
Agrochemistry and Its Aspects in India

Ganga Shy Meena

Assistant Professor, Dept. of Chemistry, SCRS Government College Sawai Madhopur, Rajasthan, India

ABSTRACT: Agricultural chemistry is the study of chemistry, especially organic chemistry and biochemistry, as they relate to agriculture—agricultural production, the processing of raw products into foods and beverages, and environmental monitoring and remediation. These studies emphasize the relationships between plants, animals and bacteria and their environment. As a branch of agricultural science, agricultural chemistry studies the chemical compositions and reactions involved in the production, protection, and use of crops and livestock. Its basic science aspects embrace, in addition to test-tube chemistry, all the life processes through which humans obtain food and fiber for themselves and feed for their animals. Its applied science and technology aspects are directed toward control of those processes to increase yields, improve quality, and reduce costs. One important branch of it, chemurgy, is concerned chiefly with utilization of agricultural products as chemical raw materials. The goals of agricultural chemistry are to expand understanding of the causes and effects of biochemical reactions related to plant and animal growth, to reveal opportunities for controlling those reactions, and to develop chemical products that will provide the desired assistance or control. Every scientific discipline that contributes to agricultural progress depends in some way on chemistry. Hence agricultural chemistry is not a distinct discipline, but a common thread that ties together genetics, physiology, microbiology, entomology, and numerous other sciences that impinge on agriculture.

Chemical materials developed to assist in the production of food, feed, and fiber include scores of herbicides, insecticides, fungicides, and other pesticides, plant growth regulators, fertilizers, and animal feed supplements. Chief among these groups from the commercial point of view are manufactured fertilizers, synthetic pesticides (including herbicides), and supplements for feeds. The latter include both nutritional supplements (for example, mineral nutrients) and medicinal compounds for the prevention or control of disease.

Agricultural chemistry often aims at preserving or increasing the fertility of soil, maintaining or improving the agricultural yield, and improving the quality of the crop.

When agriculture is considered with ecology, the sustainability of an operation is considered. Modern agrochemical industry has gained a reputation for its maximising profits while violating sustainable and ecologically viable agricultural principles. Eutrophication, the prevalence of genetically modified crops and the increasing concentration of chemicals in the food chain (e.g. persistent organic pollutants) are only a few consequences of naive industrial agriculture.

KEYWORDS: Agrochemistry, environment, technology, fertility, soil, crops, fertilizers, remediation

I. INTRODUCTION

India is an agrarian country, where more than 50% people are dependent on agriculture for their livelihood and is the largest producer of spices, pulses, milk, tea, cashew and jute & the 2nd largest producer of wheat, rice, fruits and vegetables, sugarcane, cotton and oilseeds. Agrochemicals (Crop protection products/pesticides) are designed to protect crops from insects, diseases and weeds. They do so by controlling pests that infect, consume or damage the crops. Uncontrolled pests significantly reduce the quantity and quality of food production. It is estimated that annual crop losses could double without the use of crop protection products. Food crops must compete with 30,000 species of weeds, 3,000 species of nematodes and 10,000 species of plant-eating insects. Agrochemicals are the last and one of the key inputs in agriculture for crop protection and better yield. Currently, India is the world's 4th largest producer of agrochemicals after United States, Japan and China and has emerged as the 13th largest exporter of pesticides globally.[1,2]

Agrochemicals can be broadly classified into five types:

1. Insecticides: Insecticides provide protection to the crops from the insects by either killing them or by preventing their attack. They help in controlling the pest population below a desired threshold level. They can be further classified based on their mode of action: Contact insecticides: These kill insects on direct contact and leave no residual activity,

hence causing minimal environmental damage. Systemic insecticides: These are absorbed by the plant tissues and destroy insects when they feed on the plant. These are usually associated with long term residual activity. Tropical climatic conditions and a high production of paddy, cotton, sugarcane and other cereals in India has catalysed the consumption of insecticides.

