Lee Shao Hwa 10th June 2020

Improving Singapore's Food Supply through Natural Farming

Revisiting Old Methods with New Technology

Team

Experience Team that delivered results

- Proposer: Lee Shao Hwa
  - NUS - BEng (Mechanical) First Class Honours. MSc (EE) Digital Communications specialisation
  - 20 years product design experience taking products from conceptualisation to mass production
  - 11 patents (granted and under application)
- Sponsor: Kwek Chye Hwa
  - Director of KY Sub Assembly & Engineering
  - Provider of engineering solutions through design and manufacturing
  - Major Customers: Pratt Whitney, Airfoil, Honeywell & Halliburton

Current Issues

High Food Wastage (Worldwide Problem)

- Food waste accounts for about 10 per cent of the total waste generated in Singapore, but only 18 per cent of the food waste is recycled. The rest of it is disposed of at the waste-to-energy (WTE) plants for incineration[1] .
- In 2019, 607,000 tonnes are disposed of

Dwindling Landfill

- Semakau Landfill has seen its lifespan shorten from the initial 2045 to the current projection of 2035[2] .

Dependent Food Supply

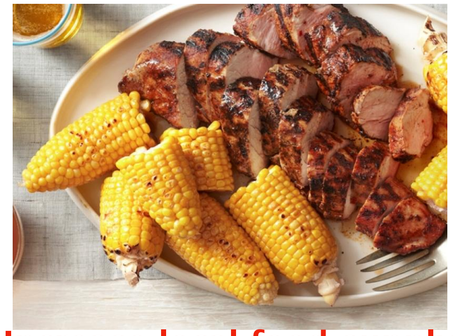
- Covid-19 situation highlighted the importance of not only “diversification” but also “self-sufficiency” in food supply for survival[3].

Year	Food Waste Disposed of ('000 tonnes)	Food Waste Recycled ('000 tonnes)	Total Food Waste Generated ('000 tonnes)	Recycling Rate (%)
2019	607	136	744	18%
2018	637	126	763	17%
2017	677	133	810	16%
2016	680	111	791	14%
2015	681	104	786	13%
2014	687	101	789	13%
2013	696	100	796	13%
2012	618	85	703	12%
2011	606	70	676	10%
2010	538	102	641	16%

Our Value Proposition

Recycle Food Waste
- 108,000 tonnes recycled
- 100% increase in Food Recycling

Reduce Pollution
- Less incineration
- Less landfill
- Less waste logistics



Increase local food supply
- >5% pork supply
- >40% live pork
- with some crops supply

Employment & Research
- Research opportunities in Life Sciences, AI and Robotics
- High Value-Add employment

Vitalise Landfill
- Make Landfill productive
- Farm expands with Landfill

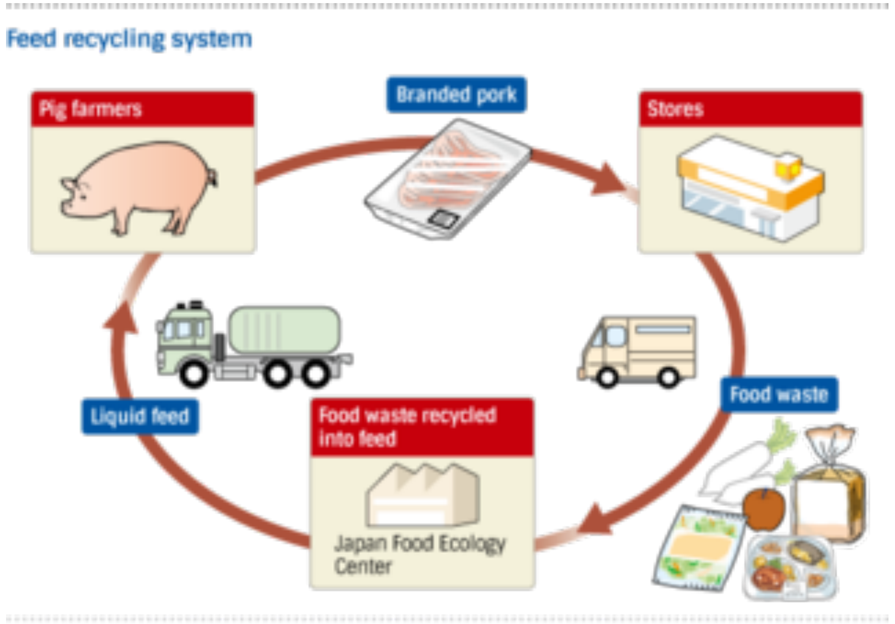
Low Startup Cost
- Concept Testing with 400sqm farm
- Low initial cost to demonstrate feasibility

