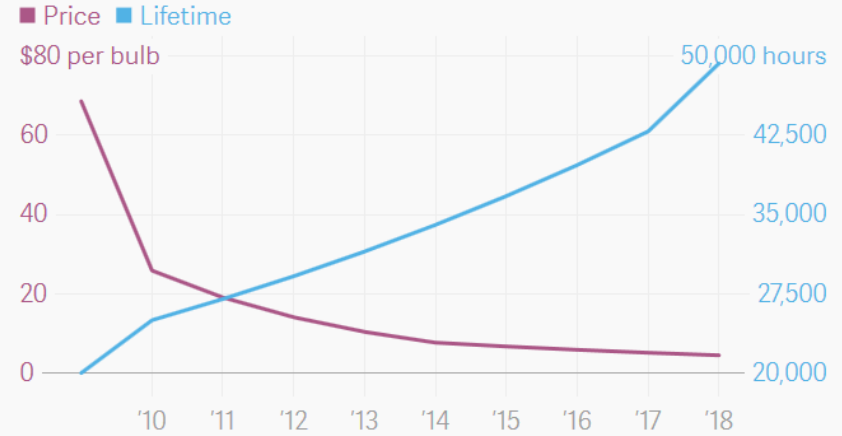
Plant Factories - LED

- Light Emitting Diodes (LEDs)
 - Light recipe (red, blue and far red wavelengths)
 - Intensity controls photosynthesis (high), flowering process (low), shape and characteristics (high-low)
 - Improving efficiency with improved energy savings (45% energy conversion to light)



The Department of Energy says the price of LEDs has fallen 90% since 2010, and should keep falling in the years to come. At the same time, LED efficiency (light emitted per unit of energy) and lifetime (now up to about 36,000 hours) have nearly doubled.

Cost and lifetime for LED lighting 2010 - 2019 (projections)



ATLAS | Data: US Department of Energy, Annual Energy Outlook (AEO) 2015

Share

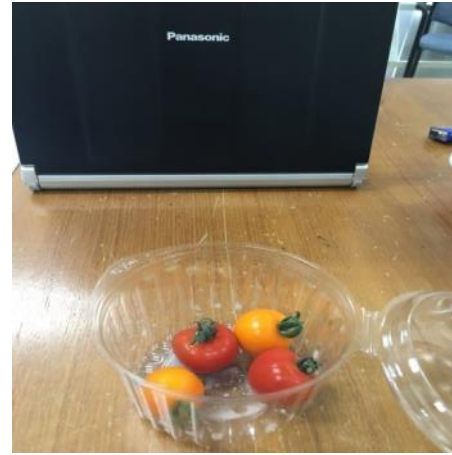
Although California supplies about 80% (pdf) of the United States' lettuce and other produce, indoor farmers say they will soon be supplying tastier, fresher and, eventually, cheaper produce to many cities. They are even turning a profit doing it. "We make a healthy margin," says Marc Oshima, chief marketing officer for AeroFarms. "There's a reason that Goldman Sachs and Prudential have invested in our farms."

SONY



In the Miyagi Prefecture, Japan, Sony has built one of the largest indoor urban farms, which produces 10,000 lettuce heads daily

- Uses a warehouse of 2,500 square meters is fitted with 17,500 LED lights
- 40% energy consumption compared to conventional farming.
- Light is emitted around-the-clock at wavelengths optimal for plant (lettuce) production.
- 100-fold improvement in productivity (10,000 lettuce heads a day).
- Water consumption reduced by 99% (controlling humidity, irrigation and temperature).
- Food losses have reduced to 10% compared with 50% in conventional farms.



- **Panasonic** vertical indoor farm grows 30 different crop varieties in Singapore.
- Production time is halved – lettuce production takes 30 days.
- Improved shelf-life for certain products (up to 2 months)
- Uses 60% amount of energy resources as compared to conventional farming
- Utilizes soil-based and hydroponics
- Intense R&D on light exposure, soil patterns, etc.

Blind Spots?



Urban Farming



...evolving, not replacing ecosystem!

Peel Food Zone?

