SUSTAINABLE FOOD AND AGRICULTURE

Vertical farms, plant-based proteins and smart tractors could disrupt what you eat and drink.

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Malcolm Borthwick (MB): Hello and welcome to Disruption Week. Thanks for joining us. I'm Malcolm Borthwick, Editor of Intellectual Capital at Baillie Gifford. During Disruption Week we're exploring four sectors which are going through transformational change. And so far this week we've explored three of them, payments, healthcare and mobility.

The subject of today's webinar is agriculture. The world's population is expected to increase from 8 billion to 10 billion by 2050. And to feed what will be an increasingly rich and urban population, food supply will need to increase by 70% of this period according to the United Nations. And this will put pressure on a system that's already under strain.

For example, agriculture accounts for 50% of the world's inhabitable land and habitable land even. And it accounts for 70% of the world's freshwater supply. And also a quarter of the world's greenhouse gas emissions. And some estimates are higher than that.

So, how can we rise to the challenge of using less water, less agricultural land, fewer pesticides, less heavy machinery? And also, how can we use innovation to use technology to make it more efficient for farmers in agriculture?

Joining me to discuss this is Lee Qian, who's an Investor Manager at Baillie Gifford. And Lee joins us in our studio here in Edinburgh. It's a bit of a damp day in Edinburgh as you can see outside. Lee, great to have you with us.

Lee Qian (LQ): Hi, Malcolm. Thanks for having me.

MB: Great. Thanks, Lee. So, in terms of the structure of the webinar, it'll be 45 minutes. Lee will set out the case for disruption for the first few minutes. We'll have a conversation after that. And then we want to hear from you, the audience, with your questions. And we hope you'll have plenty of questions, and our conversation will spark lots of debate. So, if you do have questions, please use the Q&A button which you can find at the bottom of your screen.

And we're also interested in your views about a poll that we're about to bring up. And I think what interesting in the poll is we're going to be discussing a lot of these things later in the webinar. So, we'd like to get your views before we start the discussion on it. So, the subject of the poll is which of these innovations do you think will be most influential when it comes to agriculture? And you've got three options, if you could pick one. So, one of them is plant-based proteins. Here I'm thinking of things like plant-based meats, maybe plant-based burgers that you can find in Burger King and elsewhere.

Secondly, indoor vertical farming. This is where LED lights are used to grow crops indoors year round, mainly things like watercress and spinach and bok choy and things like that at the moment. And finally, precision agriculture where technology is used to make farming more efficient. Here I'm thinking of drones and autonomous tractors and that kind of thing. So, if you could select one of those, and we'll come back to that a little bit later.

But let's start the conversation. Lee, what I think is really interesting about agriculture, and it's the final one in our series, but also, it's probably the oldest sector to be disrupted. And also, the potential for disruption may be the greatest here.

LQ: Yes, absolutely. So, I think agriculture and food is one of the most important things in life. Every one of us needs to eat every single day. We can't live without it. So, it's importance can't be overstated. And you're absolutely right, it's one of the oldest industry of civilisation moving from a hunter-gatherer society 10,000 years ago to a settled community based on agriculture really kick started human civilisation as we know it. So, it's just a really important sector.

And it's also one that has been very hard to change. And there are good reasons for that. If we think about farmers, for example, most of farmers are operating on razor thin margins. They don't want to gamble with new technology because if it doesn't work, and if one year of crop is ruined, then that's their livelihood gone. They could be facing bankruptcy. So, they are extremely cautious about experimenting with anything new.

And then think about consumers, you and me, and the food that we eat and the stuff we bring to our mouths. We are extremely careful about what we eat as well, and rightly, for good reasons. The evolution would have made any animal or any human being that's incautious about what they eat extinct. So, for those reasons, I think, food and agriculture have been hard to change.

But why am I am optimistic about the next ten, 20, 30 years for innovation in the food and agriculture space? Well, I think, first, the need for change is greater than ever. And I think one statistic really bring this out. Since 2000, the cost of beef in the US has risen by 200% relative to just a 60% increase in inflation. So, the price of beef has been rising three times as fast as overall inflation. And why is that? It's simply because it's an extremely inefficient way of raising protein to eat. The US livestock industry, for every 100 calories that goes into the livestock industry as input, such as feed, only seven calories come out as edible protein. So, that's efficiency of 7%.

