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## **Supply Chain Management Model for NFCL and Fertilizer Industry: A Research Paper**

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### **Abstract:**

*Agriculture, the heart for any economy in the world. It supplies food grains to all living organisms for perpetuation of its race. Fertilizers are the very essential plant nutrients to yield more. Nagarjuna Fertilizers and Chemicals Limited is the major urea producing company in Andhra Pradesh. There are more than 56 companies in fertilizer industry of India. So there should be a proper chain for the supply of both upstream and downstream. Hence the present paper is to develop an integrated supply chain management model for inbound and outbound logistics of Nagarjuna Fertilizers and Chemicals Limited and for the fertilizer industry at large. This paper on supply chain management model for Nagarjuna Fertilizers and Chemicals Limited and fertilizer industry deals with why the supply chain management should work as the circulatory system and distribution as the pumping organ (the heart), and also deals with the bottle necks in Supply Chain Management are the supply of natural gas, over control of government on the distribution and their policies related to expansion of industry, Nutrition Based Subsidy and allocation of natural resources, lack of company's won vehicles, and TPL (third party logistics).*

**Keywords:** *supply chain management, circulatory system, pumping organ, fertilizer, agriculture.*

### **1. Introduction**

A circulatory system of the human beings, it collects deoxygenated blood from various organs and parts of the human body and circulate it to the lungs for purification and receive oxygenated blood and send it to all parts of the human body. It's a continuous process that's why the human beings stay alive. Hence there should be a similar process here in supply chain management (SCM) of Nagarjuna Fertilizers and Chemicals Limited (NFCL) and in the fertilizer industry itself.

Supply Chain Management as the circulatory system and distribution as the pumping organ (the heart)

The inbound logistics of NFCL is a continuous process as it supplies natural gas and other inputs for manufacturing of Urea, the process is nonstop process through out the clock, and round the week.(except maintenance days about 25days in the year). The output is continuous process i.e. 4300 tons per day. Department of Fertilizers says 'Since one decade there has been no new urea capacity addition in India. The demand supply-gap has widened over the past decade. Currently indigenous urea production is of about 22 million tons and the consumption is of some 29 million tones, the 7 million tons shortfall is bridged through imports'.<sup>1</sup>

The demand for urea by the farmers in India is also continuous demand. So the firm should meet the demand in continuous process. But the bottle necks in the process are due to deficit in supply. The government of India is importing urea to meet the additional demand. But this is not continuous process so the farmers are facing shortage of urea in right time for cultivation.

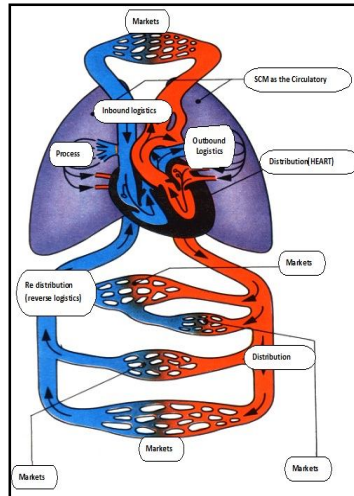


Figure 1: SCM as the Circulatory System and Distribution as the Pumping Organ (The Heart)

**2. Major Bottle Necks in this SCM of Fertilizer Industry**

In this study the major bottle necks in this SCM of fertilizer industry can be the supply of natural gas, over control of government on the distribution and their policies related to expansion of industry, NBS and allocation of natural resources. The bottle necks in SCM of NFCL are lack of company’s won vehicles, and TPL (third party logistics).

*2.1. The supply of natural gas*

According to The Hindu business line January 31, 2012, at present there is a plan with the Indian authorities to go ahead with a new investment strategy for the fertilizer sector, especially urea. This policy seeks to create a 1.5 million-tons capacity for the production of urea over a five year-period. The new policy may provide gas linkage for up to 75 per cent of new capacity created from domestic gas resources, while the rest will have to be met through imports.

The Government may provide a subsidy for the price differential between domestic and imported gas. The proposed policy is for both Greenfield (new plants) and brown field plants, i.e. capacity addition to existing plants or revival of old or closed plants. The proposed policy is based on the current availability of gas within the country and rising trend in global gas prices. The new policy is expected to be announced in the Budget for 2012-13 and then the issue will be placed before the Cabinet for a final decision. As it is the limiting factor to the study it can be suggested that if these policies are implemented properly the bottle necks related to inbound logistics can be rectified.