- Comparative advantages
 - Government (State and Local) support
 - Biodiversity, biosecurity, safe and quality food production
 - Better logistics enabling shorter supply chain into parts of Asia
 - Relatively stable weather patterns and environment for land-based greenhouses that can support blended (e.g. sunlight combined with artificial light) production approaches
 - Opportunity to produce high-value products
- Challenge
 - Scale of production (investors willingness for greenfield sites?)
 - Time to market (roadmap to PFZ)
 - Community's willingness and speed to act

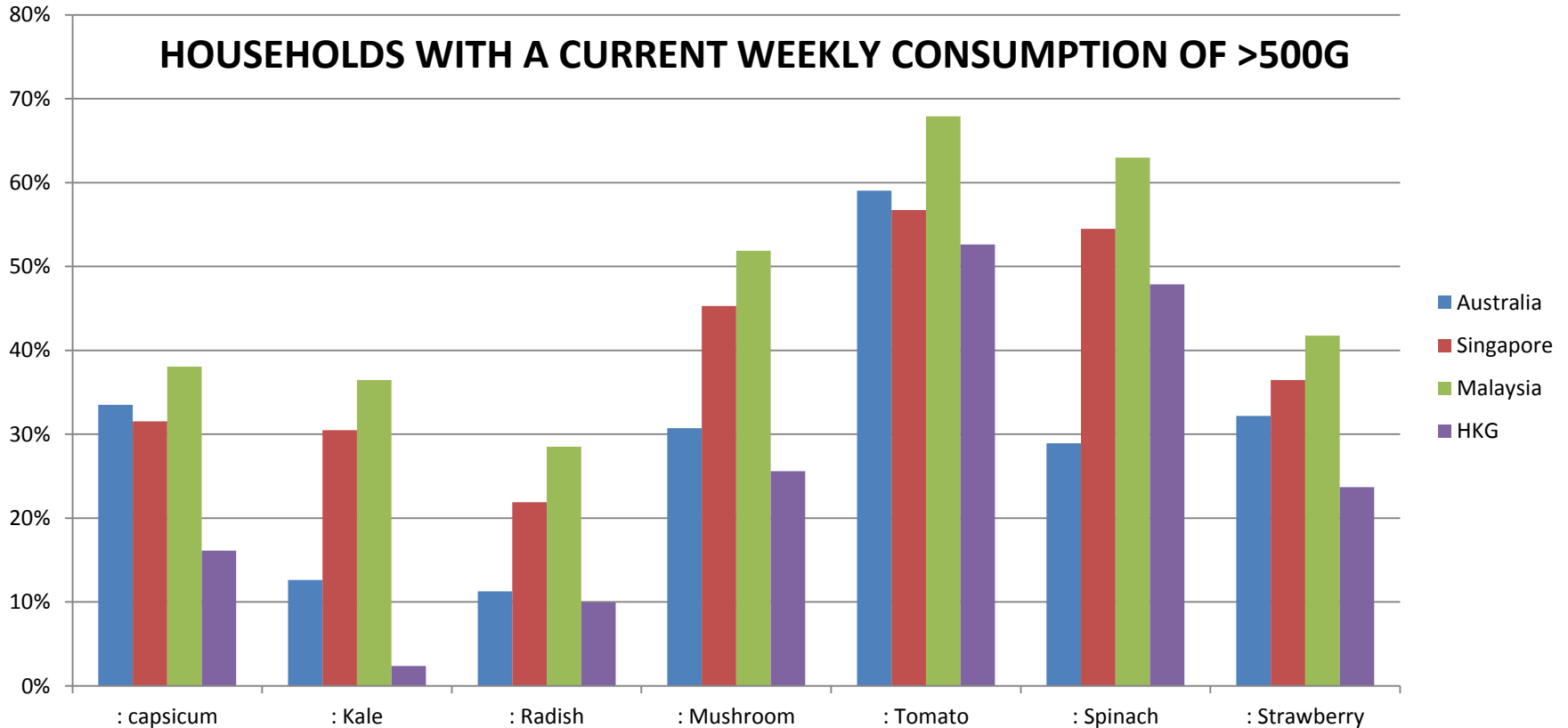
Consumer Study

- Research designed to ascertain taste and preferences of consumers in “key markets”
- Markets selected on the basis of their export potential as well current trade data on Western Australian food and vegetable exports.
- Products selected based on price differential (WA price – global or domestic price) as well as technology considerations (i.e. is the technology available in the market or currently being piloted).
- Survey field tested twice before being deployed through professional surveyors in Singapore, Hong Kong, Thailand, Australia, Malaysia, and UAE.

