

Navigating Fertilizer Futures: Unravelling Challenges And Unlocking Opportunities In India's Supply Chains

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How to cite this article: Sajo Francis, P.Mohanraj, G.T.Thiru Arooran, M.Sankar, M.Gurusamy (2024) Navigating Fertilizer Futures: Unravelling Challenges And Unlocking Opportunities In India's Supply Chains. *Library Progress International*, 44(3), 20126-20136.

Abstract

India is also the second-largest consumer of fertilizers worldwide and, demand during critical cropping seasons like Kharif and Rabi is very important from food security point-of-view. However, despite the increased consumption, logistics and supply chain management (SCM) in India is still nascent vis-à-vis other developed nations where nearly 18% of GDP is spent on these generated services; only around 2%. This paper aims to study important factors affecting the effectiveness of SCM in India's fertilizer industry with a specific focus on its impact on competitiveness. By a scoping review methodology, the study searched from several data sources to summarize main challenges and opportunities. The results show the cost of marketing in fertilizer company financial performance can be optimized by implementing SCM appropriate. The paper wraps up by suggesting that for the sake of good SCM in the Fertilizer sector, there is an urgent need to amalgamate transport management grade and develop better distribution networking.

Keywords: Agricultural Cycles, Fertilizers, Logistics, Modern Agricultural Word, Supply Chain Management.

INTRODUCTION

Fertilizer have been playing vital role in the modern agricultural world so as to secure the existential food security of rapidly expanding global population (FAO, 2023) Amid widespread efforts of countries to cater the food needs for expanding population, fertilizer sector has been carved into this landscape agriculture value chain (World Bank, 2022). Timely, cost-effective and reliable delivery of fertilizers to farmers is of strategic importance and requires proper supply chain and logistics management (Gautam et al., 2021). Of particular importance is India, where agriculture accounts for about 20% of Gross Domestic Production (GDP) and employs a large segment of the country's work force (Ministry of Agriculture undefined). India is the largest second consumer of fertilizers in the world and it has attracted all around international attention over its fertilizer market, where demand otherwise fluctuates linked closely to agricultural cycles of Kharif and Rabi seasons (ICAR 2023). During those periods,

timely supply of fertilizers is essential to enhance crop productivity and food sovereignty (Rao et al., 2022). Still, the fertilizer supply chain in India is plagued with an array of problem areas such as logistic inefficiency, transportation cost and infrastructure bottlenecks (Sharma & Singh 2023). Although, there has been great strides in technology and practices into agriculture, SCM is still an underdeveloped sector of the Indian economy with logistics cost accounting for 14% GDP compared to very low levels as much lower than around 8-10 %in developed countries (Deloitte, 2023). These inefficiencies lead to increased costs of fertilizer distribution, which ultimately reduces the affordability and accessibility for farmers (NITI Aayog, 2023).

Fertilizer companies have to compete on the basis of SCM effectiveness affects their, consequently, it is important cannot just be seen as a leveler in terms operational efficiency but rather as comparative criterion (Kumar & Rathii 2022). This emphasizes the need for improving transportation costs which make up 30 percent of supply chain costs from \$135 to an average price is crucial in this industry that has government regulations and global market conditions determine selling prices too (World Bank, 2022). It also offers capabilities to integrate with TMS, ERP and MIS for advanced Supply Chain Management (SCM) strategies that can help in optimizing inventory levels as well shorten lead times during operations. As a result of these innovations, companies are able to react more effectively and timely on the market demands, deal with their supplies under disruptions providing customer satisfaction through complete deliveries at right time (ICAR, 2023). In addition, the diversity and large geographical area of India further complicate the fertilizer supply chain. Fertilizers need to travel through different types of landscapes from coastal ports where raw materials are imported, upcountry till the rural hinterlands-only naturally why not! (Sharma & Singh 2023). This necessitates the proper functioning of a multi-modal (road, rail and waterways) transportation network through well-coordinated logistics. It is important to note that the poor infrastructure conditions like underdeveloped port capacities, nonfunctional rail networks etc. NITI Aayog 2023 can only be dealt with a proper push from government on developing these (infrastructural) fronts.

Increased need for high agricultural productivity due to the rise in fertilizer demand is essential, and it draws attention to more effective supply chain strategy as agriculture turns into a business of heavy inputs (FAO, 2023). Whether or not fertilizer companies can leverage their supply chain efficiency to effectively compete in both domestic and global markets will be key. This paper investigates the main elements of supply chain and logistics capabilities in Indian fertilizer industry to facilitate effective distribution systems or logistic system along with identifying issues and opportunities that will enhance competitiveness. This study endeavors to identify the current status and assess potential innovations, providing actionable points for how it can improve its competitiveness.

