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Whilst we are talking about solutions, I would like to turn to Amit Roy, who will give us a very brief overview of the current situation. At the end of the day, a plant needs fertilisers.

A plant needs fertilisers; I am not an agronomist, so I will keep a low profile in that regard. However, I understand that a plant needs to be fed in order to grow, and that food is mostly fertiliser such as urea, potash or phosphates. Could we use these more effectively, and could we run into a shortage of these products in time?

Amit Roy

I am delighted to be here and to be given the opportunity to speak, and I am grateful for the hospitality that has been shown. I would like to spend a couple of minutes talking about fertilisers, and let me start with the basics. Three primary nutrients are needed for plant growth: nitrogen, phosphate and potash. Nitrogen is free; it is 80% of the air that we breathe, but we need energy to convert that nitrogen into a form that can be used on plants. Certainly there are certain plants that can fix nitrogen biologically, but they have certain traits which are not common to all plants.

Nitrogen was fixed on an industrial scale for the first time in 1913 by Mr. Haber, and that is a technology which is used today. That technology certainly allowed us to increase food production. Now, in terms of the fertiliser itself, the US Government invested a significant amount of money after the Second World War with the Tennessee Valley Authority, TVA, and today 70% of the fertilisers that are used worldwide were developed in TVA and paid for by the US Government.

Phosphate is a finite and non-renewable resource, which can be found in many parts of the world, but Africa has the largest share. Potash is also distributed worldwide, but it is mainly found in temperate climates because of the nature of the salt. The only places you will find potash is in the Atacama Desert in Chile, where it never rains, and in the Dead Sea.

Regarding the fertiliser itself, Mr. Thorat talked about the high-yielding variety of seed that was developed, leading to the Green Revolution, for which Norman Borlaug got the Nobel Peace Prize. When he accepted the Prize, his comment was that these seeds were the engine, but that it needed fuel to run, the fuel being fertilisers. 40-50% of the growth in crop yield is attributed to fertiliser; we have achieved tremendous growth all over the world. Today the growth in fertiliser consumption and cereal production are highest in developing countries. Globally we use about 170 million tonnes of nutrients, nitrogen, phosphate and potash, and out of that 100 million tonnes are nitrogen in the form of urea.

Here is the biggest challenge going forward. Nitrogen is a very important element for human development, every cell in our bodies has nitrogen, but it is also a destructive element in terms of the environment. Nitrogen in the form of urea is very mobile: once it is applied to the soil, it essentially breaks down rapidly, and if the plant does not take it, it is lost to

air and water. Two bags on average are lost for every three bags of urea applied to the soil in developing countries, whereas the rate in developed countries is about 40% efficiency and 60% losses.

You need energy to produce the urea fertiliser that is produced today, and in terms of energy consumption, it requires the equivalent of four barrels of oil to produce one tonne of urea. Therefore, when I say that 100 million tonnes of nitrogen are used globally, urea is close to 200 million, so you can quickly do the arithmetic and see the loss of energy. This loss, on top of that, essentially results in N2O, nitrous oxide, which is 300 times more potent as greenhouse gas than CO_2, so we have a major challenge ahead of us.

Phosphate is a very stable element; when you apply it to the soil, it remains available to the plant over a longer period of time, and over a ten-year period you can recover 90% of it. The challenge is that when it is extracted from the ground and converted to the finished product, the losses from that process are relatively high. The global average is 40-60%. Therefore, there is a challenge for us, because phosphate is a non-renewable resource.

There has been a lot of talk recently in terms of running out of phosphate. We will reach peak phosphate in 30 years and run out of it in 130 years. Our institute has the largest database on phosphate; we did our own calculation and came out with a report ten days ago, which shows that we have more phosphate globally than previously thought, at four times as much. This is a preliminary estimate. The reserve and resources, it should be mentioned, also depend on the economic issue: when the price goes down it goes from reserve to resource, and as the price goes up you have more resources than reserves.

The products being used today were developed 40 years ago, and there are no new products in the market. Our institute launched an initiative about six months ago called the Virtual Fertiliser Research Centre. We recognise that fertiliser is needed to increase productivity; the population, as you heard, will go up to 9.2 billion by 2050; but if you take the dietary change, in terms of increased protein consumption, we essentially have to produce for 11.3 billion people, because consumption of protein increases along with income.

Therefore, fertiliser is a necessity, and our institute has launched the Virtual Research Centre to try to get the best minds in the world to come up with the next-generation product. The current fertiliser, when it is applied to the soil, is released based on the moisture content and temperature of the soil. We need to think about what fertiliser we need to have which will respond to the needs of the plant and not the temperature of the soil.

That is the ultimate goal we want to reach, and our institute is trying to achieve that long-term goal.

Philippe Chalmin, Professor, Paris-DauphineUniversity, founder of the Cercle Cyclope

Thank you very much, Mr. Roy. Let's not forget that the biggest takeover bid on the planet at the moment is in the fertiliser sector, from BHP for Potash. The world leader BHP has put up 45 or 48 billion dollars to take control of the Canadian Potash Corporation of Saskatchewan Inc., which is the world's leading producer of potash. If they are planning to move away from their traditional sector, i.e. iron, coal and non-ferrous metals, to move into what are new areas for them, they must believe there is a strategic advantage to doing so.