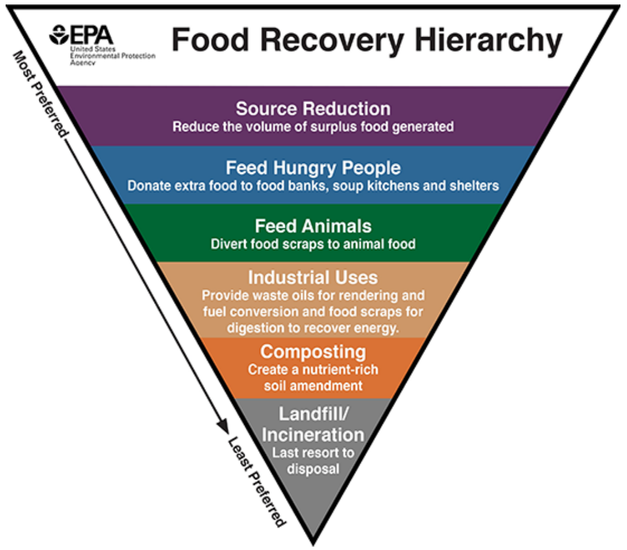
Self Sustaining Green Farm
- No air and water pollution
- Self sustaining Farm
- No antibiotics needed
- Own water and electricity

Worldwide Solution

Pigs as Food Waste Recycler

- Pigs were originally domesticated for two main reasons – pork production and waste management[4].
- Gaining Popularity Worldwide
  - Japan[5] [6] [7] - Japan Food Ecology Center's recycles 32 tons of food waste a day into pig's feed. To kill E. coli and salmonella, the finely chopped waste is put into a heat exchanger and sterilised at 80-90 C for a few minutes. Liquid feed fermented with lactic acid bacteria is ready in about half a day or a day.
  - UK[8] - The Pig Idea campaign encourages the feeding of surplus food that is no longer fit for human consumption to pigs and chickens.
  - US[9] [10] - U.S. EPA has suggested that converting food waste into animal feed is the preferred method to recycle food waste
    - MGM Resorts International, which owns most of the Vegas strip, has been trying to rebrand itself as sustainable. Their efforts seem to be working: in 2018, the U.S. EPA recognized their food recovery efforts by awarding them with a Food Recovery Challenge Award[11].
    - NJ Rutgers University[12] - Reduction of $60 per ton of trash to landfill to $30 to farm as food waste.