LITERATURE REVIEW

It is estimated that, by 2050 it will demand about 380 million tons of bread and flour (DEO). Fertility consumption, which is directly correlated with food grain production alone can help in achieving this target. But, the amount of fertilizers that are consumed in India ranks much below other big agricultural countries like China and Egypt. This gives an indication that proper marketing of fertilizers will be needed in India to maintain optimal consumption, a healthy nutrient balance and increase agricultural productivity such that the status quo might not help (Puthin Kumar et al. 2017). Logistics constraints in fertilizer supply chain management (SCM): During crucial cropping seasons, the efficient and cost-effective delivery of fertilizers can only be achieved through a well-coordinated SCM system. Existing analysis has focused on logistics as a means of achieving lower distribution costs and, thus greater marketing efficiency overall. Chouhan et al., 2016) stressed the importance of logistics in controlling operational costs of fertilizer distribution and Rastogi et al. Transportation is one of the highest cost in marketing of fertilizer (Matumba et al., 2018) and customer satisfaction level often hinges on ability to effect deliveries promptly, efficiently at all times.

Logistics, as we all know, is recognized by one and all around the world but when it comes to India there still remain challenges in SCM across various sectors, especially in fertilizer sector. In India, only 2% of GDP is shared among logistics while in developed countries it is approximately 18 % (Chakraborty et al., 2015). This difference is indicative of the high improvement potential in logistics and SCM infrastructure for India, which could translate into improved competitiveness and financial performance for Fertilizer players. There is evidence that processing SCM practices like real-time information systems and coordinated transport management can increase the likelihood for cost savings, improved distribution of fertilizer (Koster et al., 2017). So, understanding the present dynamics of SCM and determining factors influencing its effectiveness is essential to provide a basis for

development of an efficient fertilizer marketing strategy in India. The fertilizer policy of India is deeply linked with the GOI mission to enhance consumption and crop yield. Fertilizer is used more in Kharif and Rabi crops which are dependent on the monsoon, for example., most of States. It is here that distribution and logistics play a critical role: most farmers have to carry the final product in season so there are extra costs for either the farmer or processor. At the same time, manufacturers need to keep stocks of raw materials at sufficient levels if production is running continuously. In context of the government objective to balanced nutrient use... achieving this requires understanding farmer behavior, ensuring availability and proper utilization by farmers as well as distribution at competitive pricing for which challenges will only become more daunting.

Logistics, particularly transport, has a substantial impact on the cost of products and services, making transport management a critical function within organizations. Currently, logistics costs for fertilizers account for approximately 6-12% of the sales cost. It is essential to integrate transport functions with accounting, engineering, inventory management, legal, manufacturing, purchasing, marketing, sales, and warehousing. One approach to achieving this integration, while considering the costs involved, is through the use of information technology to provide real-time information and enable quick decision-making. In India, the Department of Fertilizers is responsible for ensuring the movement, distribution, and allocation of subsidized chemical fertilizers through a network of manufacturers. The logistics process integrates the marketing and production strategies of organizations with replenishment processes, inventory, and order management. The performance of a transport system is evaluated based on factors such as quality, value, speed, reliability, performance, flexibility, and cost. Distribution resource planning (DRP) can help reduce costs and improve inventory management and customer service.

In the 2020-21 fiscal year, India produced approximately 433 lakh tons of fertilizer and imported 189 lakh tons. Similarly, raw materials like natural gas, ammonia, rock phosphate, sulfur, sulfuric acid, and phosphoric acid were also imported during the same period. Importing these raw materials from various countries highlights the importance of an effective transport management system (TMS) for maintaining product capacity utilization. The current financial management pressures on many industries to downsize may impact fertilizer distribution and, by extension, food security. Improvements in supply chain management can be achieved by utilizing an integrated TMS with activities such as production planning, raw material availability, and utilization. Enhancing the productivity of the transport system through the integration of TMS with ERP and MIS can significantly reduce marketing and inventory costs. In India, government policy and movements in global raw material prices influence fertilizer price levels, hence importance should be given to optimizing supply chain & logistics for profitability. This will assist in preparing a comprehensive strategy for fertilizer marketing by examining the supply chain efficiency as well as market competitiveness of individual firms depending on their ex-factory price and facilities available from infrastructural point.

RESEARCH METHODOLOGY

This study investigates supply chain and logistics management in Indian fertilizer industry and examines the competitiveness of the same from manufacturers' viewpoint using a descriptive research methodology. This study is decomposed into a top-down description of the various aspects related to environmental factors on SCM effectiveness. A wide range of secondary sources, including academic journals, government reports industry publications and online databases were used to gather data for this research (DOF 2022). Qualitative insights have been further captured through discussions and interviews with industry experts to understand underlying nuances of the sector – be it challenges, opportunities presented by its ecosystem. The study was developed by modeling the material flows between procurement of raw materials and final delivery to farmers within supply chains.