*2.2 .Over control of government on the distribution*

According to Department of Fertilizers

- The distribution and movement of fertilizers along with imports of finished fertilizers, fertilizer inputs and production by indigenous units will continue to be monitored through the online web based “Fertilizer Monitoring System (FMS)”.
- 20% of the prices decontrolled fertilizers produced / imported in India will continue to be in the movement control under the Essential Commodities Act 1955 (ECA). Department of fertilizers will regulate the movement of these fertilizers to bridge the supplies in underserved areas.
- Freight reimbursement on account of primary movement of P&K fertilizers (except SSP) by railway shall be paid as per actual on the basis of railway receipts. No freight reimbursement shall be made on account of secondary movement of P&K fertilizers. Freight reimbursement on account of direct road movement of P&K fertilizers (except SSP) shall be paid as per the actual subject to maximum of equivalent rail freight. Maximum allowable distance under direct road movement shall be 500 km. For the purpose of equivalent rail freight the following rates shall be applicable.

Movement (KM)	Rate (Rs / MT)
Up to 100	130
101 to 200	224
201 to 300	316
301 to 400	407
401 to 500	500

Table 1: Provisional freight reimbursement  
Source: FAI New Delhi

Urea continues to be under the regulatory regime and this continues to affect the Company adversely. The risk of adverse effect of government policy remains difficult to mitigate.

This factor is also a limitation for this study so it is only suggested that some liberal policies pertaining to distribution and movement of fertilizer will help the industry overcome these bottlenecks of distribution.

### 2.3. Policies related to expansion of industry: NBS and allocation of natural resources

At first The Ministry of Environment and Forest (MOEF) has deferred grant of environmental clearance to Nagarjuna Fertilizers and Chemicals Limited's (NFCL's) phase III expansion pending receipt of replies to certain queries. With this action NFCL's plan of expansion process faced slow down. Later on March 22, 2012<sup>2</sup> The Ministry of Environment and Forest (MOEF)-constituted expert committee for appraisal of chemical projects has decided to recommend grant of environmental clearance to phase III expansion project of Nagarjuna Fertilizers and Chemicals Limited. At its last meeting, the committee expressed satisfaction over NFCL's assessment of different risks including the ones posed by probable tsunami and ammonia leakage from the storage tanks under different scenarios. The Committee also took note of information furnished by the company in response to specific queries raised by in its November 2011 meeting. At its meeting held on February 16-17, the Committee thus specified incorporation of terms and conditions in the environmental clearance to be issued to the company. The Rs. 4,314-crore project provides for setting up a new ammonia unit with a capacity of 2200 tons per day (tpd) and a 3860-tpd urea unit at NFCL's fertilizers complex at Kakinada in Andhra Pradesh Zuari Industries Limited (ZIL)<sup>3</sup> has shut down its ammonia-urea stream and is faced with imminent closure of its complex fertilizer plants in Goa due to feedstock woes. The company had earlier hinted at the risk of setback to its ammonia-urea stream following a major fire that broke out in the pipeline carrying feedstock on August 19. The pipeline, which is owned by ZIL's Joint Venture Zuari Indian Oil tanking Limited (ZIOL), carries naphtha from Mormugao port to the Terminal of ZIOL. NFCL had identified Africa as a next destination for exploring growth opportunities. In view of the opportunities available there, the Company has set-up a branch office in Nairobi, Kenya, to start its International sales and marketing operations in Africa. In the initial stage, it is proposed to market plant nutrients and thereafter foray into Micro Irrigation systems at a later stage. During the next year, the Company will venture into Ghana, South Africa and other places<sup>4</sup>

This indicates some barriers are posed by the government for the industry so it is suggested that if the industry is doing effective exploitation of resources to maximize its production then it's better to formulate new policies to improve the indigenous production than going for imports, if the industry is doing over exploitation of resources to meet its targets then it's better to go for imports. (Or) If the gains from the imports are more than the gains from expansion of industry then it's wise to go for imports

### 3. The Bottle Necks in SCM of NFCL Are Lack of Company's Won Vehicles and TPL

Plan of distribution in NFCL is pending daily due to the following reasons

- Insufficient no of RAKES,
- Lack of company's won warehouses (multipurpose)
- TPL: The cherry pickers are selecting only the commercial routs but not the non commercial routs.
- The road problems to the Truck Drivers are external bottlenecks (with clear information we can reduce the problems associated with the roads)

The govt. says there are an average surplus of 0.55 lakh tones per year for nitrogenous nutrient and an average of 0.2608 lakh tones deficit per year for phosphate (P) nutrient and 1.736 lakh tones deficit per year for Complex Fertilizers (NPK). This indicates the supply and demand gap for nitrogenous (N) nutrient is nil.