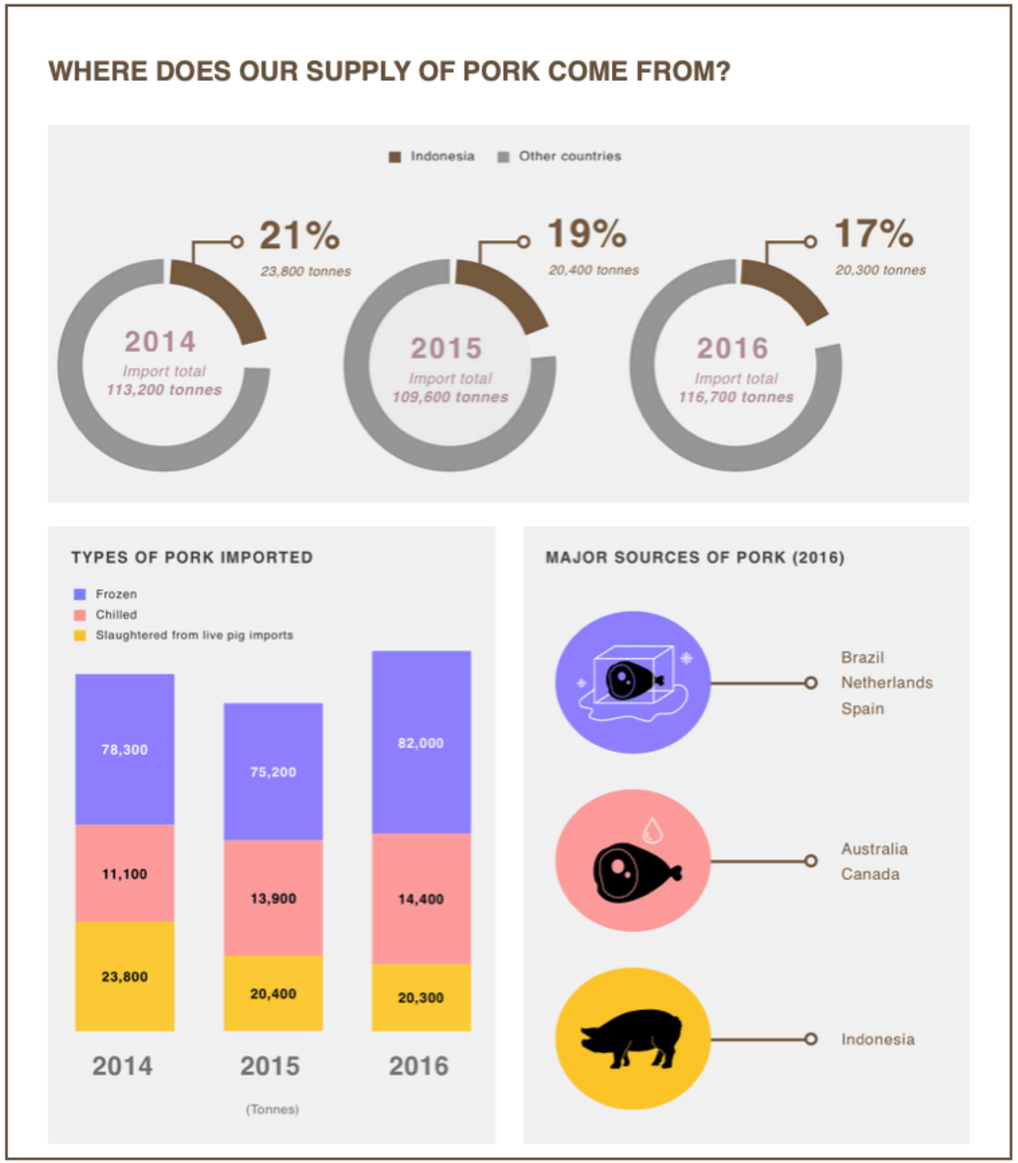
Our Target

>5% Pork Supply

- Bulan Island has 250,000 pigs and export 1100 pigs daily to SG[13]

- To date, our accredited sources of pork include[14]:
  - Frozen pork: 24 countries
  - Chilled pork: 6 countries
  - Live pigs for slaughter locally and sold as chilled pork: 1 farm in Pulau Bulan, Indonesia; and 1 in Sarawak, Malaysia