The framework which the study employed to analyze supply chains included considerations about mass customization, communication processes, exploitation of operations and performance synergy (Verma 2015). The efficiency of inventory turnover in the two-stage supply chain was measured using key performance indicators (KPIs), which were determined based on Inventory Turnover Ratio (ITR) and an average inventory conversion period (AICP). Koster et al. (2017) also considered multi-dependencies among the various supply-chain component when evaluating how logistics affects cost control and customer satisfaction in their study

FINDINGS AND DISCUSSION

The major elements of physical distribution in the fertilizer segment include transportation, inventory, warehousing, and inventory handling. Fertilizer consumption depends on the season and hence the availability of the warehousing space plays a great role in logistics management. It is important that the fertilizers industries need to plan the channel partners and consider the factors like market mix strategy, organizational resources, environmental factors, market characteristics, farmers' preferences, behavioral nature, and availability of intermediaries.

ENVIRONMENT

The fertilizer demand in India is poised to increase by 1-2 % every year. This is due to the push for higher yield, rise in MSP, increase in reservoir levels and increase in awareness among farmers about the need for fertilizers for crop productivity. At present India is having 33 large-size urea plants, 21 units producing DAP & Complex fertilizers, and two units manufacturing Ammonium sulfate as a by-product. Table 1 shows the volume of fertilizers handled during the year 2020-21 which shows an increase of more than 3.2% in comparison with the previous year. India has two main cropping seasons mainly Kharif (July to September) and Rabi (October to March) and hence it is important that fertilizers need to be stocked during the off-season and available for farmers when they wanted. As a result, the raw material stocks need to be at an appreciable level to maintain continuous production levels. It is noted that there is a lead time of 3 to 4 months for procurement and planning of raw materials.

Table 1: Fertilizer Produced in India and the quantity imported													
Sl no:	Item	2018-19(L tonnes)				2019-20(L tonnes)				2020-21(L tonnes)			
		N	P2 O5	K2 O	Total (N+P2O5+ K2O)	N	P2 O5	K2 O	Total (N+P2O5+ K2O)	N	P2 O5	K2O	Total (N+P2O 5+K2O)
1	Fertili zer Produ ced	133 .8	45. 6	nil	179.4	13 7.2	47. 9	Nil	185.1	13 7.4	47. 4	nil	184.8
2	Fertili zer Impor ted	47. 2	31. 7	26. 5	105.4	52. 1	24. 1	23. 1	99.3	56. 6	25. 4	26.9	108.9
		248.8				284.4				293.7			

The inbound transport from the port to the plants is mostly handled by conveyors and pipelines. Indigenous fertilizer production is dependent on the import of materials like natural gas, rock phosphate, sulphur, muriate of potash, etc. In the fertilizer industry, most of the raw materials and traded goods are imported from abroad and most of the companies opt for shipping agreements (CFR) for raw material availability. Considering the fertilizer production in India, the Department of Agriculture and Cooperation and farmers' welfare access the chemical fertilizer requirement. The gap between the requirement and production is filled by importing fertilizers. In India around 25 % of the fertilizer requirement is imported. The Department of Fertilizers ensures the movement of fertilizer following the assessment of the state-wise requirement by the Department of Agriculture and Cooperation and farmers' welfare.

The distribution of fertilizer is carried out using fertilizer stock points, agricultural cooperatives, dealers, and retailers throughout in India under various zones. The eastern zone includes Arunachal Pradesh, Assam, Andaman & Nicobar Islands, Bihar, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tripura, West Bengal, Tea board. The western zone consists of Dadra & Nagar Haveli, Goa, Gujarat, Madhya Pradesh, Maharashtra,

Rajasthan. The northern zone includes Chandigarh, Delhi, Haryana, Himachal Pradesh, Uttar Pradesh. The south zone consists of Andhra Pradesh, Karnataka, Kerala, Pondicherry, Tamil Nadu, Coffee Board, Planters association. Table.2 shows the zone wise fertilizer consumption in India and the percentage change.

Sl no.	Zone	2019-20	2020-21	%variation	2021-22	%variation
1	East	4495.82	4779.92	6.3	4240.42	-11.3
2	West	9875.03	10917.63	10.6	9860.13	-9.7
3	North	8804.79	9437.37	7.2	8859.52	-6.1
4	South	6194.69	7400.63	19.5	6836.20	-7.6
	All India	29370.33	32535.55	10.8	29796.27	-8.4

In the case of fertilizers, most of the raw materials like natural gas, rock phosphate, phosphoric acid, sulfur, sulphuric acid, and potash are imported in addition to what is produced in India. Considering the quantum of imports needed and the international fluctuations it is seen that the manufacturers maintain a 60- 100 days stock of raw materials. This is also influenced by the lead time, demand, and inventory costs. The many forms of transport include road (raw materials, finished product), railway (raw materials, finished product), pipeline (liquid, gas), and sea transport (liquid and solid bulk cargo). Considering the quantum of imported materials handles most of the largest companies are situated near the port facility. The consumption of natural gas for the manufacture of fertilizer during the year 2021-22 is 18079 million cubic meters and it increases by 2 percent per year.