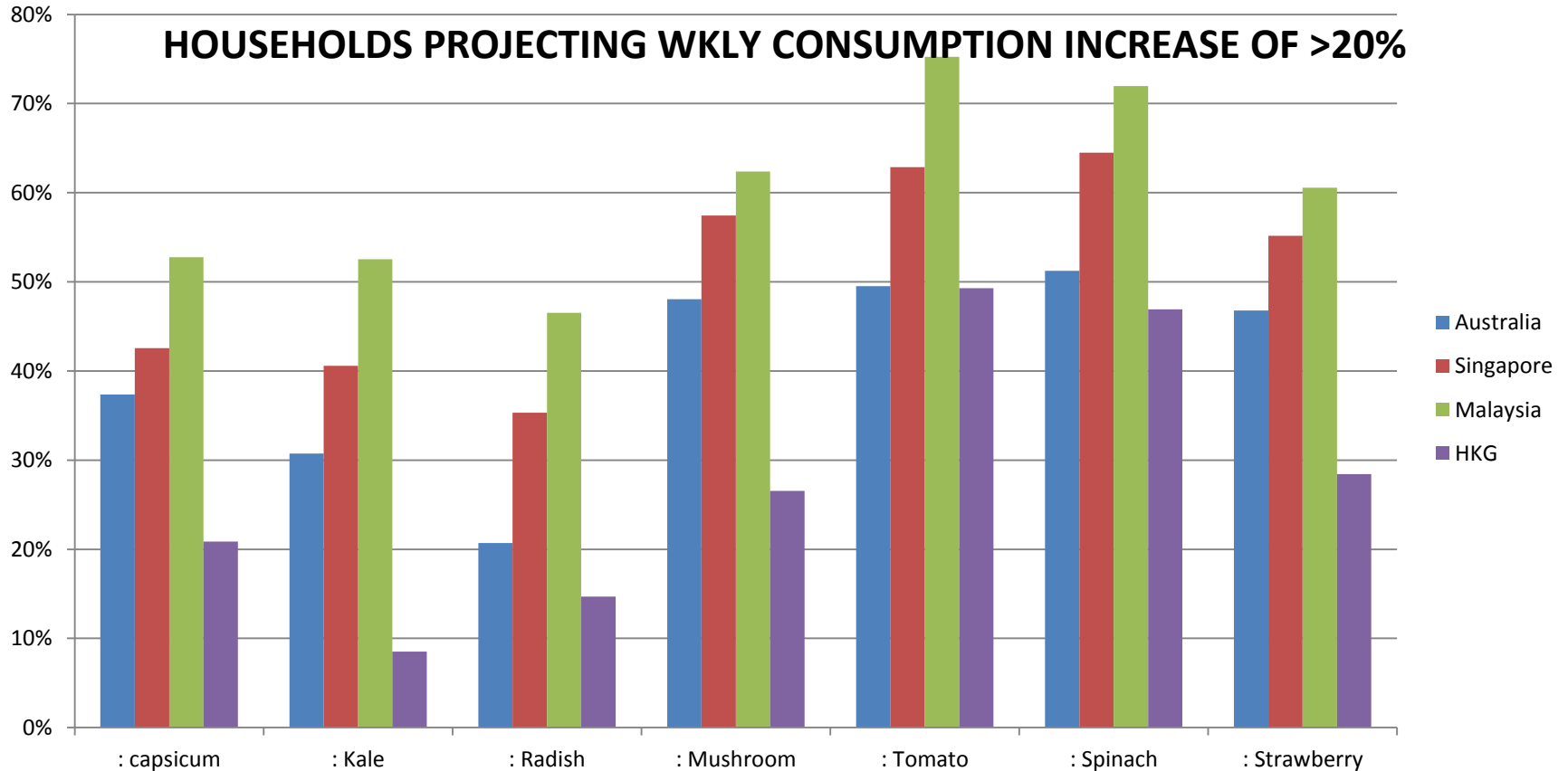
What do consumers want?