- Target 500 pigs daily with a pool of 125,000 pigs



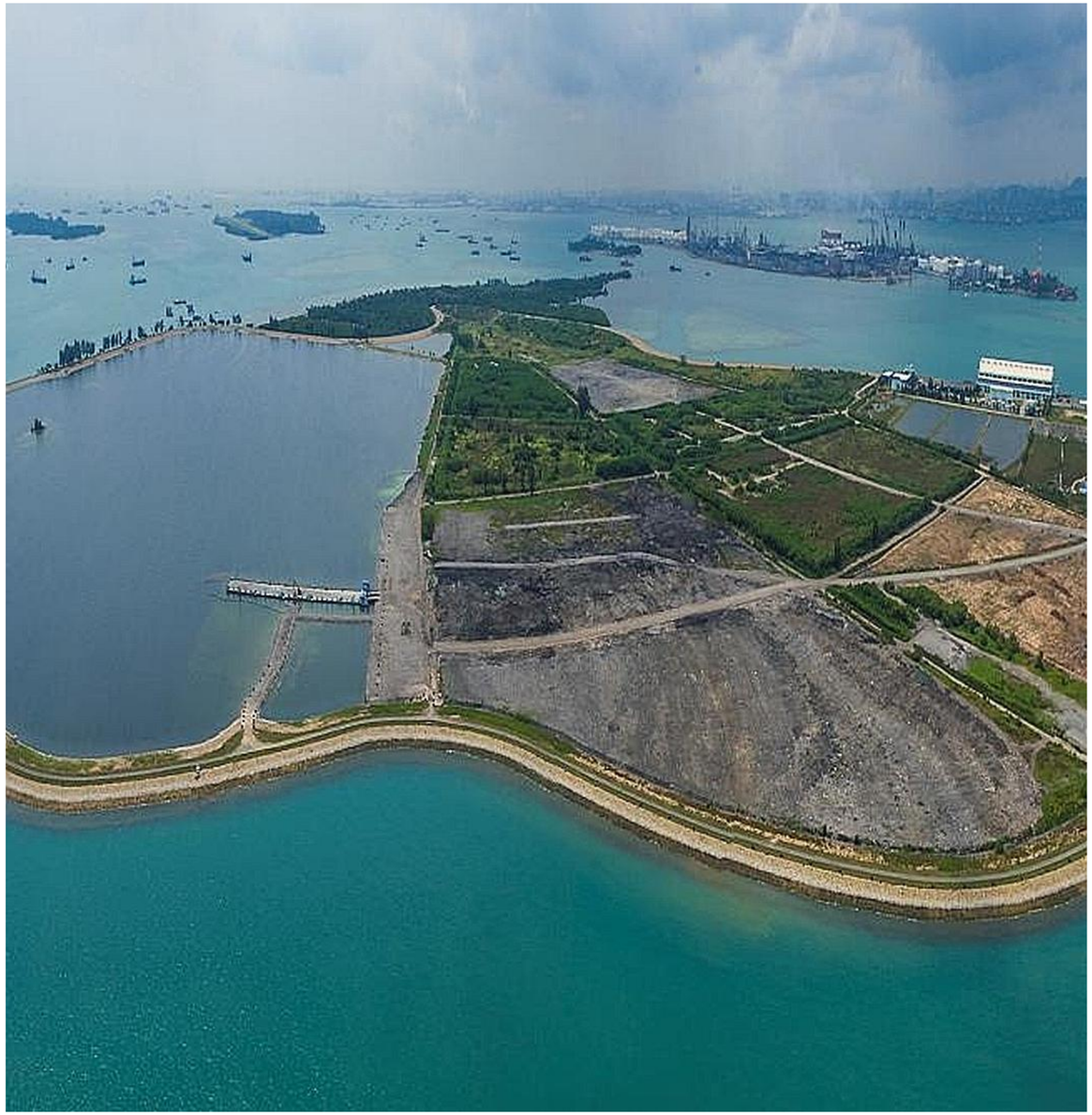
Food Waste Consumption

- 600000 tonnes of food waste not recycled.
- Assume a 18% reduction. 108,000 tonnes of food per year for pigs or 296 tonnes of food per day.
- Each pig eats 4kg of food a day. For 125,000 pigs, this make 500 tonnes. Since not all are full-size pigs, estimate about 300 tonnes of food a day.
- There should be enough food to feed the pigs.
- This equates to doubling our current food recycling effort
- By doing this we are converting waste food to good quality pork and crops for our People!

Home for 125,000 Pigs

Semakau Island

- Utilises 1 sq km of the 3.5 sq km Landfill which has low economic value.
- Houses existing fish farm, Barramundi Asia.
- Isolated from main island. This minimises risks of contamination and has no impact to main island.
- Pigs can be transported to abattoir using existing sea transportation. No roads needed.
- Easy access to sea water for Transportation and Farming.



Types of farming
Choosing suitable method

- Intensive/commercial Farming
    - Pros - Highest production. Cons - Bad air and water pollution. Lower meat quality and higher risks of sickness. Inhumane animal treatment. High Production came with a heavy price.
- Free Range
    - Pros - Best form of farming. Cons - Ineffective use of land.
- Natural Farming
    - Best of both worlds. Gaining popularity. A few variation with Korean Natural Farming seems the best.
    - Much high production than Free Range and has the benefits of farming in a self sustaining ecosystem with no pollution. Humane animal treatment in line with global farming trend and consumers' expectation.

