2015 iGEM HKUST-Rice Team Human Practices
The Exploratory Research on the Study of Stakeholders' Perceptions towards the In-field Use of NPK Microbial Biosensor
Interview Transcript
Interviewee: Mr. YIP, organic farmer of Natural Network Farm
Interviewers: Lok-Chun "Justin" CHAN, Yee-Ki "Alice" TO
Interview Setting: Interview was conducted in Natural Network Farm on 6th July, 2015
Transcript prepared by Lok-chun "Justin" CHAN

1. **Which method(s) did you use for agriculture?**
   In general, we use organic methods for agriculture. Chicken's faeces are normally used to make manure, besides we also make farmyard manure ourselves, which are composed of collected vegetables' leftovers and rotten fruits as well as hay. So we mainly use chicken's faeces as manure and farmyard manure, cooperated with crops rotation and growing plants in accordance to their suitable growth-season of the year, following the nature to grow the plants.

2. **Does organic farming focus on quantity or quality?**
   Well, it is a very personal question, we indeed focus more on the quality, because our organization is not production-oriented, we thus do not attach much importance to quantity of our plants.

3. **Do you mean that those commercial organic farms may focus more on quantity than quality of their plants? And normally, for those educational ones may focus more on quality than quantity?**
   Yes, you can interpret it like this. As for those commercial organic farms, they have to reach certain amount of products to ensure their profits so as to maintain the operations of their farms. Therefore, if they are commercial-oriented, they will prioritize the quantity over the quality. Say, if they want to obtain more eggplants, they may be less concerned about the quality, like their sizes before they harvest their products.

4. **How can your aforementioned agricultural methods, like what you mentioned, growth different crops in corresponding seasons, help with balancing nutrients content of the soil?**
   Chicken's faeces manure is treated natural material, when spread to the soil, certain portion of which will be absorbed by the plants, and they absorb nutrients depends on their needs, while the rest will retain in the soil. The surplus manure may be washed away by rain water, that way, it is either captured by the soil or washed away, and would not affect the insects' living in the soil. Moreover, soil also contains a number of microorganisms, which would also decompose the manure into other mineral particles. Indeed, the microorganisms contribute a lot in maintaining the balance of soil nutrients content. In normal practice, the amount of manure we add to the soil should be within the acceptable and tolerable range of both the soil and the microorganisms.

5. **So you mainly make use of the microorganisms to maintain the balance?**
   Exactly. Also, we add manure to the soil quite frequent, though the amount we add each time is lesser to avoid creating great burden to the soil and microorganisms. That is how we have our soil-control manually.

6. How can you decide the amount of manure to be added?
   It depends on which kind of crop we are growing. For example, when we grow certain vegetables, we usually add manure once a month. When we grow certain fruits, like

tomato, we would add it more frequently, twice a month. While we are growing larger plants like winter melon, we usually add manure 3 times in the first month then twice starting from the second month.

7. **Do you have any quantitative means to measure the amount of nutrients that the plants require?**

   Our agricultural practice does not involve much quantitative measure; we add nutrients to the soil rather casually instead. Interviewer: Got it! Let me introduce some information about our project first, we aim to make a biosensor that can be divided into 2 main groups: first, biomolecules which make use of enzymes, proteins or certain biochemical to detect our desired targets. Second, it is microbes; microbe we are using is Escherichia coli. We engineer their genes to perform and achieve desirable function – detection of certain chemicals. Just like what we are doing this time, the E.coli gene is engineered to make it capable of detecting amount of potassium, nitrate and phosphate ions in the soil. The advantage of the biosensor is that it can give us the detection result efficiently.

8. **How long would it take for the detection time?**

   It takes around 10 minutes to 1 hour, according to the international standard. Of course, we are yet to have our final product of the biosensor until now so we are not able to tell you the exact duration for detection. Moreover, the cost for it is relatively low as the number of microbes proliferates under rapid cell division. Furthermore, the microbes also decompose themselves and undergo cell death regularly so the biosensor will not do serious impact to the environment. And let me provide more information about that, if our biosensor is able to monitor the change of a non-usable form to an usable form of an nutrient during conversion by biosensor, does it help farming?

   Yes. If the biosensor can monitor the duration and the rate of the conversion process, the amount of nitrogen being converted to nitrate, this can help with our farming. Or, if the biosensor can tell us the amount of usable nutrients in the soil, it will benefit agriculture so much. Knowing the amount of nutrients, which will be absorbed by the plants in the soil, poses great advantage to farming.

9. **So after learning about our biosensor, what is your attitude towards it? Positive or negative?**

   I have a positive attitude towards it for sure. As it can detect certain nutrients, and can report the data, telling us which nutrient is in scarcity or in excess.

10. **Would you do any soil test regularly?**

    We do not do any.

11. **So you just manage the soil base on your experience and the natural cycle?**

    We do not do it quantitatively; rather, we usually monitor the soil quality by observing the plant growth.

12. **Should soil nutrients be well-maintained over time or replenished when there's a deficiency?**

Ideally, we should maintain the soil nutrients to specific level over time. It is less desirable to replenish when there is a deficiency.

