Group ID: 10-31

Future Trends Report
Based on Analysis of the Team's Chosen Community / Organisation in Mid-Term and Final Evaluation

Community / Organisation Studied: FOLO Farms
STEP 1. Identify Challenges

Read the Future Scene carefully and generate ideas for challenges, concerns, and possible related problems. Choose the 5 most important challenges and write them in the space provided. Include applicable research with appropriate in-text citations.

Challenge #1: Lack of feasibility for farming as a profession

According to our interview with FOLO Farms, most of the smart people want to become bankers lawyers, doctors, computer programmers, etc. but none of them want to become farmers. Society does not truly reward farming. Farming is seen as a low job, so they reward banking and other professions with very high salary instead of farming. According to Statistics Singapore 2017, there are only 21,700 employment in Agriculture, Fishing, Quarrying, Utilities and Sewerage industry, compared to 519,200 employments in Community, Social and Personal Services industry. Furthermore, in a highly urbanized country of Singapore, there are other obstacles to encourage more people to take up a profession in farming, such as lack of land. Thus, it is a challenge to introduce smart farming when there are not many people committing their careers in agriculture. According to an article by Today Singapore, as Singapore rapidly industrialized in the 1970s and shifted its focus to higher value activities in the following decades, many farms were phased out. According to the Department of Statistics Singapore, Agriculture, mining and quarrying activities, which are grouped under the 'Other Goods Industries' category, contributed 0.027% to Singapore's Gross Domestic Product in 2017, and 0.026% in 2018.

Challenge #2: Lack of awareness of IR4.0

89.7% of the members of an online farming community we surveyed say that technology advancements, such as robotics and sensors, will be the future trend in farming, but only 64.7% of those people we surveyed say that they are willing to invest in technology to improve their harvest. This shows contradictory observations. People are somehow open to new ideas and new technologies, but they are not convinced enough to really make the investment, and are not aware of the consequences for not adopting the technologies. This shows that they are not fully aware of the trend towards IR4.0, and the benefits from it. According to a survey by CLIMMAR Congress published in October 2016, in the Netherlands, the knowledge level of the farmers about precision farming is still alarmingly low, where inadequate knowledge is registered in most of the survey categories.

Challenge #3: Lack of land

Majority (73.5%) of the members of an online farming community we surveyed say that they either have no farm or a small farm only. Understandably this is an issue for a small country with limited land like Singapore, but it speaks a lot about one of the biggest challenges in smart agriculture. Land is very important in agriculture, because most plants grow on land. Without sufficient land, agriculture activities can only be carried out at a very small scale, and that hurts the economies of scale. According to Wikipedia, in 1987, there were officially 2075 farms in the country, covering an area of 2037 hectares, an average of less than 1 hectare per farm. With a growing population, the average farm size can only be smaller. According to Mr Peter Koh, executive director and chief executive officer of Oceanus Group said that when a place is too small and not scalable, it is difficult to be profitable.

Challenge #4: Lack of knowledge

45.6% of the members of an online farming community we surveyed say that soil type and soil fertility is a problem they face, and 23.5% of them say that they have to deal with weather, such as drought or too much rain. All these speak about a truth, that our farmers do not possess enough knowledge about the wellbeing of their plants. Each plant needs different kinds of living conditions, such as nutrients and amount of water. Sometimes our farmers do not know what soil is suitable for their plants, sometimes they do not know how to water the plants, sometimes they simply do not have enough data about the soil profile and weather conditions. It seems that this problem will get worse, according to a post by Sachin Hegde in Quora, not only this generation but future generations will also be lacking the basic knowledge about agriculture. According to an article by Mission 2014: Feeding the World, many farmers in rural areas do not have the most up-to-date information on how to grow food efficiently and economically. Improving their knowledge of new techniques and technologies, in addition to providing them with any physical resources necessary for implementation, can dramatically increase the farmers' level of productivity.

Challenge #5: Lack of productivity

23.5% of the members of an online farming community we surveyed say that their plants do not bear fruits, and 33.8% of them say that their plants do not bloom. Plants not blooming and bearing fruits mean one thing, that the plants are not productive! In Singapore, with limited land, warm weather, and insufficient nutrients, plants are not productive enough to feed the citizens. According to an article by Today Singapore, with traditional methods, one can farm only about 1kg of prawns per cubic metre of water. Given the size of our farms, this problem is even more acute. According to an article in Your Article Library, Land is limited, and has almost reached the level where more expansion in cultivated area is not possible.

STEP 2. Craft the Underlying Problem

Using the challenges listed in Step 1, identify a problem of major importance to the chosen community / organization in the future. Write your Underlying Problem making sure your question clearly explains the action that will be taken and the desired results/goal of that action.

Underlying Problem:
Given that Singapore is a small country with insufficient farmland and small farming population, how might we make farming more productive, so that agricultural industry becomes a sustainable industry in Singapore by 2030?