2. Fungicides: Fungi are the most widespread cause of crop loss. Fungicides are used to control disease attacks on crops and are used to protect the crops from the attack of fungi. There are of two types – protectants and eradicants. Protectants prevent or inhibit fungal growth and eradicants kill the pests on application. This in turn improves productivity, reduces blemishes on crop (thus enhancing market value of the crop) and improves storage life and quality of harvested crop. Fungicides find application in fruits, vegetables and rice. The key growth drivers for fungicides have been a shift in agriculture from cash crops to fruits and vegetables and the government support for exports of fruits and vegetables.[3,4]

3. Herbicides: Herbicides also called as weedicides are used to kill undesirable plants. Their main competition is cheap labour which is employed to manually pull out weeds. Sales are seasonal, owing to the fact that weeds flourish in damp, warm weather and die in cold spells. Herbicides can be of two types - selective and non-selective. Selective herbicides kill specific plants, leaving the desired crop unharmed, while non-selective herbicides are used for widespread clearance of ground and are used to control weeds before crop planting. As the weeds grow in damp and warm weather and die in cold seasons, the sale of herbicides is seasonal. Rice and wheat crops are the major application areas for herbicides. Increasing labour costs and labour shortage are key growth drivers for herbicides. 4. Bio-pesticides: Bio-pesticides are the new age crop protection product manufactured from natural substances like plants, animals, bacteria and certain minerals. [5,6] They are eco-friendly, easy to use; require lower dosage amounts for same performance as compared to chemical based pesticides. Currently a small segment, the bio-pesticide market is expected to grow in the future owing to government support and increasing awareness about use of non-toxic, environment friendly pesticides. 5. Others: Fumigants and rodenticides are the chemicals which protect the crops from pest attacks during crop storage. Plant growth regulators help in controlling or modifying the plant growth process and are usually used in cotton, rice and fruits. Insecticides dominate the Indian crop protection market and form almost 53% of the domestic agrochemicals market. Herbicides are, however, emerging as the fastest growing segment amongst the agrochemicals. Paddy accounts for the maximum share of agrochemicals consumption around (26%-28%) followed by cotton (18% -20%). The eight states including Andhra Pradesh, Maharashtra, Punjab, Madhya Pradesh, Chhattisgarh, Gujarat, Tamil Nadu and Haryana account for usage of >70% of the agrochemicals used in India. Andhra Pradesh is a leading consumer of crop protection chemicals with a market share of 24%.

The Agrochemical industry has transformed the agricultural landscape in India, benefitting the farming community in terms of better yields and crop performance. It is the onset of the agro chemicals era that helped India graduate from a food deficient to a food surplus country. The contribution of the agrochemical industry to the economic growth of the country over the past two decades cannot be undermined.[7,8]

Agriculture and its allied sectors continue to remain central to the Indian economy, contributing nearly 17% to our GDP. More important, it is a source of livelihood for more than 50% of the country's population. As a result, a sector like agrochemicals, is on a far stronger wicket than many others in the economy, driven by major government actions and interventions.

The Indian agrochemical market is worth ₹38,000 crore divided almost equally, between India's domestic consumption at ₹20,000 crore and exports accounting for ₹18,000 crore. Despite the challenges of this lockdown, the agrochemical industry will continue to expand in the coming year with an expected growth in agricultural output. India expects a record 298.3 million tonnes of foodgrain production, of which 149.92 million tonnes in the kharif (summer) season and 148.4 million tonnes during the rabi (winter) season, representing a 2% projected growth compared to the previous year.

The government also expects an increase in production of non-foodgrain crops such as oilseed. Besides, data from the Department of Fertilizers shows a surge in all-India nutrient sales at 20.56 lakh tonnes (2.06 million tonnes) as against 14.17 lakh tonnes (1.42 million tonnes). Urea sales grew by 36.2%, over the corresponding month last year. This year's rabi harvest, despite some initial hiccups, is also nearly complete. As reported by the state governments, about 98%-99% of wheat crop has been harvested in Madhya Pradesh, 88%-90% in Rajasthan and 75%-78% in Uttar Pradesh. As an outcome, the government is estimating a record 106.5 million tonnes of wheat production in the current year. Additionally, with the hope of a decent monsoon, paddy sowing acreage is estimated to go up by 27% compared

to the last season at 32.58 lakh hectares (3.26 million hectares), during the ensuing kharif season. All these signs point to the resilience of India's agricultural industry and its close association with agrochemicals.