The Department of Fertilizers plans the off-take and movement of the agreed monthly supply plan of all the fertilizers in consultation with the manufacturers and importers as per the fertilizer (movement) control order, of 1973. The monthly supply plan considers the fact that approximately 50% of the supply should be from indigenous sources and keeping the lead distance as minimum as possible. Considering the geographical nature, the fertilizers are mainly transported through railways considering the quantum moved and all suppliers are to maintain an 80:20 ratio with respect to rail and road. The requirement of a state is fulfilled through 3 to 5 sources, to maintain availability in the market considering any exigencies like plant failure or any bottlenecks concerned with logistics.

Table 3 shows the number of raw materials handled for the production of fertiliser in India either indigenous or imported .. Logistics management includes reordering quantity, order processing, acquisition, packaging, and maintaining optimum stock at the lowest cost. In the case of fertilizer, it is a difficult task as most of the raw materials need to be imported and the finished products are to be dispatched to all corners of the country.

Sl no	Item	2019-20	2020-21	% variation	2021-22	% variation
1	Ammonia produced	14957.2	15195.0	1.6	15688.0	3.2
2	Ammonia imported	2636.2	2416.6	-8.3	2307.2	-4.5
3	Phosphoric acid Produced	1604.2	1563.1	-2.5	1753.3	12.1
4	Phosphoric acid imported	2498.6	2510.5	0.5	2117.1	-15.6
5	Sulphur imported	1235	1463	18.5	1895	29.5
6	Rock Phosphate Imported	7655	7734	1.0	9660	24.9

India has 11 major ports which can handle a capacity of nearly 56 lakh tons of finished fertilizers. The 20 minor and intermediate ports are available with a capacity of 40 lakh MT which can also be utilized for handling fertilizers. Considering a utilization factor of 80 percent around 65 lakh MT is available for fertilizer handling at

ports in India. Mundra Port is designed to handle Panamax vessels in India. The Department of Fertilizers develops a supply plan as per the monthly requirements of fertilizer as projected by the Department of Agriculture and farmers' welfare, in consultation with the manufacturers and importers. The plant capacity utilization also depends on the port facility, transportation, rake availability, maintenance, breakdown, fluctuation in raw material availability, cost, and labor relations. Table 4 shows that the public and cooperative sectors' capacity utilization in India and it is much better than private.

The logistical model mix in the country is highly skewed towards road transport and it presently plays a prominent role in the country's fertilizer raw material /product movement. It helps to direct the delivery of fertilizer to the customer's doorstep. The total length of Indian roads is around 3 million kilometers in length of which 52000Km come under the national highways. The transportation industry uses 22 lakhs heavy-duty and 6 lakh light-duty trucks. Insufficient road network along with poor infrastructure will push the logistics cost. Most fertilizer companies and ports rely on roadways for the transport of raw materials and finished goods

Sl.No	Sector	Installed Capacity (Lmt)	Production During 2020-21(Lmt)	% Variation from Installed Capacity
1	Public	86.98	83.63	- 3.85
2	Cooperative	97.54	112.70	+ 15.54
3	Private	381.02	237.34	- 37.7
	Total	565.54	433.67	-23.3

In India, the major volume of fertilizers is moved to warehouses by rail. Indian railways have a rail network of around 63327Km with about 800 railway stations for rake handling, 8153 locomotives and 207719 wagons. Considering the volume handled, the railway is the prominent carrier of fertilizer goods over longer leads. Hence the economics of fertilizer movement and distribution would fluctuate with the efficiency of Railway operation. Port - Railway facilities and port-rail connectivity also play a significant role in ensuring the timely availability of fertilizers. At present the waterways are being used only on a very small scale by the fertilizer industry due to logistic disadvantages. Gujarat water ways and Maharashtra water ways together have a share of 75% in inland water way mode of transport. 1.35 million tons have been identified by IWAI for national waterways through coastal shipping which is about to touch 9 million tons by 2025.FACT is one of the fertilizer companies which utilizes waterways for the transport of raw materials from the port and between the divisions.

Large volumes of fertilizer are distributed through a well-developed marketing network spread throughout the country. The distribution channel for fertilizer includes state cooperative marketing federations, district-level cooperatives, village-level cooperative societies, dealer stock points, and retailers.

