

# ISAS Insights

No. 502 – 20 July 2018

Institute of South Asian Studies  
National University of Singapore  
29 Heng Mui Keng Terrace  
#08-06 (Block B)  
Singapore 119620  
Tel: (65) 6516 4239 Fax: (65) 6776 7505  
www.isas.nus.edu.sg  
<http://southasiandiaspora.org>



## Indian Agriculture: Technological Innovations and New Investment Opportunities

*With a population of 1.32 billion, where an average household spends 45 per cent of its expenditure on food (NSSO, 2011) and where the gross domestic product is growing between seven to eight percent per annum, India offers a big investment opportunity in its food-feed-fibre value chains. Innovations all along the agri-value chains – from seeds of crops to sexing technologies in the dairy sector, from the ‘uberisation of farm machinery’ to micro-irrigation through mobile solar pumps, and from solar-powered cold storages to processing, packaging, and retailing through e-commerce – are some of the emerging investment opportunities that can be game changers in the Indian agricultural sector.*

Ashok Gulati<sup>1</sup>

In very simple terms, innovation implies better ways of doing things that can add value in the market economy. In the agri-food space, innovations could be in policies, technologies, institutions, processes and even in products, all along the value chains from the farm to the fork.

---

<sup>1</sup> Dr Ashok Gulati was an Academic Visitor at the Institute of South Asian Studies (ISAS), an autonomous research institute at the National University of Singapore (NUS), from 27 June 2018 to 3 July 2018. He is currently the Infosys Chair Professor for Agriculture at the Indian Council for Research on International Economic Relations in New Delhi, India. He can be contacted at [agulati115@gmail.com](mailto:agulati115@gmail.com). The author bears full responsibility for the facts cited and opinions expressed in this paper.

Looking back at Indian agriculture since independence, one of the most remarkable innovations was manifested in the “Green Revolution” in 1967. It was triggered by the import of 18,000 tonnes of high yielding variety seeds of wheat (Lerma Rojo and Sonora 64 types) from Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center) in Mexico. The ‘miracle seeds’, as they were called, were fathered by Norman Borlaug, who received a Nobel Prize for Peace in 1970 – these seeds saved millions of lives around the world, especially in India. Wheat production in India jumped from 6.5 million metric tonnes in 1950-51 to 98 million metric tonnes in 2017-18, more than 15-fold jump, due to this technological innovation.

Another technological and institutional innovation in Indian agriculture came through ‘Operation Flood’, led by Verghese Kurien, during 1970s and 1980s, ushering in the “White Revolution”. This institutional innovation was in procuring milk from millions of small holders through a cooperative network of milk societies, and technological innovations included bulk milk coolers, pasteurising and homogenising milk, making milk powder from buffalo milk (first time in the world) and transporting that milk as far as 2,000 kilometres (from Kaira in Gujarat to Kolkata in West Bengal) through specially designed milk trains. The retail network of Mother Dairy’s refrigerated milk booths was also a technological innovation that ensured regular supplies of safe milk to consumers. As a result of these innovations, India today is the largest producer of milk in the world, at more than 170 million metric tonnes in 2017-18, up from 17 million metric tonnes in 1951, a 10-fold jump. The second largest producer is the United States (US), with milk production of about 96 million metric tonnes.

In the last 15 years, the biggest technological innovation in Indian agriculture came in cotton through what is called as the “Gene Revolution”. The Bt cotton seeds that came through Mahyco Monsanto Biotech Limited (MMBL), and multiplied by several private-sector Indian companies under an agreement with MMBL, revolutionised cotton production. It saw more than an 11-fold jump, from three million bales in 1950-51 to 35 million bales in 2017-18, making India the largest producer and the second largest exporter of cotton in the world. Today, almost 96 per cent of the cotton area in India is under Bt.