13. **So you examine the soil quality mainly by observing the plants' growth?**
    Yes. Our method is less scientific; we mainly do so by observation. Well, indeed the detail we can observe is fairly limited, and a long-term observation is needed to obtain result.

14. **Will it be too late to know about the soil condition when plants are approaching maturity?**
    Yes, it will be late. Normally, if we realize there is nutrients deficiency in the mature crops, we will immediately replenish corresponding nutrient to it, while it depends on whether the plant can efficiently absorb the nutrients and compensate the deficiency. Though generally, it is still a little bit too late.

15. **Is it an inefficient agricultural practice to replenish soil nutrients when plants are poorly grown?**
    Yes, it is inefficient.

16. **Will it be in no avail even if you replenish the nutrients to the plant immediately? Say, if the leaves already turn yellow, will it become healthy again if you supply nutrients to it at once?**
    The situation is quite difficult, if there already exists certain serious deficiency disease in the plant, it is very difficult for it to recover. Even if the symptoms are not obvious, based on our experience, it is still beyond

17. **You may face an elevation of nutrients in farming, do you know this redemption problem? How is the plant growth in such condition? Can it be seen?**
    We have not encountered this problem before.

18. **Base on your knowledge, how is the plant growth in such condition?**
    Don't know

19. **Can this condition be seen?**
    Don't know

20. **Do you know about the adverse effects of prolonged luxury consumption by plants?**
    Actually, a plant will stop obtaining nutrients when it is sufficient. For example, during the growth of the plant, if there are a lot of nitrogen-content nutrients in the soil, the plant will focus more on its leaves' development. However when the plant grows fruits, the fruits may not be that corpulent. Indeed, this condition takes place only if there is a very imbalanced and singular nutrients supply from the soil.

21. **Is it an extreme case?**
    Yes, it should be.

22. Is soil condition or plant growth the main concern?

We are more concerned about the soil condition under the principle of sustainability. We grow different plants in various seasons of the year, like a rotation; however, we use the same soil over years, so we are more concerned about the composition and nutrient content of the soil.

23. Is this a sustainable farming practice, as claimed by organic farming, if replenishment is done only when there's a deficiency?

Um… I should say that only if we maintain the soil nutrients content to a certain stable level could we designate it as a sustainable practice. We should come up with practices that can maintain the nutrient cycle in the soil to achieve the sustainable development of the soil. Sometimes, we also do the replenishment after realizing the deficiency, this kind of practice should actually be avoided in the future.

24. Knowing the total concentration of a particular nutrient, instead of a particular compound, does it help?

I would prefer knowing the concentration of a particular compound, especially those in the soil. The reason is that, say, in nitrogen cycle there.

25. What kind of detection would you prefer other than nutrient are certain nitrogen containing compounds being absent in the soil, so we may need not to know about those not showing up in the soil. Concentration detection by means of biosensor? Heavy metal? pH? Electrochemical values?

We want to know the information of both the heavy metal and pH value of the soil. Besides, it is also in want to know more information about other derivatives of NPK in the soil. Indeed, we want to know the entire nutrient content in soil, which are essential to the plants as well as the number of microorganisms present in the soil.

26. Is using genetically-modified-organism-containing machine in field an appropriate practice in organic farming? WHY? What principles of organic farming are violating?

In my opinion, it is not an appropriate organic farming practice. As the genetically engineered microbes are not naturally bred organisms, and are artificially modified, this point violates the principle of organic farming.

27. What factors will you take into account when considering whether you would use our NPK biosensor or not? What makes you want to use it?

As it can show the nutrient content in the soil, which can provide us some direction to improve our soil quality. This let us become capable of growing crops and plants with better quality.

28. So what about cost and time needed for the detection? Are they the factors that you are concerned about?

Yes, our farm is not a commercial one, we are not selling our crops in the market; instead, our farm is education-oriented, we just aim at letting the participants to experience more about agriculture so it is hard for us to buy a machine and specifically detect the soil nutrient concentration. Our main goal is to educate, so it is okay for us not

to successfully growth the crops. Therefore, it may not be an incentive for us to use the machine.

29. **As you mentioned, your farm is education-oriented, so time required for detection would not be a factor affecting your incentive to use the biosensor?**
    Time required for the detection is not what we are concerned about. No matter how long it takes, like 1 week or 1 month, to give the result, it won't do much effect to our operation. Even if the soil is in nutrients deficiency, the participants can also experience the farming practice, like cutting the herbs.

30. **Let me talk more about what we are doing in the laboratory now, we are trying to incorporate the 3 systems which detect N, P and K respectively together into the microbe. Though, we still haven't done any risk assessment. There may be certain potential risks, for example, soil pollution, soil degradation and uncontrollable outbreak. Now, with all these potential risks, do you still have a positive attitude towards our biosensor? Or will you have a more negative attitude?**
    The level of my positive attitude towards this is declined, but my attitude is still rather positive. As without this kind of project, our knowledge on the soil is still quite limited, and I am also interested in knowing more about the relation between the soil and the microorganisms.

31. **How should the data presented? What makes it easier to understand and clearer to read?**
    I prefer knowing the data in terms of numerical presentation, which makes the result more accurate.

32. **We wanted to contact some local hydroponic farms, do u have any suggestions?**
    Wing Lam