What we proposed

Korean Natural Farming

- Invented by Cho Han Kyu. Popular in Korea, Hawaii and Thailand.
- Use of Indigenous Microorganism (IMO) that is cultivated locally not purchased commercially.
- No waste treatment necessary - manure are fermented use IMO rich soil.
- No smell, no flies[15] - this results from successful manure fermentation.
- Humane - pigs are not packed and have sufficient space to move around.
- Not antibiotics or hormones needed - IMO is the natural defence mechanism.
- Employed domestically and extendable commercially.
- Evolving and under university research[16] [17].

What is IMO?

- Cornerstone of KNF - use Indigenous Microorganism (IMO) to ferment food and wastes[18].
- Mimics forest environment and uses IMO to ferment pigs manure without need for cleaning.
- Harvest in house with local soil. No commercial license or purchase required.
- IMO is used to ferment feed for better healthier feed. No antibiotics needed.
- We are already doing something similar - Sakura Chickens[19]!

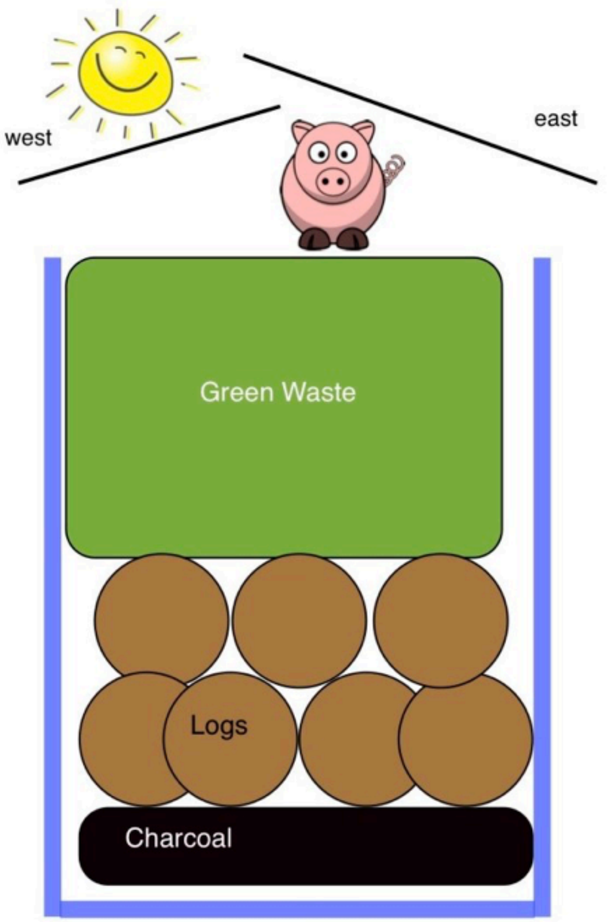
KNF -Pig Pen Design

Cross Section View

- Manure Management Plan[20]
- This requires minimal maintenance. Top soil may be periodically added.
- The structure can last for years.
- Air circulation helps keep floor dry which is important.
- Plastic Liner is to protect against excessive water but not applicable for us.
- One Pen could be 5x8m and houses 10 pigs. This is an high estimate. This works to 4 sqm per pig. Size could be as low as 2.4 sqm per pig.
- 0.5 sq km Pen space will be needed for 125,000 pigs (4sqm) or 200,000 (2.4sqm).

Deep Litter Floor Plans

Natural Farming "No Smell" Pig Technology



Building Requirements

1. Longer dimension oriented north to south
2. Opening in **top** and east/west **sides** of building to allow air to circulate naturally with heat of sun

Floor Materials

1. Plastic liner
2. 6 inches depth of Charcoal (not briquets)
3. 2 feet depth of logs greater than 4" diameter and at least 4' long
4. 2.5 feet depth of green waste such as chopped banana stalk or wood chips