Now, as you said, as the world population increases and the demand for food increases, but our supply of land, of inputs such as water, those are finite. So, with any inefficient technology the price will just go through the roof. So, we must find a more efficient way of growing our crops, growing our food and coming up with protein so that we can satisfy a growing population. So, I think that's really a need for change, to make food just affordable so that people can eat.

And then there's another element, is that just the amount of new technology has been expanding. And you mentioned that this week we have discussed a few areas such as healthcare and biology advances. All of that, and on top of the improvement in semiconductor data technology, it's just creating a proliferation of

opportunities for innovation and new technology to make agriculture and food system more efficient. So, I think for those reasons I'm really optimistic about innovation and disruption in the food and agriculture sector over the coming years and decades. I think there could be a lot of exciting investment opportunities as well.

MB: I think that's really interesting, especially in terms of your comments on food inflation, which is very topical at the moment, given fuel costs and other things. So, let's get to the results of the poll. It's really interesting results here because you, the audience, are really split on this. Plant-based proteins, 39%, indoor vertical farming, 24%, precision agriculture, 37%. So, it's very close between plant-based proteins and precision agriculture. So, let's start with what you, the audience, have suggested and what's most significant to you, which is plant-based proteins.

I think what's really interesting here, Lee, is, I guess certainly the Western diet is very heavily dependent on meat. How do you think consumer behaviour... Where are we with consumer behaviour, and is it changing at all?

LQ: So, if we think about meat, why we eat, it's so culturally ingrained in the way we eat, thinking about Christmas or Thanksgiving, you have your turkey. And trying to think about, okay, well, let's replace it with tofu. And that's just really hard. So much of what we eat is embedded in the society, in our culture. So, it is very hard to change.

And in the past, a lot of the vegetarian options, they haven't tried to mimic the sensory experience of animal protein. So, it's always regarded as kind of an inferior option, or tofu. It doesn't quite hit the spot as a meat option. And as a result vegetarians have been about 5% of overall consumers. And that has been quite stable, and it's always been kind of a small niche.

But the reason I'm excited about plant-based protein, or the new generation of plant-based proteins, is that they are trying to mimic the sensory experience of meats. And I have tried a number of those, and they taste, they look like, and texture, once in your mouth, it feels like animal protein. So, you're not having to make the sacrifice in terms of your enjoyable experience of eating it. And that just makes it easier for mainstream consumers and for meat eaters to adopt plant-based proteins. And if you give them the option that, hey, you can have this dish which tastes just as great as animal-based protein, but is also healthier, and it has less of a carbon footprint on the planet, then the choice is just becoming quite easy.

And then, on top of that, right now plant-based protein, a lot of them are still more expensive than animal protein. But as mentioned at the start, animal protein is increasing in cost because it's a really inefficient way of growing protein. But plant-based protein, we're optimistic with improvement in technology and scaling up of the manufacturing, the cost will decrease. So, in the long term, we will have an option which is just as tasty as animal protein, potentially cheaper, good for you, good for the plant. So, I think that could be a very exciting opportunity.

MB: You mentioned the long term there, Lee, and I think what's really interesting is, if we look back through history, in the 17th century, in certain parts of Europe there was a lot of scepticism for eating potatoes, for example, because they weren't mentioned in the Bible, and some thought they caused leprosy. Do you think that we'll reach the stage further down the track where meat will be the niche product as opposed to the other way around?

LQ: Yes. I think there is quite a realistic probability that might be the case. I think maybe in 20 or 50 years' time, we will look back and think about the idea that we would cram 10,000 chicken into a small hut to raise them in really awful, poor conditions, and then eat the carcass of that product, might just feel

extremely outdated, unsanitary and weird. So, I think that's entirely possible that in the long term we will look back and think about the current practice just as really outdated.

MB: Let's go to the second option that our audience have chosen, which is precision agriculture, just a couple of percentage points behind. So, I'm going to bring up a picture on your screen which is of John Deere's See and Spray technology, which is interesting and used a lot in North America in a lot of John Deere's sales there. If you, Lee, could talk a little bit about this and the benefits of precision agriculture, that would be great.