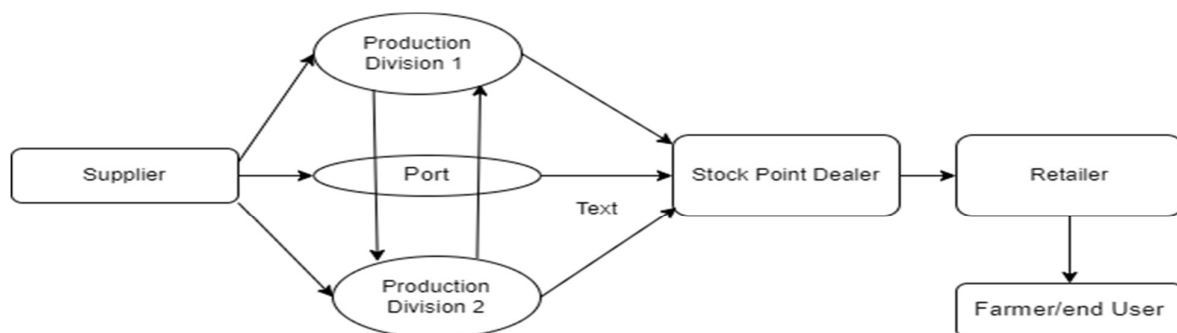


Fig 2: Supply chain competitiveness of FACT

SUPPLY CHAIN COMPETITIVENESS: The supply chain for one of the leading south Indian fertilizer

companies, Fertilizers and Chemicals Travancore Ltd (FACT) was analyzed in detail to understand the system from the manufacturers' perspective. FACT has two production units, one at Udyogamandal & the other at Ambalamedu. The Udyogamandal division has plants producing ammonia, sulphuric acid, Factamfos, and ammonium sulfate. The Cochin division produces Factamos, sulphuric acid, and phosphoric acid.

OPERATIONAL EFFICIENCY

The production of the company increased by 3.8% during 2020-21 and it further increased by 12% during the year 2022-23. FACT has ensured that all plants have good technology from renowned process licensors to ensure the utilization of process capabilities. Plants are operated at more than 100 percent capacity when the segment-wise average is around 77% which ensures optimum utilization and operational effectiveness. The raw material conversion ratios and specific energy consumptions of FACT are the best in the segment. The operation and safety of all the plants are ensured through the distributed control system and by following SOP, quality, and HSE management. FACT has certifications like ISO 9000, 14000, 45000& 50000. The raw materials are ensured through long-term contracts, monitoring the reordering quantities, and ensuring timely availability. The employees are selected on a competitive basis and planned training is imparted to them for development as executives. Corporate planning ensured the continuous operation of all plants throughout the year. These efforts helped to increase the turnover of the company to around 6000 crores from 2000 crores within three years. The turnover of the company increased by 17.6% during 2020-21, 35.7% during 2021-22, and 40.1% during 2022-23.

ORGANIZATIONAL EFFECTIVENESS

The manpower strength was brought down to around 2000 from around 9000 by conducting organizational studies and rearrangement of various functions/ departments. The work handled by an employee rose from 1 crore during 2020-21 to 3 crore during 2022-23. Manpower is recruited regularly and they are suitably trained to take higher responsibilities in the corporate sector. The grooming of each employee is monitored by the FACT training center through in-house/external training, Industrial exchange programs, executive effectiveness programs, and industry/academia interface programs. Proper synchronization of various departments and their functions was reoriented so that each vertical is operationally viable. Considering the volatility in prices and availability of raw materials and products, the hierarchy is designed and tuned for quick decisions. The organizational effectiveness got reflected during the Covid Pandemic with maximum production and distribution of fertilizers. The profitability of the firm tripled in three years.

MATERIAL MANAGEMENT

FACT has distributed around 1.1 million tons of fertilizers during 2022-23 and its capacity is being augmented by 5 lakh tons per year. Inventories are an important part of the total current assets and they are controlled by effectively monitoring inbound logistics, operations, outbound logistics, marketing, stores, services, and the firm's infrastructure. The strategy of reducing the inventory and pushing the products near the farmer has succeeded in bringing rich dividends to the company. The average inventory turnover ratio (ITR) is showing an increasing trend from 2.4 during 2019 -20 to 4.2 during 2022-23. The average inventory conversion period (AICP) is showing a decreasing trend with 150 days during 2019-20 to 85 days during 2022-23. The inventory performance of FACT was found to be better when compared with others in the segment. The company has its berth at cochin port to handle ammonia, rock phosphate, sulfur phosphoric acid, and sulphuric acid. Stocking facilities like tanks, godowns are also available at individual divisions for optimum inventory handling. The unloading from the ship is carried out by pipelines, conveyors, and cranes. Long-term and short-term agreements with suppliers ensured continuous supply at affordable rates. Monitoring the reordering quantity, stock levels, and reduction in handling time brought in rich dividends. Contracts for inbound, inter, and outbound supplies ensured the movement of raw materials and products in time. FACT is having rail head connectivity at Ambalamedu and it's on jetty at all divisions for the barge movements. The movement of materials was optimized by various management functions and production was maximized bringing down inventory costs. These measures ensured the highest sales volume in the marketing of fertilizers which in turn improved the profitability.