For every 100 sqft

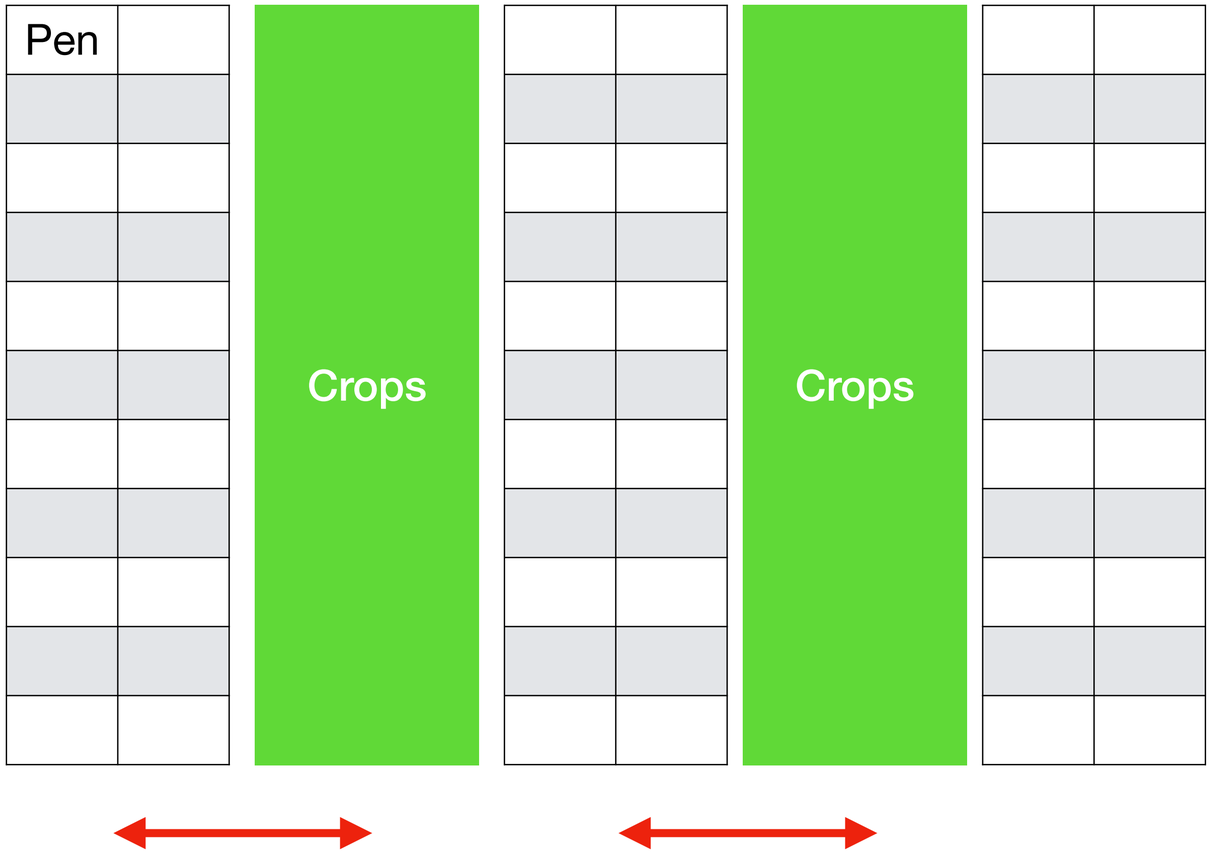
- inoculate with 2lb IMO#4
- activate with 3 Tbsp LAB and 3 Tbsp FPJ diluted in 1.5 gallons of water

Activate floor 2 weeks before introducing animals. If smell arises, re-activate. Protect from the rain and do not let floor get excessively wet.