LQ: So, with precision agriculture the idea is that to integrate increasingly sensor-camera communication and software technologies into agriculture equipment, tractors, planters, harvesters, etc. to make them smarter, more efficient, and as a process make farming practice more sustainable and less resource-intensive.

So, I think the See and Spray technology is a great example. What that is is in front of the tractor there's a camera that can analyse, with the help of computer vision analyse in real time what's in front of it. And you are able to identify what is a crop and what is a weed. And then the sprayer at the back will only apply the pesticides onto the weeds and not the crop. Or they will only apply the fertiliser onto the crop and not elsewhere. So, by doing that they can drastically reduce the amount of pesticides and fertiliser that's being used by more than half in some instances.

And we know that the over-spraying of pesticides and fertiliser has a very detrimental impact on the environment. So, if we can cut down on those, and whilst still at the same time, growing more and more crop to feed the growing population, then that would be a great improvement.

MB: And I want to talk about some of the companies that are driving this innovation. And here I'm thinking, in particular, John Deere. What I find interesting about John Deere is that often with disruption, so, a company coming from the outside in... But looking at some of the ways John Deere are exploring the future of agriculture, they're managing to stay ahead of the curve as well, aren't they?

LQ: Yes. It's in some way quite an interesting example of incumbents that has been innovative and investing aggressively in future technology. And we don't see that very often. In the automotive sector, when we talk about mobility, a lot of it is startups coming to disrupt the industry. But in farming, John Deere seems to have got the right strategy.

They have been investing in precision agriculture for the last 20 years. The company invests over a billion dollars in research and development every year. So, that's a huge amount going into coming up with new technology, whether that's See and Spray or even more advanced technology like drones or autonomous tractors. So, they seem to be taking a long-term view. They seem to be looking at what are the future technologies that could really impact on farming over the next five, ten and even longer time frame, and trying to incorporate those technologies and stay ahead of the curve. So, it's a very interesting company, given the context of its 180-year history.

MB: And I think I can see why a lot of this technology would work in the developed world. I can see it in North America on the huge farming plains of Saskatchewan and elsewhere. But what about the developing world? What innovations are we seeing there?

LQ: I think in the developing world you do need to have localised innovation and that you develop services and products within the country rather than just shipping existing solutions from developed world to developing countries.

We see there are quite a lot of innovative companies in developing markets that are improving farming. And a good example will be a business like Safaricom which is a telecom operator in Kenya. But they also have part of their business called Digicom which is helping to improve small holder farmers by providing them with more timely access to information such as weather pattern or crop prices, so they can plan ahead and decide what to farm and how to farm. And they also provide a better way to access the market to sell product as well. So, we are seeing quite a lot of those local innovation that are targeted for specific countries or communities which can have a very positive impact in developing countries.

MB: And I hope you don't mind, Lee, I might jump about a little bit before we go on to the next one which is indoor vertical farming. I wonder if maybe, I think we could have explored with plant-based proteins some of the companies there that we're seeing innovating. To go back to plant-based proteins, which companies there are you seeing innovating in this area?

LQ: I think there are clearly companies, startups, disruptors, the likes of Beyond Meat and Impossible. They have really pioneered the plant-based protein sector for the meat alternatives. And they have built now a really convincing product, as mentioned, that replicates the sensory experience of eating animal protein. They have built out their distribution. They have a very strong brand. So, those businesses have, I think a decent chance of capitalising on that opportunity.

We're also seeing a newer breed of companies that are working on what's called lab-grown meat, which is trying to grow cells, actual animal cells, indoor in a lab, rather than using animals to grow protein. It's brewed in big, vast tanks, and use that to create protein as well. It's a much earlier technology and much more expensive. But it has potentially interesting applications to mimic whole cuts of meat, think about like a steak rather than a sausage or a burger. So, that could be another interesting opportunity to keep our eye on.

MB: But there's still quite a lot of scepticism I think within society of lab-grown products, aren't there, and genetically with these products?