Smart Urban Farm Factories - Market Survey				
<i>Author calculations 22 Feb 2017</i>				
Households current consumption (above 500g)	Australia	Singapore	Malaysia	HKG
: capsicum	33%	32%	38%	16%
: Kale	13%	31%	36%	2%
: Radish	11%	22%	29%	10%
: Mushroom	31%	45%	52%	26%
: Tomato	59%	57%	68%	53%
: Spinach	29%	55%	63%	48%
: Strawberry	32%	36%	42%	24%
Household projecting over 20% increase in consumption	Australia	Singapore	Malaysia	HKG
: capsicum	37%	43%	53%	21%
: Kale	31%	41%	53%	9%
: Radish	21%	35%	47%	15%
: Mushroom	48%	57%	62%	27%
: Tomato	50%	63%	75%	49%
: Spinach	51%	65%	72%	47%
: Strawberry	47%	55%	61%	28%
Households willing to pay premium of 10% & over for Australian grown products	Australia	Singapore	Malaysia	HKG
	48%	43%	69%	49%
Top 3 factors in buying decision	1. Price	1. Price	1. Nutritional Value	1. Nutritional Value
	2. Nutritional Value	2. Nutritional Value	2. Organic Production	2. Price
	3. Certification (GAP etc)	3. Organic Production	3. Certification	3. Organic Production

What are the consumption patterns?

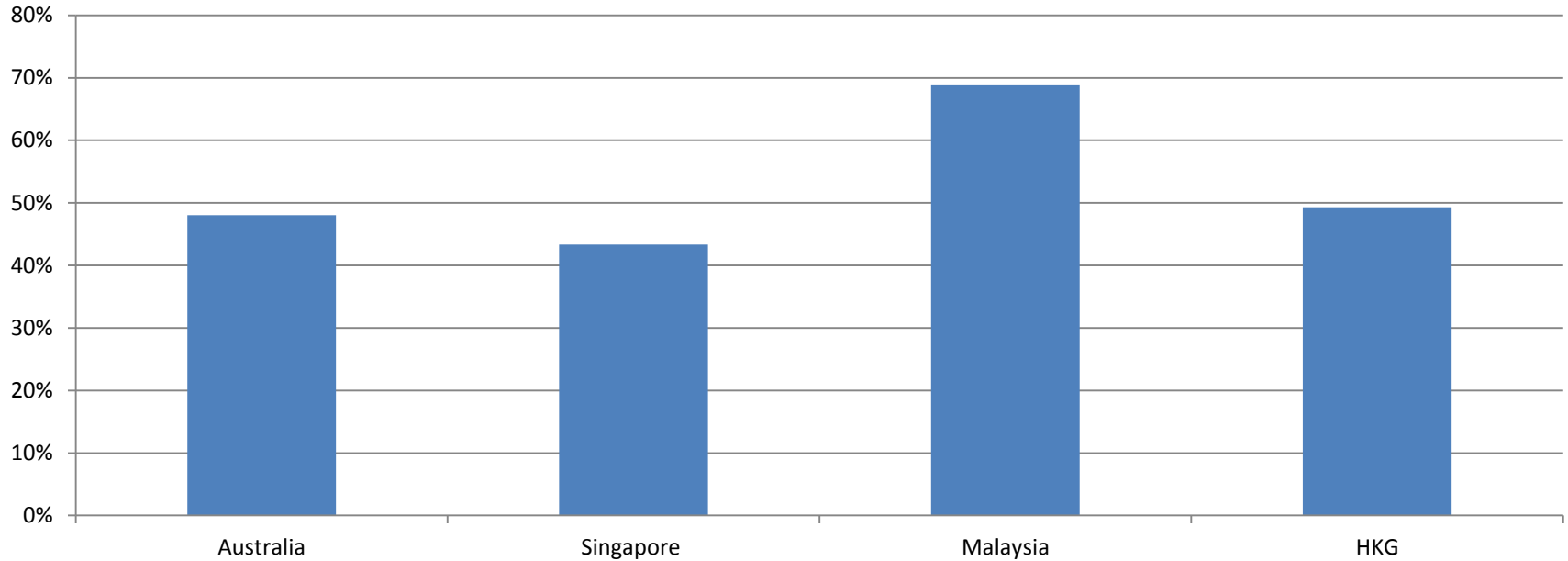


What is future consumption going to look like?