While this may seem counterintuitive compared to other sectors, China's example is worth considering. China's experience during SARS shows that the agrochemicals sector saw a short dip in growth initially, but fully recovered within two quarters. More recently, we have seen that agrochemical stocks have been more resilient than the overall index. While the Shanghai Stock Exchange has been largely flat at -1% , agrochemical stocks have increased in value by about 3.6% . [9] This is clearly a harbinger of good news for the Indian agrochemicals sector as well, which should see a strong recovery from the crisis after a short-term impact. Signs of improvement have already started to show in the Indian context with stocks of major agriculture-related firms showing a sharp increase after government's policy boost. Disbursement of subsidies to farmers worth ₹18,000 crore under the PM Kisan Samman Nidhi (PM-KISAN) will improve liquidity for farmers and therefore the value chain.

In addition, farmers' incomes will definitely get a boost with the government's efforts to ensure a timely rabi harvest, vigorous drive by state-led procurement agencies like National Agricultural Cooperative Marketing Federation of India (NAFED) and Food Corporation of India (FCI) to procure rabi harvest of foodgrain, cereals and oilseeds from across the country.

II. DISCUSSION

Promise of a good 'on-track' monsoon should also ensure strong domestic demand, with limited impact. Driven by these factors, as of May 4, major agrochemical companies have shown about a 38% improvement in stock prices since the initial lockdown started compared to about 23% by the Sensex, overall . [10]

However, there may be some challenges on the supply side in terms of availability and cost of raw materials, packing/packaging materials as well as availability of labour for manufacturing to commence. Issues like availability of warehouses and trucks will also be crucial. Given the government's support to the agriculture value chain, these issues are unlikely to make any significant dent in meeting the required demand. That being said, in a scenario where many problems cases increase and restrictions are applied again, supply constraints could become much more crucial.

For the export market as well, similar demand and supply side forces are at play. Demand remains very robust given the need for global food security. In fact, demand for some specific agrochemical products have increased as buyers are trying to shift their sourcing away from China. Orders are coming in from key international markets like Brazil, Japan, the U.S. etc., which have neither the expertise of producing such a wide array of agrochemicals nor the capital for capacity expansion of their own plants, given the inherent cost advantages of China and India. Therefore, we estimate only a marginal revenue impact for the export segment. In India, supply side challenges continue to rise owing to local logistics issues. Major ports like Hazira, Dahej, Pipavav etc., are operating at partial capacity, with lesser trucks and labour shortages choking the ports due to slow evacuation of containers even though they are labelled as essential services. However, this situation is improving on a day-to-day basis. Any further downside will be largely dependent on how quickly individual firms are able to address their supply chain bottlenecks.[11]

While the impact on agrochemical companies seems to be limited compared to other industries, the industry needs to be prepared for any eventuality. Despite the optimism, Indian agrochem players, both large and small, need to do four things right:

Manage liquidity tightly: Firms must focus on collections with detailed customer-wise tracking which will be critical to ensure that sufficient working capital is available to support the upcoming season. Additionally, it is important to work with suppliers to optimise payment terms to help improve the working capital flow.

Avoid or delay discretionary cost: Costs need to be controlled on a war footing. All discretionary costs, for example sales promotions, field assistants, discount schemes, sponsorships travel and training will need to be avoided or delayed, and additional costs like new manpower should be carefully evaluated.

Proactively manage supply side constraints: Enormous focus will be required to mitigate supply side constraints like availability of truckers and ports, raw materials availability and pricing, and warehousing capacity to ensure that the right product reaches the right location.

Engage deeply with customers: Despite the strong demand, it will be crucial for firms to follow up adequately to secure volumes from customers. Given the robust competition, customer engagement and service levels will be key to success. This will require creative methods such as digital engagements with the farmer and devising channels which may not have been used in the past.