LQ: Yes, definitely. I think trying to get the consumer acceptance will be a very important hurdle for those businesses to overcome. And I think it's true, an open question, just if plant-based protein can do really well in terms of mimicking the sensory experience of eating meat, what would be the role of a lab-grown alternative? Is it as desirable as a plant-based protein? So, it'd be interesting to see how those two complement each other or compete against each other.

MB: And let's move on to the third topic we wanted to talk about which is indoor vertical farming. I think indoor vertical farming is quite a hard to conceptualise. So, there's an image up on your screen at the moment which is of an indoor vertical farm in Newark, New Jersey. And this is one of AeroFarms' vertical farms, and they're growing things like kale, watercress, bok choy and things like that there. Where are we at the moment with indoor vertical farming, Lee?

LQ: So, there are a lot of interesting advancements in vertical farming, once again piggybacking on a lot of innovation elsewhere in the industry. Thinking about LED lighting and getting more efficient and cheaper all the time because we are installing that in our homes. Semiconductor is getting cheaper. Data and computation technology are improving. All of those are key ingredients into indoor vertical farming. So, we're seeing rapid progress in that sector.

Right now a lot of it is still used to grow high-value crops. So, as you said, lettuce, bok choy, that kind of stuff rather than volume crop like wheat or potato. And I think to get to that level we need costs to come down a lot more for indoor vertical farming. And it'd be interesting to see what technology might enable that over the coming years and decades.

But it's certainly an area with tremendous opportunity and tremendous positive impact as well because you are growing crops in a controlled environment, so, you don't have to worry about pests or insects. So, you don't need to spray pesticide. A lot of the produce from indoor vertical farming are organic and they are premium, so they can have a higher value as well, a higher price.

With indoor vertical farming you can locate those closer to urban centre, so, next to a city or in a city using old abandoned factory space, for example, which means you don't have to transport food across the world or across the country which has a huge carbon footprint as well.

MB: So, I get the impression with indoor vertical farming that it's still at quite an early stage. We talked about precision agriculture with John Deere. We talked about plant-based proteins with Beyond Meat. There seem to be fewer companies maybe that you're looking at. But I know that within your research framework that we have relationship with The James Hutton Institute, for example, in Dundee, not far away from here. And it's something that you're looking at through research, but maybe not investing in it at the moment yet.

LQ: Yes. So, it is an area we are researching. So, The James Hutton Institute is a great example. They are experimenting with what's called a carbon negative farm. And we are seeing interesting startups as well. So, through our private companies team we are meeting with some companies that are working in the indoor vertical farming space.

And, as we know, with those type of technology-based innovations, once technology improves to a point where adoption becomes possible, the growth can be extremely fast. It's that typical hockey-shaped growth once you've figured out the solution and you address the pinpoint, the growth opportunity can be really fast. So, I think it is possible that over the next five or so years, well within our investment time frame, that we will be able to see a few scalable businesses operating in the indoor vertical farming space.

MB: It's interesting that you talk about that, the hockey-shaped curve. I mean, as an investor, how do you choose or select when to invest? Do you wait for a company to reach a certain scale before you invest? Or how do you approach it?

LQ: So, for us, we need to think about... We're looking for validation that the technology has a likelihood to succeed. So, we would be looking at research that helps us to understand the properties of this new technology and the economics of it and how quickly it can improve and at what pace. And if we can gain confidence that the technology has a realistic chance of making an impact, and we can also gain confidence that there is a very strong management team behind it, then that starts to give us interest to think about investing in those businesses.

So, we don't have to wait until a business is completely proven and is profitable and is already making a huge impact. Because by then everyone else would know, the whole market would know. So, it would be very difficult for us to have a differentiated view. But by researching companies early on, by leveraging with relationships such as The James Hutton Institute and other academic sponsorship we have and speaking to industry experts and collating wide sources of information, that helps us to form a view and potential insights before the market is giving value to that particular technology.

MB: It's interesting. There are a lot of commonalities in terms of what we've heard earlier this week as well, Lee, in terms of what you're mentioning there, especially in terms of management teams and culture. I want to go to audience questions now because there are lots coming in, one which is, is it just about eating differently, or do we humans need to eat less?