Nevertheless there is a surplus in the records of government in the actual picture the farmer is facing shortage of urea and other complex fertilizers. The causes for this problem can be lack of proper distribution (out bound logistics) management and urea is being supplied to the mixture units (complex fertilizers). Another reason for the shortfall in supply can be the dealers who are creating artificial shortage in peak demands so that they can enjoy more profits by rising prices. So the government and the company should maintain a transparent distribution control system which is accountable for both the public at large and the industry and the government itself.

These problems can be solved when *the SCM in NFCL and in the fertilizer industry works as the circulatory system and distribution as the pumping organ (the heart).*

### 4. What This System Is?

The SCM in NFCL and (or) in fertilizer industry is consist of the primary activities like inbound logistics, operations, outbound logistics and marketing sales and services with the supportive activities of firms infrastructure, HRM and the procurement.

The SCM system should work as a circulatory system and distribution as the pumping organ (the heart). The heart collects deoxygenated blood from various organs and parts of the human body, and circulates it to the lungs for purification and receives oxygenated blood, and sends it to all parts of the human body. As long as it's the continuous process and the heart receives both the inflow and outflows of blood without any hurdles in its channels the heart function healthily. But any hurdle in its channels of both inflows and outflows can result heart stroke. Hence there should be a similar process in SCM of NFCL and (or) in the fertilizer industry itself.

<sup>2</sup>News Letter Ministry of Fertilizers

<sup>3</sup>News Letter Ministry of Fertilizers

<sup>4</sup> NFCL Annual Reports 2011

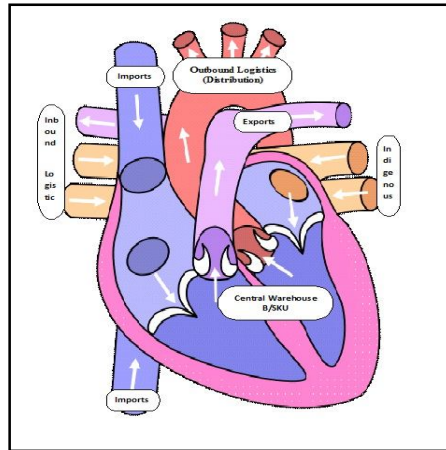


Figure 2: Distribution as the Pumping Organ (The Heart)

4.1. The inbound logistics

The NFCL and (or) the fertilizer industry is wholly driven by the major input the natural gas, and other inputs like naphtha, fuel Natural Gas, Catalysts Chemicals and Consumables, Packing Material and spares. The industry is running with a shortage of about 25% of natural gas as it became the major fuel gas for domestic cooking, electricity feedstock, CNG fuel gas to automobiles and other manufacturing industries are being run by the natural gas but the availability of natural gas is limited in some areas. It should be allocated to all the nearby states as it was the nation’s property.

In this study there is less emphasis given to the inbound logistics as the allocation of natural gas is strictly under the government control so only advisable suggestions are given. The government should supply sufficient natural gas without any shortage to this fertilizer industry to gain its self sufficiency to meet the domestic demand as the fertilizers are the major inputs to the agriculture the primary sector of India.

Sl. No	Nutrients	NBS (Rs. Per Kg of Nutrient)
1	N	24.000
2	P	21.804
3	K	24.000
4	S	1.677

Table 2: Implementation of the Nutrient Based Subsidy (NBS) Policy for Phosphate and Potassic (P&K) for the year 2012 – 13 to be implemented w.e.f. 01.04.2012

Source: FAI New Delhi

If the cost of all inputs in manufacturing of Kg of nutrient is reduced or less than Rs. 24.000 the NBS proposed by the government the firm will earn profits.

4.2. Imports

India is importing 7 million tons of urea to bridge the gap between the demand and supply. Nevertheless the farmer is facing shortage of urea in right time. The reason for this problem can be the irregular periods of imports. So it can be suggested the government should make available of imports in right time as the production of this product in this industry worldwide is a continuous process.

4.3. The operations

In this study less emphasis is given to operations as the topic is very narrow to the operations activities. So only few suggestions are advised to make it functional.