MASS COMMUNICATION

Internal communication was improved by using the intranet, MIS, and ERP systems. The movement of goods and stock are tracked on a real-time basis. It has helped to ensure goods are at their required destinations with reduced

transit time. The tailor-made MIS has helped to analyse the conversion ratios, sales, stock in hand, specific energy consumptions, and financial parameters and helped to take quick decisions aiming for improvement in profitability. The availability of the fertilizer to the right destination /customers is ensured by e-Pos, SMS alerts, and tracking through FIMS. The farmers are also communicated effectively through marketing programs, services through agro /soil testing centers, and cultural initiatives.

COMPETITIVENESS

Knowing the attributes affecting the marketing of straight fertilizers, complex fertilizers and consumer awareness of the product will give an insight into the need of understanding logistic factors. Understanding farmer's behavior will help to access the demand, and location and formulate a movement strategy for the market mix. FACTAMFOS brand of FACT is widely accepted by farmers and its brand loyalty is very FACT is one of the most prominent and growth-centric fertilizer manufacturers in South India which was incorporated in the year 1943. The supply chain and logistics management of FACT was one of the attributes of its turnaround strategy. From the analysis, it is understood that the supply chain competitiveness of FACT can be rated high under the quick response model which has been reflected in its financial performance. The model adopted will give insight into the formulation of marketing strategies for other manufacturers in the fertilizer industry.

LOGISTICS 5C STRATEGY:

FACT is an organization supplying fertilizer throughout India and sourcing raw materials from all parts of the world.

CAPACITY

The total amount of fertilizer transported from the manufacturing unit comes to around 11.71 Lakh tons during 2020-21. Sufficient inventory is maintained to sustain continuous production which brings in operational efficiency and productivity. The capacity utilization of the plants at FACT is more than 130 percent. Considering the demand for complex fertilizers, FACT is augmenting the Factamfos and raw material handling facilities.

Table 5: The production level of FACT					
Product	Capacity	Production 2019-20 (MT)	Production 2020-21 (MT)	Capacity utilization %	% change in production
Factamfos	633500	844512	861455	135.9	2
Ammonium Sulphate	225000	220951	245676	109	11

SUPPLY CHAIN COMPONENT

FACT has been the pioneer and pacesetter in fertilizer marketing. The product NP- 20:20:0:13 (FACTAMFOS) commands very high brand value. The marketing network of FACT is spread over the southern states of India - Kerala (2628), Tamil Nadu (905), Pondicherry, Karnataka (1539), Andhra Pradesh (647), and Telangana (515). FACT has recently expanded to North Indian States like Maharashtra, West Bengal Odisha, and Gujarat, presently having pan India presence. The network consists of 42 Agro centers, 43 stock point dealers, 56 field storage points, and 6000 retail selling points. These serve farmers by the supply of fertilizers and agronomy advice through innovative farmer education and fertilizer promotion programs. The share of Factamfos is around 25% in the market.

The Cochin division is having its railhead and 95% of the despatches are made by rail route. At Udyogamandal division the finished products are despatched through road as well as by rail from Kalamassery railway station. Considering the importance of fertilizer transport, the government has included the Udyogamandal rail head under the Gatishakti scheme. FACT has its berth at WI to handle the import of ammonia, rock phosphate, sulfur, sulphuric acid, and phosphoric acid. Interdivisional transport of raw materials is carried out by road and through barges utilizing Inland waterways.

CONNECTION

This includes long-term and short-term supplier contracts, marketing links with farmers, SAU, Agro centers, warehousing networks, dealers, and retailers. The relationships with various stakeholders are built on trust and product quality. This is the main reason why the farmers accept FACT products and the market share of FACTAMFOS is around 25 percent in the Indian market. The present inventory turnover ratio (ITR) is 4.2 and the average inventory conversion period (AICP) is 85 days. The customers are well connected through retail, dealer outlets, and agro centers. The agro centers are involved in field services and soil tests guiding farmers in crop selection and increasing yield. This connection has helped the organization to develop an image of customer centric and it also earned respect and value in the society.

COST PER CONTRIBUTION

Cost is involved in every aspect and is scrutinized and kept at low levels. Long terms and short-term contracts with suppliers and carriers have reduced the inventory carrying cost. In the case of finished goods, the strategy followed is to minimize the stock at the manufacturing center and push the product to the user's end. All the costs be it in inventory management, marketing, or transportation are kept at low levels by optimum utilization of resources. The transportation includes inbound transport, internal and outbound and it is kept at a minimum by developing good vendors. The work handled by each employee at FACT has increased to 3 crores from 1 crore during the year 2022-23. This is reflected in the financial performance, the profitability increased by 75% and market capitalization has increased over two times during 2022-23.