Improving with Automation & AI

Movable Pen Layout - Top View

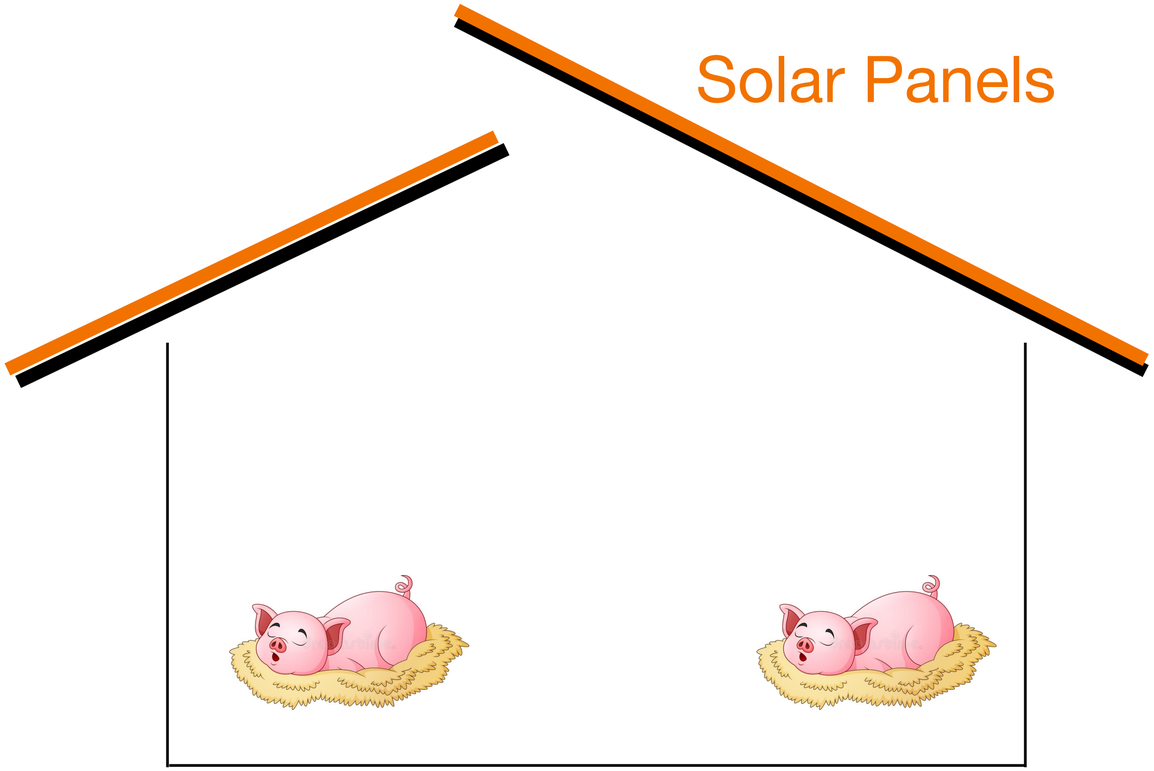
- Alternate Pig Pen and Farm Land design.
- This means a total 1 sqkm for 125,000 pigs.
- Pigs fertilise the area below and can be alternated to crops farming. Movable Pen enables this feature.
- The crops can be selected to supplement the pigs' feed and/or supply to Singapore.
- One good example is corn. The corn fruit is good for human consumption and the corn stalk is good for pigs. No wastage.
- Concept can incorporate Chicken Farming.



Self sufficient electricity

Solar Panels mounted Roofs

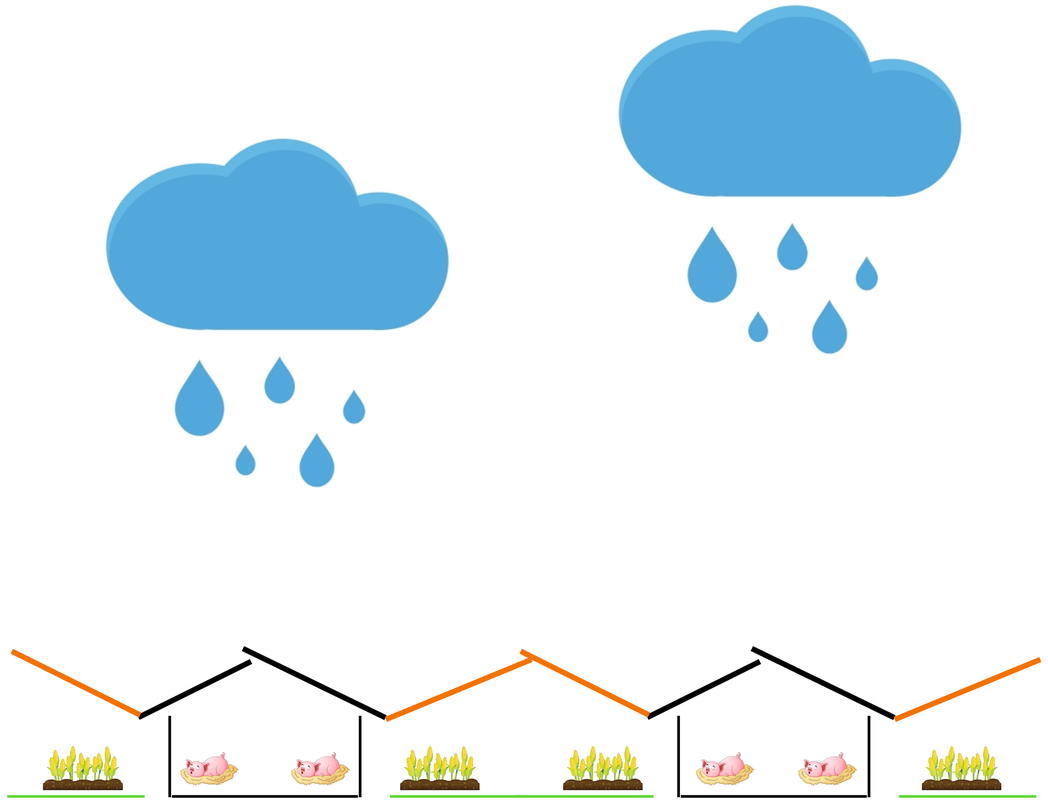
- Top of the Pigs Pen can be mounted with Solar Panels.
- Not all 0.5 sq km of roof needs to be mounted.
- The farming operation has low energy requirements.
- The farm is expected to be energy self sufficient.