From a more long-term perspective, CEOs will need to start thinking about how to leverage new opportunities that have appeared as an outcome of this crisis such as shifting manufacturing away from China. In wake of the government's support of this shift, it could be a game-changer for the industry and first movers will benefit strongly.

Irrespective of how the pandemic unfolds, it is imperative for industry participants to engage with the value chain—both upstream and downstream—to deliver a strong kharif season and build the momentum for the remaining of FY21. This will essentially boil down to getting the basics right—keeping people safe, operating the plant efficiently (which includes a detailed plan to ensure availability of raw and packaging materials), and managing multi-vendor logistics, in addition to a strong cash focus.

III. RESULTS

Agrochemicals or agrichemicals is a contraction of agricultural chemical. It is a chemical product that is used in agriculture to increase the output from the land. In various cases, agrichemical refers to pesticides, including fungicides, insecticides, and herbicides. India is the fourth largest producer of agrochemicals in the world after the USA, Japan and China. The agrochemical industry is a significant industry for the Indian economy. India's agrochemicals market grew at a rate of 11% from \$ 1.22 billion in fiscal 2008 to an estimated \$ 1.36 billion in fiscal 2009. India's agrochemicals consumption is one of the lowest in the world with a consumption of just 0.58kg per Hectares compared to the US (4.5 kg / ha) and Japan (11 kg / ha). In India, rice accounts for the highest share of pesticide consumption with around 28%, followed by cotton (20%). The Indian population is growing and the land area per capita is falling, the use of pesticides in India must be further improved. In addition to increasing domestic consumption, India's agrochemical industry's exports could double over the next four years if the industry adopts appropriate strategies and sophisticated technologies.

There are around 125 technical grade manufacturers (10 multinational companies), 800 formulators and over 145,000 distributors in India. 60 technical pesticides are produced locally. Technical quality manufacturers sell high purity chemicals in bulk (generally in drums of 200-250 kg) to formulators. In turn, formulators create formulations by adding inert carriers, solvents, surfactants, deodorants, etc. These formulations are packaged for retail and purchased by farmers. The Indian agrochemicals market is characterized by low capacity utilization. The total installed capacity in fiscal year 2009 was 146,000 tons and the total production was 85,000 tons, resulting in a low capacity utilization of 58%. The industry suffers from high inventory levels (due to seasonal and irregular demand due to the monsoons) and long loan periods for farmers, which makes working capital intense. India is a net exporter of pesticides to countries such as the US and some European and African countries because of its inherent strength in low cost manufacturing and a skilled, low cost labor force. Exports accounted for ~ 50% of total industry sales in FY08 and reached a Compounded Annual Growth Rate (CAGR) of 29% from FY04 to FY08.[12]

Increase in strategic alliances among large players for greater market reach and acquisitions of smaller companies globally to diversify product portfolio. For example: Rallis has a marketing alliance for key products with FMC, Syngenta, Bayer and Nihon . In addition, UPL has had a series of small acquisitions globally to enter new geographies and gain product expertise. The India agrochemicals market is a significant region, contributing to the growth of the Asia Pacific agrochemicals market. The Asia Pacific region is growing at the fastest rate on a global basis due to the enormous consumption of pesticides and fertilizers for farming activities. This is a result of adopting modern and advanced farming practices in the region.

The Asia Pacific region gives domestic as well as international companies a place to grow within the region. After the revival of the economy and the stabilization of regional currency rates, the farmers are now focusing on investing in these crop-protecting and growth-boosting chemicals. India, along with China and Japan, exhibits the largest agrochemical markets of the Asia Pacific region. At present, China is dominating the market with its developing agricultural sector, in confluence with the need for its growing population. Globally, the country is the largest producer as well as the largest consumer of fertilizers. The India agrochemicals market is driven by the rising population within the country, which has led to maintaining sufficiency in agricultural practices, further boosting the use of Indian agrochemical products for farming activities. The industry is positively influenced by the Indian Development of the agrochemical industry, which has fuelled the sales of agrochemical products. Other factors affecting the growth of India agrochemical industry include an increase in the population growth, rising need for food production, and economic growth.