COMMUNICATION

The company has developed an effective communication system with MIS, Intranet, and ERP systems. The purchasing system is all digital utilizing e-tendering and Gem portal. Companies' website is used as a medium to interact with suppliers, end users, and the public. The drivers of globalization like reduction in tariff, improved transportation system, and communication system has been fully utilized for reengineering internal business practices and improving services through better supply chain management. The farmers are educated through its agro centers and soil testing divisions.

CONCLUSION

The supply chain and logistics of FACT were analyzed using supply chain competitiveness and 5C logistics. From the data analysis, it is seen that FACT has brought down its inventory cost which led to an increase in its profitability. The logistics cost can be brought down using effective supply chain management. It is found that the strategy of FACT falls under the quick decision model. Hence fertilizer manufacturers can utilize the model followed by FACT and bring in measures of improvement in the present system of marketing, distribution, and logistics will be helpful to reorient the business strategy of other manufacturers in the fertilizer segment. It would be advantageous for the country if a digital unified integrated platform is used for logistics services for the operation of fertilizer movement. The logistic strategies and competitiveness increase value to the customer, customer satisfaction, competitive advantage, and increase in profitability. The supply chain management strategy will be effective only if the environment can accommodate the changes necessary as per the need of the situation India has the second largest arable land area in the world but the net sown area is almost stagnant. To feed the increasing population, crop yield needs to be increased. The crop yield can be increased only by optimum use of fertilizers where other factors like irrigation and high yield variety etc. are constant. An increase in the consumption of fertilizer is imperative for crop productivity and nutrient balance. Hence there is a need for higher production capacities in fertilizer and effective supply chain management. The increase in fertilizer consumption needs to be handled by proper logistic management as it has a direct impact on the marketing cost. logistics cost attributed to 6-12 % of the total sales cost. Presently a reasonably good infrastructure exists for the marketing and logistics of fertilizer operated by one or other companies depending on the area of operation but it needs to be improved considering the future requirement. The study helped in understanding the activities, roles, and responsibilities of suppliers, manufacturers, distributors, and the government. India imports around 20 million tonnes of fertilizers every year. The infrastructure development of ports along with the development of roads by way of widening and proper matting will help a lot in handling more fertilizers. Increasing the fertilizer cargo transportation through coastal and inland waterways will reduce the freight cost and decongest rails and roads.

Hence there is a need to provide a thrust to the development of Inland Waterways and coastal Shipping in India which will ease the movement of fertilizers and raw materials. An appreciable effort is needed to increase the capacity of the existing vessels of the coastal merchant fleet considering the country's growth in industry and the agricultural sector. The concerns of coastal shipping like lack of priority berthing, high cost of bunkers, spares, and stores, high handling costs, etc. are to be addressed for improving domestic cargo. The study has confirmed that supply chain effectiveness is an important part of marketing strategy and increases profitability of the fertilizer firms.

FUTURE RESEARCH AND DIRECTIONS

This study demonstrates that with efficient supply chain management, profits may be raised while reducing logistics costs. Additionally, by fostering the development of fertilizer cargo transportation via inland and coastal waterways, freight costs will be decreased, as well as the reliance on railroads and roadways. The primary emphasis of this study was the fertilizer company's supply chain management in order to save transportation costs and make efficient use of logistics management techniques. This study might be expanded to include manufacturers of pesticides, agricultural equipment, and other products that support agriculture, as well as distributors of those products. By the way, costs might be decreased for both consumers and producers.