LQ: Well, I think we need to eat differently, there's no doubt that the over-consumption of animal protein is detrimental to the environment, to health. The overuse of antibiotics in the livestock industry is really scary, and is heightening the risk of antimicrobial resistance. So, we do need to chance what we eat. The amount that we eat, yes, there will be some countries where the average consumption, just from a calorie perspective, is more than what is required. And I think by education and improving consumer awareness of the importance of health and good diet, we can start shifting that to a better level of consumption.

And then, we also should think about how to reduce waste in the food system as well. So, a lot of produce wasted in the food system, partly because things go out of date due to really bad distribution. So, if you have an indoor farm in a city, you don't have to spend days or weeks to transport that food, and some of those won't go off in the intermediate time. So, there are ways to reduce waste as well. So, I think we need to approach this problem holistically. There isn't a silver bullet for this very complex problem. But there's a lot of areas where innovation can be made and improvements can be made.

MB: Absolutely. This is an interesting question. With regard to farms of the future, will a good internet connection be more important than the quality of the soil?

LQ: I think we will probably need both. So, definitely, the new precision agriculture technologies require internet connections. And it's actually interesting that John Deere is working quite closely with different companies to improve access to 5G in rural communities because they know that it's important for the adoption of precision agriculture.

But at the end of the day, you need soil to grow crops, and so, soil health is very important and is something that is often neglected because the current practice just assume that just apply fertiliser and that will solve the problem. But this is not a long-term sustainable solution. We need to think about soil health. We need to explore different farming practices such as no-till farming or using low compaction equipment on the farm. So, I think all of that to improve soil health is important as well.

MB: Especially with the depletion of groundwater supply in a lot of these developing countries. And also there's a potential for a whole other new debate there about whether or not space satellites could provide some of the answers. But that's a whole other discussion, maybe the disruption of space.

So, there's a question that's coming in here about nature's ability to provide solutions here. What are nature's answers to solutions here?

LQ: I think there are a lot of natural solutions. So, so far I said a lot of the improvement in yield has been coming from using fertiliser, pesticides, synthetic products that are made through chemicals that... A lot of it comes from the petrochemical industry. But there are also ways in which biology can improve farming output. There are a range of companies that are exploring the use of microbes in soil to improve yield. So, they can coat seeds with a particular strain of microbes, and that will help to protect the crop. And some of the microbes can also fixate nitrogen from the air, and then give that nitrogen to the plants. So, reduce the need for chemical fertilisers. So, there are definitely natural-based solutions, and there are more companies looking at those as well.

MB: And speaking of solutions, this is a great question that's come in about vertical farming and whether or not it'll reduce the need for countries like the UK to import so much fresh food, particularly out-of-season fresh food. I mean, I always feel bad buying blueberries from Peru this time of the year, which isn't a great thing. What's your view, not on blueberries, but on whether or not it will reduce the need for the countries like the UK to import food, vertical farms?

LQ: I think definitely there's that opportunity, especially for out-of-season crops or high-value crops, growing them near urban centres or in abandoned spaces that are currently just not being used, and grow those crops in the countries, or even better, closer to the area of demand. That will reduce the need to transport foods across long distance. It will reduce the vulnerability of the supply chain that we all live through right now, and it will reduce costs, and it will reduce the emission of the foods that we eat as well.

MB: I remember having been based in the Middle East for a while. There are quite a few indoor vertical farms coming in there, especially in countries like Israel for that reason, because they're so dependent on importing. This is a sizeable question, actually. With the innovation we're seeing in agriculture and food, what is the risk of food overall becoming more expensive and less affordable for those in poorer regions, less well off? And how do we balance that?

LQ: That's a really good question. I think the sad reality is that food is getting more expensive already. As mentioned that price of beef has risen three times as fast as inflation in the US. And as demand for food in those areas increases, they are taking up resources from emerging markets. Food is a global market. So, if any innovation that can make food more efficient, that will require less input, then that should have a beneficial impact in the cost of producing food and make that more accessible for people across the world.

We do need to think about the accessibility of food and equality of access, not just in terms of emerging markets and developed world, but also within a particular country there's a huge range of income levels. Even in the UK, it's incredible, the amount of people that are relying on food bank. The work of Marcus Rashford has highlighted how tragic the situation is even in a developed country like UK.