As the demand for food products is increasing, the landmass available for agriculture is gradually decreasing due to the heightened effect of urbanization, which is providing an impetus for the farmers to use different agrochemicals to increase land productivity and maintain soil health. The positive trend and the integrating farming practices in the country are expected to propel the industry growth rate of agrochemicals in India within the forecast period. However,

the market may find hindrance due to low awareness of the benefits of agrochemicals among the farming community, and their low acceptance of the modern-day farming practices. The report gives a detailed analysis of the key players in the agrochemicals industry in India, covering their competitive landscape, capacity, and latest developments like mergers, acquisitions, and investments, expansions of capacity, and plant turnarounds. The comprehensive EMR report provides an in-depth assessment of the industry based on the Porter's five forces model along with giving a SWOT analysis.[11]

IV. CONCLUSIONS

With a population of 1.3 billion people, India is the second most populous country in the world and is also the world's largest producer of milk, pulses, and jute. With the green revolution, it also became the second-largest producer of cereals like rice, wheat, as well as vegetables, groundnut, fruit, sugarcane, and cotton. Crop protection sector has played an important role in bringing this change from subsistence farming, low growth in crop and grain production to the green revolution that propelled surplus production in the 1980s.

However, not much is said about the important role played by the backend R&D in the agrochemicals sector which is playing an important role in making this transition possible. Crop Protection chemicals, with a market size of approximately Rs 30,000 crore plays a key role in enhancing India's agricultural capability. The agrochemical sector thrives on a purely scientific basis that gels well with the traditional farming practices. While in the initial days, collaboration was a part and parcel of this scientific journey, with the pandemic, Indian companies are fast becoming interested in upgrading their research and development capabilities and facilities to harness their power independently. In the process, they are not only bolstering Indian manufacturing but are reorienting themselves from being a manufacturer to a solution provider.

Formulations offer performance, technicals offer expertise

Agrochemicals are of two types – a) technicals, and b) formulations, either generic or new generation. Technicals are the primary chemicals or active ingredients that form the basis of an insecticide, herbicide, fungicide or plant growth regulator (PGR). They are available in raw form and hence, are not suitable for direct use. This is where formulations come to play. Formulations are usually a different type of combination of various proportions and varieties of technical products, mixed with a suitable and compatible carrier. The carrier helps the concentrated mix of technical to dilute and make the technical available as per the recommended dosage of the same, to be used by the farmer. While the collaborations are instrumental in introducing world-class agrochemicals to India, but today the new generation formulations made in India have also been proven to be equally efficient and cost-effective too. They are easy to spray or easy to broadcast with a low dosage and effective control.[10,11]

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For example, according to a study, earlier one acre of wheat cultivation on heavy textured soil usually required 500 grams of the generic formulation of Isoproturon, while, the same amount of land will require only 13.5 grams of Sulfosulfuron. Hence, it is obvious that agrochemical companies will increasingly focus on introducing new generation formulations in their R&D capabilities and product mix to have an edge. Indian agrochemical companies are also making significant strides in developing technicals, especially in the wake of the pandemic when its main exporter China had to shut down operations. Estimates show that the Indian agrochemical industry is expected to record a CAGR of 8 per cent by FY22. This is a major movement towards attaining self-reliance in the industry.

Recognitions & certifications help build credibility

Being recognised or certified by the government and other related agencies ensures that the R&D centre meets standards set for the research in the industry. However, getting certified can be a long haul and though it does not remove the necessary checks and balances required as part of the regulatory framework for the crop protection industry. The certifications issued by the Department of Scientific and Industrial Research (DSIR) under the Ministry of Science and Technology, and the National Accreditation Board for Testing and Calibration Laboratories (NABL) certification by the Quality Council of India are two crucial certifications along with GLP for research and QC labs in India.

Insecticides (India) Limited (IIL) started its research with its first R&D centre at Chopanki in 2005 which is recognised by DSIR and is NABL accredited and is in process for GLP accreditation.[12]

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