BIBLIOGRAPHY

- Chakraborty, K. (2015). Determinant of demand for fertilizer: A case for India. *Ageon Search - Asian Journal of Agriculture and Development*, 13(1), 54-65.
- CRISIL. (2021). Assessment of the fertilizer market in India.
- CRISIL. (2022). Market Intelligence and Analysts.
- Dent, J. *Distribution Channels: Understanding and Managing Channels to Market*.
- Department of Fertilisers (DOF). (2018). Fertiliser scenario 2018. Government of India.
- Department of Fertilisers (DOF). (2018). Report of the Working Group on Fertiliser Industry for the Twelfth Plan (2012-13 to 2016-17). Ministry of Chemicals and Fertilizers, Government of India.
- Department of Fertilisers (DOF). (2022). Annual report 2021-22. Ministry of Chemicals and Fertilisers, Government of India.
- Deloitte. (2023). India logistics report. Deloitte Insights.
- FAO. (2023). The State of Food Security and Nutrition in the World 2023. Food and Agriculture Organization of the United Nations.
- Fertiliser Association of India (FAI). (2021). Fertiliser statistics (66th ed.). New Delhi: The Fertiliser Association of India.
- Fertiliser Association of India (FAI). (2022). National logistics policy and the fertilizer supply chain. *Indian Journal of Fertilisers*, 18(10), 45-55.
- Gautam, R., Sharma, M., & Singh, A. (2021). Supply chain management in fertilizer industry: Strategies and challenges. *Journal of Supply Chain Management*, 12(4), 29-40.
- Government of Odisha. (2012). Fertilizer distribution at Angul, Gajapati & Puri for P & C department. National Productivity Council.
- ICAR. (2023). Annual report 2023.
- Jadhav, V., & Ramappa, K. B. (2022). Growth and determinants of fertilizer consumption in India: Application of demand and supply side models. *Economic Affairs*, 66(3), 419-425.
- Khan, S. (2017). Efficiency of Indian fertilizer firms: A stochastic frontier approach. *Indian Institute of Management*, 23-34.
- Koster, E., Carstens, G., & Heyns, G. J. (2017). The impact of implementing a transport management system on

- a fertilizer supply chain: A case study. *Journal of Contemporary Management*, 14, 509-530.
- Kumar, S., & Rathi, A. (2022). Competitive strategies in the fertilizer industry: An analytical study. *International Journal of Competitive Strategies*, 9(2), 100-115.
- Mala, P. (2013). Fertilizer scenario in India. *International Journal of Social Sciences and Interdisciplinary Research*, 2(1), 15-25.
- Meenu, & Rastogi, S. K. (2019). Trends of marketing practices in public sector fertilizer companies. *International Journal of Trade and Commerce – IIARTC*, 8(1), 11-21.
- Ministry of Agriculture, India. (2024). *Agricultural statistics at a glance*. Government of India.
- Mittal, S., Mittal, R. K., Singh, G., & Gupta, S. (2014). Inventory management in fertilizer industry of India: An empirical analysis. *Asia-Pacific Journal of Management Research and Innovation*, 10(1), 50-60.
- NITI Aayog. (2023). *Logistics and infrastructure development report*. National Institution for Transforming India.
- OECD. (2022). *Logistics Performance Index 2022*.
- Patnaik, M. (2014). Five Cs strategy of supply chain management in PPL: A case study. Twelfth AIMS International Conference on Management.
- Rao, P. K., Singh, K., & Sharma, V. (2022). Impact of fertilizer supply chain on agricultural productivity. *Agricultural Economics Research Review*, 35(2), 120-135.
- Raman, R., Sing, A., & Verma, M. K. (2020). Major challenges in the implementation of AADHAAR enabled fertilizer system and perception of farmers and retailers about ePOS: A case study of Kanpur district, Uttar Pradesh. *International Journal of Current Microbiology and Applied Sciences*, 9(2), 234-249.
- Sahney, S., & Shrivastava, A. (2008). Developing a marketing strategy for a leading agrochemical company: A case study on the adoption of agrochemicals by the vegetable growers in Chhattisgarh. In *Marketing to Rural Consumers: Understanding and Tapping the Rural Market Potential* (pp. 3-5).
- Sharma, M., & Singh, A. (2023). Logistical challenges in Indian fertilizer supply chain. *Journal of Logistics Management*, 18(1), 12-22.
- Sharma, V. P., & Thakre, H. (2011). Demand of fertilisers in India: Determinants & outlook for 2020. *Indian Journal of Agricultural Economics*, 66(4), 500-515.
- Soumita Khan. (2017). Efficiency of Indian fertilizer firms: A stochastic frontier approach. *Indian Institute of Management*, 23-34.
- Suryawanshi, S. (2015). Growth of chemical fertilizer consumption in India: Some issues. *Research Front, Special Issue 1*, 7-15.
- Tambe, P. R. (2015). Overview of Indian fertilizer and SWOT analysis of fertilizer industry. *The MIBM Research Journal*, 3(1), 20-30.
- Varkey, S., & Sahu, G. R. (2016). A study of marketing process and implementation of Indian Farmers Fertiliser Co-operative Limited. *Asian Journal of Management*, 7(3), 297-306. <https://doi.org/10.5958/2321-5763.2016.00026.3>
- Verma, A. (2015). An overview of supply chain competitiveness in manufacturing industries: Strategies and framework. *International Journal of Innovative Research in Science, Engineering, and Technology*, 4(Special Issue 2), 123-135. <https://doi.org/10.17148/IJIRSET.2015.4555>
- Vilas Jadhav & Ramappa, K. B. (2022). Growth and determinants of fertilizer consumption in India: Application of demand and supply side models. *Economic Affairs*, 66(3), 419-425.
- World Bank. (2022). *Fertilizer sector analysis and recommendations*. World Bank Group.