So, we definitely need more policies to make sure that food is equitable and the accessibility of food is fair for everyone, regardless of their income level. And we think that technology has that beneficial impact in terms of lowering the overall cost of producing food and therefore making it cheaper. But, of course, we still need policies to ensure that people are not left out.

MB: Quality and access is really important, as you mentioned. How does that fit into your investment process?

LQ: See, it's important when we consider the business practice of a company that we invest in and how they engage with communities, how they think about their broader responsibility on society. So, it's quite interesting that, for Beyond Meat, for example, at the start of the pandemic, they had a huge campaign where they were donating a lot of their plant-based product to people who were either on the frontline in the health pandemic, or have been badly affected by the dislocation from Covid. So, we do think about the overall business practice and how they consider their impact on wider society.

MB: We've probably got time for one more quick question. How do you think about aspects of companies you invest in which might be having a negative environmental impact? Surely the majority of a company like John Deere's machines are still diesel powered.

LQ: I think that's important to consider. And how we think about it is holistically the impact of this business. And one question we ask is, imagine if the company doesn't exist, would our society be better off or worse off? I think in John Deere's case, if there isn't a company that is continuing to push innovation and continuing to reduce the environmental impact of agriculture, then the world will clearly be worse off. So, I think the fact that John Deere's current business there are still a lot of heavy industry, heavy equipment and diesel-fuelled equipment, that is the status quo, that is what it is today.

We need to think about the future, over the next five, ten, 20 years, and where the company is moving to. And that's the importance of looking at management team, the culture, the intents, the strategy, the future

direction of the business where they are spending their research dollars. And for John Deere, that gives us the confidence that's the direction they are moving, and the long-term impact that they can have is a positive one.

MB: And this is a good question. I'm just going to try and fit in maybe one or two more. What is the outlet for the wafer-thin margins of farmers?

LQ: So, I think the very thin margin of farmers is something that clearly needs to be changed. We think technology has an opportunity here as well, but technology that is accessible as well, that are provided to farmers in an accessible way. If there are technologies such as precision agriculture that can reduce the amount of pesticides that farmers require, then that will lower the cost for them and hopefully improve their profitability. So, we think that innovation has a role to play there too.

MB: Great. Thanks very much, Lee. Well, the questions that we haven't got to in the Q&A, we'll get back to you directly about those on an individual basis. I just wanted to ask, Lee, if you had one point or one factor that you wanted to leave the audience with, what would that point be in around about a minute?

LQ: Well, I think right now there's a lot of depressing headlines about the world. And there's no doubt it's a very tough situation for a lot of people. But we are optimists, and we believe that through hard work, through innovation and encourage the entrepreneurial spirit, we can come up with new technologies and new solutions that are going to contribute to a more sustainable prosperous and inclusive future. And that's the path that we want to be on. We really want to support entrepreneurs regardless of where they are working, to drive the change towards a more sustainable future.

MB: That's a great, optimistic note there, Lee. I mean, should we be spending more time on looking at what might go right as opposed to what might go wrong?

LQ: Absolutely. A bit more ambition in terms of, and thinking about upside rather than myopically fixing on the risk and downside would be, I think, a good thing to do.

MB: And is that something that you look at in your investment philosophy as well when you're approaching companies?

LQ: Yes, absolutely. I think thinking about the next five, ten, 20 years, and thinking about the scenario if a company succeeds and what the value that would be for society and shareholders in those outcomes is something that we pay a lot of attention in our research process.

MB: Great. Thanks very much for joining us, Lee. And I hope you, the audience, have enjoyed the discussion as much as I have. And thanks for joining us throughout Disruption Week in what is the last in the series on agriculture, but, as we were saying earlier, possible one of the most significant areas that hasn't been disrupted maybe to the extent of other industries and sectors.

So, if you'd like to get a recording of the webinar, this will be available from next week. So, I hope you can enjoy those and feel free to share them with your colleagues. And also, if you'd like to find out more about our insights and what's shaping our investment thinking, you can find papers by Lee and others on our website. I particularly recommend Innovation: Why it's Crucial for Sustainability, which you can find at bailliegifford.com/insights. And thanks so much for joining us during the course of Disruption Week, and thanks for investing your time and listening to us and listening to Disruption Week. Good bye.

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China

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