Is there a premium attached to future consumption?

Households willing to pay premium of 10% & over for Australian grown products



How much are consumers paying?

\$55/kg
(AUS Product)



\$60/kg
(US Product)



\$45/kg
(Holland Product)



\$30/kg
(AUS Product)



\$25/kg
(Holland Product)



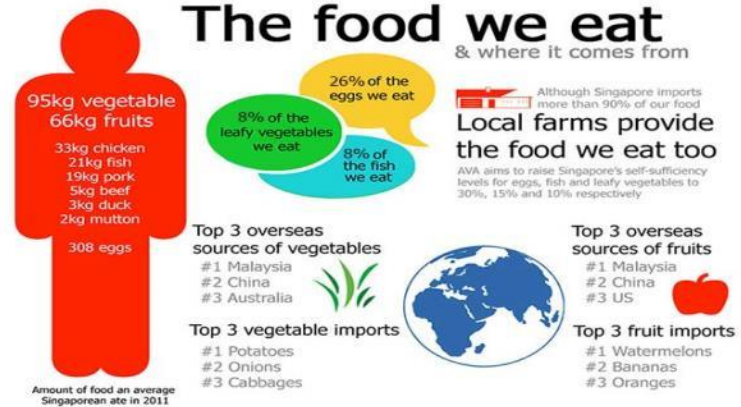
\$45/kg
(Korean Product)



Scenario: Do we have a business model to create a Singapore-Peel FZ?

- Singapore (2015)
 - Leafy Veg consumption 90K tonnes
 - Local Production: 10.8K tonnes
 - Import: 80K tonnes (S\$113m)
 - Vegetable import: S\$602m (524K tonnes)
 - L: 80K tonnes; N-L: 443K
 - Fruit import: S\$701m (444K tonnes)
- WA Veg & Fruits exports to ASEAN 34K tonnes (\$43m)
 - to Sing ~1.3% - 1.9%
 - Vegetable \$11m
 - Fruits \$9m

What must Peel do to sustainably produce 20% of Singapore's Veg, Fruit and Egg requirement??



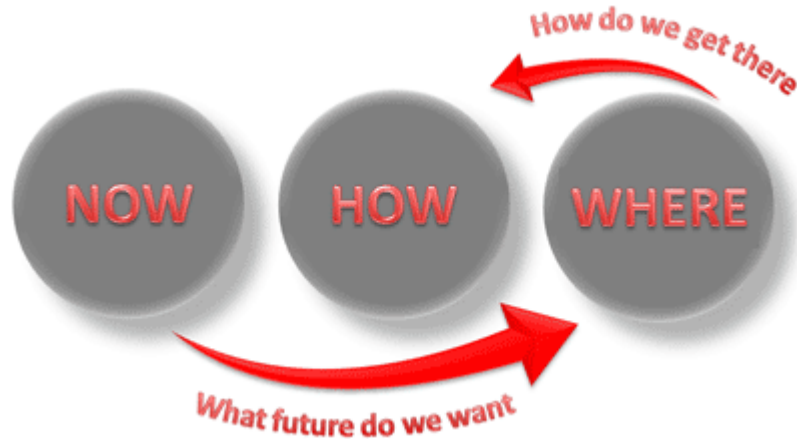
What opportunities exist for creating value added products?

Opportunities in other products?

e.g. Eggs: 1.7B consumption of which local production: 25%

What similar opportunities exist in other markets e.g. United Arab Emirates (UAE) or Hong Kong ?

So, . . .



where to, from here?



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