STEP 3. Produce Solution Ideas

Generate solution ideas to the Underlying Problem in Step 2. Choose the 5 most effective solutions and write the elaborated ideas in the space provided. Include applicable research with appropriate in-text citations.

Solution #1: Use IoT Sensors to Collect Data and Monitor The Farm to Improve Productivity

We shall recommend FOLO Farms to use IoT sensors to collect data and monitor the farm to improve productivity by 2025. By using IoT sensors, FOLO can collect miscellaneous data of the farm, such as the condition of the plants, the condition of the soil, etc. and tweak the farm here and there to ensure that everything is working well and that the farm will be very productive. Since IoT sensors collect data with sensors, it will be more accurate than using a human to measure the condition of the farm. According to an article by Eastern Peak, data, tons of data, collected by smart agriculture sensors, e.g. weather conditions, soil quality, crop's growth progress or cattle's health. This data can be used to track the state of your business in general as well as staff performance, equipment efficiency, etc.

Solution #2: Use Hydroponics and High Tech Trackers to Track the Condition of the Plants

We shall recommend FOLO Farms to promote the use of hydroponics and high tech trackers to track the condition of the plants by 2025. Plants that grow using hydroponics can directly obtain the nutrients from the water, and this is going to be free of any chemical fertilizers. Because Singapore lacks space, the hydroponics can allow a lot of people to grow crops at home without using up much precious land area. Trackers can be installed to track the condition of the plants, thus allowing us to improve the efficiency of growing crops. FarmNXT has a solution to collect the large quantity of data and analyze them to arrive at informed and intelligent decisions in hydroponic farms.

Solution #3: Floating Platforms Above the Sea to Make Use of Extra Space

We shall recommend FOLO Farms to build floating platforms above the sea by 2035. Plants that grow on the floating platform can directly obtain the nutrients from the seawater, and this is going to be free of any chemical fertilizers. Because Singapore is an island surrounded by sea, the floating platforms can make use of the sea surface area for growing crops without using up the precious land area. As this is a man built platform, sensors can be installed to control the environmental parameters, thus allowing us to improve productivity and optimize the growth condition. According to an article by today Singapore, Meod, a firm backed by public-listed company Edition, developed its own vertical growing system that allows farmers to string up crops and grow them to a height of up to 4.5m, thus maximising space. There is an organisation called Smart Floating Farms which is building prototypes of floating platforms to grow crops on the sea.

Solution #4: Educate Young Generations With High Tech Farm Tours

As the Malay proverb goes, bend the bamboo while it is still a shoot. The most effective way to create such awareness is to educate the young generations. We shall recommend FOLO Farms to equip their farms with technology and organise farm tours by 2025. With these high tech farm tours, the students can cultivate their interests in farming through learning about the plants and the technology used by the farm. These student groups can in turn be evangelists for farming and agriculture. The farms can also be a great place to start inspiring people to use IR4.0 technologies, such as collecting big data and deploying new technologies to agriculture in the future. If we manage to enlist more people into agriculture industry, it will create a Domino Effect that shall eventually trigger a true revolution in agriculture. There are already some initiatives in Singapore who are giving farm tours, such as Edible Garden City.

Solution #5: Augmented Reality (AR) and Artificial Intelligence (AI) Analysis on the Plants

We shall recommend FOLO Farms to use Augmented Reality (AR) and Artificial Intelligence (AI) to diagnose the condition of the farm by 2030. Through AR and AI, FOLO can realistically keep track of the farm's condition. Sensors and trackers shall collect the data in the farm, and feed the data to the Cloud for AI to analyze. AR, on the other hand, is like a pair of glasses, through which the analysis results from the AI can be communicated to its users instantly. For example, when a farmer is looking at a plant, the information about the plant can be communicated to the farmer through AR. If there are any problems, the problem can be projected immediately. Besides, AI can also tell FOLO how to save space and increase productivity through AR. With this technology, FOLO can save manpower and reduce errors as they do not need to use human workers to diagnose the condition of the farm. A great example of AI and AR technology being applied can be seen when the Iron Man suit prompts information or problems for Tony Stark to solve. According to an article by Futures Centre, smart sensors come to rescue today. They can monitor all plants' vitals, send all necessary data in a real-time mode. Here is where machine learning comes in. Algorithms check all information, explore it to predict what pests can attack it. Also, mixed reality applications make it possible for farmers to monitor crops condition using special helmets with virtual and augmented reality.

STEP 4a. Select Criteria

Generate criteria to determine which solution idea does the best job of solving your Underlying Problem and/or addressing the Future Scene situation. Select the 5 most important criteria for measuring solution ideas and write them in the spaces provided.

Criterion #1:
Which solution will be the most cost effective to implement by FOLO Farms to improve productivity?

Criterion #2:
Which solution will likely to have the greatest impact for FOLO Farms to have a lasting effect on improving agriculture as a whole?

Criterion #3:
Which solution will be the most practical for FOLO Farms to implement to address the shortage of land?

Criterion #4:
Which solution will be the most effective for FOLO Farms to maximize the power of knowledge?