Self sufficient water supply

Extendable “Open Arms” Roof

- Roofs can open up like “open arms”. This serves two purposes:
  - To protect Pen and Crops from excessive rain.
  - Maximise rain collection
- Singapore has 2340mm annual rainfall. Assuming 1 sq km, this works out to be 3.2 million litres per day assuming 50% efficiency (2.34m*1000m*1000m*0.5 / 365days).
- For 125,000 pigs, we need 4*125000 = 0.5 million litres per day.
- Hence, the farm is expected to be water self sufficient even with crops farming.
- This feature is expected to be low cost and effective.



Almost Self sufficient Food Supply

- Bulk of the food can be from food waste:
  - Raw food and outside “sell by” food are good choices.
  - Processed controlled cooked food from Army or catering services.
- Some feed can be complemented by farming alongside.
- Some feed that is less viable to be harvested, like rice bran, may be needed to be purchased to supplement the feed.
- Food should be pasteurised and fermented similar to Japan Food Ecology Center’s method. This is in line with KNF.
- Expected to charge waste food producer the cost of transporting food waste to Semakau and the food waste should be at zero cost to Semakau Farm.

Artificial Intelligence

- Video recognition AI can be used to monitor pig's growth and movement.
- Feed can be automatically adjusted depending on the Pig's size.
- Abnormal movement and sound recognition can be used as 24 hr monitoring system to serve as advance warning for sickness.
- Manure should be monitored.
- Implemented in China[21].

Phase 1
Concept Testing Stage

- Conduct small scale testing on Singapore island starting 10 pigs and scale to 100 pigs. A 400sqm farm is needed.
- Objectives
  - Work with universities
    - Conduct various experiments on IMOs to fully understand IMOs' performance. Establish the right procedures.
    - Experiment with different feeds and understand the impacts.
  - Design In House
    - Evaluate different Pen design especially automated roof design.
    - prototype automated rooftops and assess effectiveness.
- Duration
  - 1-1.5 years

Phase 2

Small Scale Test

- This can commence about one year after Phase 1 after acquiring good understanding of Farming Techniques.
- Small scale farm at Semakau with about 2000 pigs supplying 10 pigs per day can be established.
- This will be mainly a cheap setup. Some “lessons learnt” expected and heavy investment is not recommended at this point.
- Farm is expected to at least cover its operating costs during this phase. One pig is expected to sell at $300 contributing to a $90,000 a month revenue.
- Duration - 1 year

Phase 3

Full scale commercialisation

- Commercial Production can start 1-2 years after Phase 2.
- This can only begin after solid understanding of all aspects of the farming and Pig Pen design.
- There will be overlap between Phase 2 & Phase 3.

Summary

- Pig Farming can be highly beneficial to Singapore, providing solutions for many pressing problems: High food wastage, Dwindling Landfill, and Dependent Food Supply.
- Landfill can be turned to self sustaining farm that provide food for Singapore and also recycle food wastage.
- Farm at Semakau can be water and energy self sufficient.
- Isolated location from Singapore provides a safety disease barrier both ways.
- This will be a profitable business that will not require consistent Government Funding and can contribute to Government Tax. Initial Grant will be required.