Innovations in seed technologies have been a catalyst for revolutionary changes in Indian agriculture in the past. What other technological innovations could there be on the horizon that could lead to large investment opportunities and add value in the market? One can think of at least the following five areas for such technological innovations:

1. Investments in the ‘Uberisation’ of farm machinery;
2. Mobile solar pump-sets replacing diesel pump-sets, and solar-based cold storages, reefer vans and push carts/motorised vendor carts;
3. Sex selection semen technologies in the dairy sector;
4. Precision farming, hydroponics and aeroponics; and
5. “Operation Greens” (TOP: Tomatoes, Onions and Potatoes).

### **Investments in the ‘Uberisation’ of Farm Machinery**

The average holding size in Indian agriculture is just 1.15 hectares (Census, 2010-11). Over time, it has declined from 2.3 hectares in 1970-71 and it may continue to decline in the near future due to population pressure in rural areas. However, agri-labour is becoming expensive and scarce, especially during the peak sowing or harvesting times. The use of farm mechanisation has been gaining momentum. However, given the small size of holdings, not everyone can own tractors or harvest combines. As in the urban areas in several cities of India, where Uber has brought about a transformational change in commuting services through its facility of taxis on the go, similarly, one could think of revolutionising the farm machinery services in the rural areas on the principle of “pay per use”, and that too on demand. This will cut down the farmers’ costs of production and make agriculture more cost competitive. It will also be inclusive as even the small holders would be able to pay for such services without owning expensive machinery. Already, many farmers have been using such services of harvest combines in developed agricultural states like Punjab. Its expansion to other states and the inclusion of other farm machinery – from tractors to farm implements – offers huge scope for investment opportunities.

## **Mobile Solar Pump-sets replacing Diesel Pump-sets, and Solar-based Cold Storages, Reefer Vans and Push Carts/Motorised Vendor Carts**

There are more than five million diesel pump-sets in the country, as per last count of the Minor Irrigation Survey (2013-14). The cost of running them on diesel comes to more than ₹15/kWh (S\$0.30). Most of these pump-sets are concentrated in the eastern belt where power supplies are poor, but groundwater availability is much better than in the other regions. A large investment opportunity exists in providing irrigation service to them through mobile solar pump-sets (where power costs will be less than one-third of diesel pump-sets) on the lines of the 'Uberisation' model for farm machinery. There is no need for small farmers to own these pump-sets as the upfront capital cost (about ₹4 lakhs [S\$7,940] for a 5-HP pump) can be prohibitive. However, they can avail of irrigation services on demand on the 'pay-per-use' principle. As private entrepreneurs will find it remunerative for them and farmers find it cost effective, it will make business sense at both ends and can potentially scale up fast.

Solar power can also be used for more than 7,000 cold storages in the country. Cold storages for potatoes in Agra in Uttar Pradesh, which is the hub of potatoes, receive power from the State Electricity Board (SEB) at commercial rates of about ₹10/kWh (S\$0.20), and that too not regularly. As such, they often use diesel generators to keep cold storages going. All this can be made much more cost effective through roof top solar panels, reducing their kWh costs and giving freedom from the erratic supply of electricity of the SEB. The only issue for many is the upfront capital costs, and herein lies the investment opportunity. The use of solar power can also be extended to reefer vans. In fact, even small motorised or push carts with a refrigerated section could be designed.

## **Sex Selection Semen Technologies in the Dairy Sector**

Dairy is an important sub-sector of Indian agriculture, which gives regular income to small and marginal farmers. Even landless workers can afford to go for this. Women make up more than 70 per cent of employment in the dairy sector. However, milk productivity of India's indigenous cattle is very low at 2.5 litres per day as it is primarily a household venture

without much infusion of high technology and good fodder which are necessary for high productivity milching animals. It is 5.2 litres per day for buffaloes and 7.5 litres per day for the crossbreds. Cross breeding with high yielding foreign breeds has been going on for some years. Yet, its penetration is limited. However, the latest technology of sex semen selection can help significantly by having the preferred progeny as a cow rather than a bull.