Criterion #5:
Which solution will be the greatest improvement over what is presently being done by FOLO Farms so that the challenges will be addressed?

STEP 4b. Apply Criteria

List the solution ideas from Step 3 on the grid. Use each criterion to rank the solutions on a scale from 1 (poorest) to 5 (best). The weighting for one important criterion may be doubled if necessary.

	Criterion 1: Most cost effective	Criterion 2: Greatest, most lasting impact	Criterion 3: Most practical to implement	Criterion 4: Most effective to maximize the power of knowledge	Criterion 5: Greatest improve- ment over present method	Total
Weight:	2	3	4	3	5	
Solution 1: Use IoT Sensors	4 (8)	3 (9)	5 (20)	4 (12)	3 (15)	64
Solution 2: Use Hydroponics and High Tech Trackers	3 (6)	1 (3)	3 (12)	1 (3)	2 (10)	34
Solution 3: Floating Platforms Above the Sea	1 (2)	4 (12)	1 (4)	3 (9)	5 (25)	52
Solution 4: Educate Young Generations with High Tech Farm Tours	5 (10)	2 (6)	2 (8)	2 (6)	1 (5)	35
Solution 5: AR and AI Analysis on the Plants	2 (4)	5 (15)	4 (16)	5 (15)	4 (20)	70

STEP 5. Develop an Action Plan and Evaluate its Feasibility

Develop your top-scoring solution idea into an Action Plan. Thoroughly explain how the Underlying Problem is solved, how the plan will be implemented, and how the community / organisation will be affected. Explain how this Action Plan is feasible with secondary research consulted, preferably also with primary research (feedback from chosen community / organization)

Action Plan derived from Solution #5:

Our action plan is to use Augmented Reality (AR) and Artificial Intelligence (AI) in farming.

In recent years, we have seen a lot of progress in AR and AI. In fact, they are 2 complementary technologies that will greatly benefit mankind in many industries, including agriculture. AI is all about machine learning, it is capable of ingesting tonnes of data, and makes sense of it without involving any people. As computing is moving to the Cloud, coupled with the wide availability of GPU for parallel computing, enormous computing power has now become available to ingest the data and perform machine learning. To apply AI in the agriculture industry, if we can capture the pictures and videos about the farms, we can actually use AI to interpret the data, turn that into information, and ultimately cultivate knowledge from it.

On the other hand, AR glasses are tools that overlay information over objects that one sees. Therefore, AR provides a means for people to obtain information about the objects they see instantly, and the information is typically from the AI. Via the AR lenses, one can easily access the information, such as the status and historical data about the objects, and even training information. In agriculture, AR will be very helpful, because it will be able to present the information and knowledge about the farms, as generated by AI, to the farmers. Imagine that, upon seeing a vegetable, a farmer can immediately access the information about that vegetable, e.g. how well it grows, what nutrients it needs, when it can be harvested etc, via the AR lenses. A great example of AI and AR technology being applied can be seen when the Iron Man suit prompts information or problems for Tony Stark to solve.

But this will take time to implement. So we propose the following action plan:

1. Stage 1 (2023)– Collect the data. FOLO Farm should start installing sensors around the farm, so that data, such as temperature, pH, humidity etc can start to be collected
2. Stage 2 (2024)– Install cameras. This is to capture as many images as possible. These images will be very important for training the model in AI
3. Stage 3 (2026)– Create data repository on the Cloud. This involves pushing the data in Stage 1 and 2 onto the Cloud. It will be even better to connect with other farming community, so that we can have even more data available for AI
4. Stage 4 (2028)– Create AI applications on the Cloud. FOLO will need to reach out to data scientists to train the models on the Cloud, and develop AI applications
5. Stage 5 (2030)– Integrate the applications with AR. FOLO can have the AI applications integrated with the AR devices, and then can use the AR devices in the farm

With this action plan, our farming community in general, and FOLO Farms in particular, will be positively affected. It can save manpower as AI can replace some human work needed in diagnosing the farm and taking care of the farm. It can reduce errors as humans may misdiagnose. AR technology can project the information of the plants, such as when it will bloom and bear fruits, and what nutrients does the plant need most, to the farmers in an easily understood fashion so that the farmers can fully understand the information. It can improve productivity as this is precision farming which maximizes the yield for the farm. It can also save cost because all the resources used are fully optimized.

In terms of feasibility, there are good news about the advancement in technologies, which makes our plan feasible. According to an article by Musfira F.A. and Linosh N.E., AR can be used to add dimension lines, coordinate systems, descriptions and other virtual objects to improve investigation and analyze the captured images. According to an article by Futures Centre, smart sensors come to rescue today. They can monitor all plants' vitals, send all necessary data in a real-time mode. Here is

where machine learning comes in. Algorithms check all information, explore it to predict what pests can attack it. Also, mixed reality applications make it possible for farmers to monitor crops condition using special helmets with virtual and augmented reality. This means that AI and AR analysis is feasible in the future as people believe it!

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Cite the resources you consulted using the APA format.

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