Given the difficulties in the disposing of bulls due to the ban on slaughtering in many states, farmers have to incur costs of feeding them, which does not pay them back. The technology of sex selection gives the farmer the desired gender with 90 per cent success rate. The technology of sex semen for commercial use was originally patented by US-based XY Inc., which was later acquired by Sexing Technologies™ headquartered in Navasota, Texas. The company produces sexed (sorted semen) straws, and then sexing of semen service is provided by independent companies such as Select sires, Genex, Accelerated Genetics, CRV, ABS Global WWS and Prime Genetics. In India, BAIF has been doing pilots with success from imported semen straws, and it appears this technological innovation has the potential to transform the dairy sector further if commensurate investments and extension takes place.

## **Precision Farming, Hydroponics and Aeroponics**

The future of agriculture is likely to involve the greater role of precision farming, whereby the soil would be nourished by the exact quantities of different fertilisers (minerals) that the farm soil needs, the seeds are placed at the right depth where moisture is sufficient for them to grow and so on. The idea is to optimise the use of various inputs in a manner that the sustainability of agriculture is ensured, along with cutting down the cost per unit of production. This is being described as the in-coming “Brown Revolution”, as it takes care of Mother Earth much better than has been the case in the “Green Revolution”.

This process has already started in the US with Monsanto taking the lead and tying up with John Deere and Climate Corporation. Climate Corporation’s Field-View Drive provides seamless data of the farmer’s field to Climate Corporation’s Field-View Account, where it analyses the data and sends messages back to the farmer on his tractor or harvest combine, displaying various characteristics of his field for him to take right decisions right on the spot.

These technologies can easily be replicated and adapted to small holder economies such as India, saving precious resources through precision agriculture and raising productivity. The ‘Uberisation’ of such machines can further reduce the cost for small farmers. Here in lies the investment opportunities for the frontiers of agri-technologies.

Hydroponics, which can grow plants even in pipes without formal fields, vertical farming, and aeroponics, where the roots are irrigated through water mist, and growing certain plants without any soil are emerging in developed countries. Even in India, many pilots are being done. Its economic viability must be carefully worked out vis-à-vis traditional field cultivation practices before scaling up can take place.

### **“ Operation Greens” (TOP: Tomatoes, Onions and Potatoes)**

In the Indian Union budget for 2018-19, Finance Minister Arun Jaitley announced a new scheme called “Operation Greens” (TOP) for building pan-India value chains for tomatoes, onions and potatoes (TOP) on the lines of milk. There is a provision of ₹500 crores (\$99 million) for this year but it is likely to increase in the coming years as the scheme is rolled out. One may recall, that “Operation Flood” in milk, which started in 1970 was as much a technological innovation in logistics as it was in institutional engineering to procure milk from millions of small holders. “Operation Greens” is likely to follow a similar approach. There would be large investment opportunities in helping to build pan-India value chains for TOP. In one of his speeches recently, India’ s Prime Minister Narendra Modi spoke about giving it a priority so that farmers can obtain a higher share in consumer’s rupee.<sup>2</sup> In milk, Amul claims to give 75-80 per cent of the consumer’s rupee back to the farmers, while, in the case of TOP, the traditional value chains give not more than one-third of the consumer’s rupee back to the farmers. Wastages in storing due to the lack of modern storage facilities, in transporting, in retailing, and weak linkages with processing, among others, are the main reasons for this lower share to the farmers. Herein lies the opportunity to invest, save on these wastages, and share the savings between farmers and investors.

---

<sup>2</sup> Prime Minister Modi spoke about his government’ s Operation Greens (TOP) in an address at a farmers’ rally in Bengaluru on 4 February 2018.

## Conclusion

These are only a few ideas about possible investment opportunities in the Indian agricultural sector in the coming years. However, India will be the most populous country by 2024, and with projections that its overall gross domestic product is likely to rise by 7 to 8 per cent in the next 5 to 10 years, there will be a major demand for more nutritious and safe food – from milk and meat to fruits and vegetables. Building value chains offers large investment opportunities.

In a demand-driven system, the consumer will be the king and, hence, the retailing part of food, which is currently largely made up of mom and pop stores, will change in the coming years, be it to ‘big box’ stores of supermarkets or to the rapidly emerging e-commerce market. As such, from production to logistics to retailing, all along the value chain, significant opportunities for investment exist. One needs to have an eye for those and the courage to tap into them.

. . . . .