In the performance of fertilizer industry it is identified that (see industry performance analysis) the firm is doing well and it can do more effectively and efficiently because MOEF panel clears NFCL phase III urea expansion and NFCL shortlists technologies for its Phase III expansion. Nagarjuna Fertilizers and Chemicals Limited (NFCL) has shortlisted three ammonia and three urea technologies for its proposed Rs. 4,314-Crore expansion project. In its environment impact assessment (EIA) report on the project, the company says: “The single stream Ammonia / Urea plants of 2200 MTPD / 3860 MTPD capacities have been selected and will use one of the following process technologies.” The technological options for ammonia Plant are: Kellog Brown and Root Process, Haldor Topsoe Process and Uhde Process. The short-listed urea technologies are: Stamicarbon Process, Snamprogetti Process and Toyo’s ACES-21 Process. The project named phase III is targeted for completion with 30 months from the zero date. NFCL has an agreement with RIL and GAIL for supply of 3.255 MMSCMD of natural gas for the existing two ammonia-urea streams. It has already given a request to the Union Government to allocate additional gas of 2.4 MMSCMD for Phase III project. Subsequently it is suggested that if the industry is doing effective exploitation of resources to maximize its production then it’s

better to formulate new policies to improve the indigenous production than going for imports, if the industry is doing over exploitation of resources to meet its targets then it's better to go for imports. (Or) If the gains from the imports are more than the gains from expansion of industry then it's wise to go for imports.

#### 4.4. Outbound Logistics: Distribution as the Pumping Organ (the Heart)

This system can work well with the help a sound IT in the distributions system. After gaining the knowledge pertaining to demand and the supply of both indigenous and imports a sound planning of distribution will work as the pumping organ the heart. First of all collect the product needed to meet the demand from both the sources of indigenous and imports in right time continuously. Secondly Stock it in B/SKUs in the factory premises for indigenous and near the ports for imports. And thirdly the product can be distributed to the destinations by following ways of distribution continuously

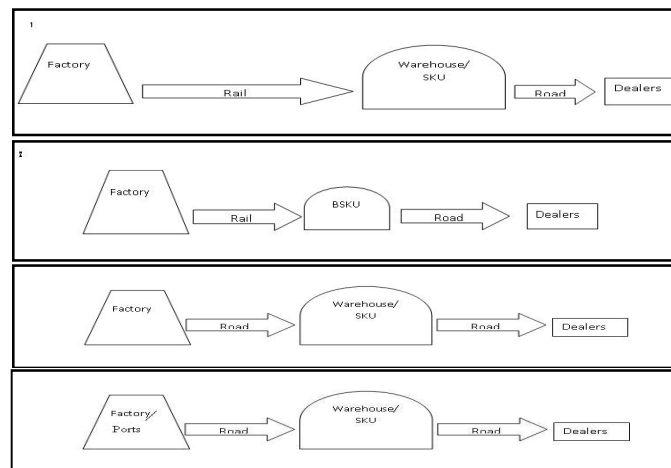


Figure 3: Channels of Distribution

Rail ways are recommended when there is availability of RAKes, priority of demand and for long distances. It should send or distribute more to the working organs (where demand is more). Information system should provide information about demand / crop / season/ type of fertilizer required/ the quantity required. It should maintain BSKUs to stock for long time without any loss. ZSO (Zonal Sales Officers) and ASO (Area Sales Officers) are responsible for product information.

#### 4.5. Bulk Stock Keeping Units

##### 4.5.1. Why this BSKUs?

Along with the regular mode of transportation the pool or bulk urea can be transported and stocked safely with cost effectively and efficiently. The firm is used to store the bulk urea near its bagging plant when there are no rail or road transportation wagons. The same is re retrieved from the bulk storage house to bagging plant and bag it and transports when there are the wagons for transportation. This can be implemented to far reaching destinations also when there is low demand for fertilizer (after harvesting to new plantation) the bulk or pool urea can be transported and stocked until the demand for fertilizers rise. It can save the time for bagging, space of transportation, and cost of labor involved. And also the product is distributed evenly to all the destinations based on the demand and the stipulated movement of fertilizers by the government. The firm is acting as the Clear and Forward agents for imports in the same manner it can bag and distribute the bulk stocked urea as and when required.

##### 4.5.2. Location of warehouse

Is should be near to rail, market (cultivated land), and road facilities

##### 4.5.3. Design

It should be just like a tomb or a water tank with large input and output openings



##### 4.5.4 Advantages

Cost effective in building, less maintenance cost, optimum utilization of capacity, use of conveyer belts, less loading and unloading time, cost, moisture free and safe from rain water, stored for long time when stored with good ventilation and in dry place and used for other food grains after cleaning with a proper agent, Act as multipurpose

#### 4.5.5. Maintenance

It can be maintained by the company or it can be leased from the TPL vendors or from the government.

### 5. Market Segmentation

On the basis of geographic (travel distance), availability of ports for imports and market demand (usage rate)

Sl. no	Name of the district covering above 500 km	No of destinations for Urea	No of ports	No of major rail stations	Name of the district covering below 500 km	No of destinations for Urea	No of ports	No of major rail stations
1	Adilabad	129	Nil	6	East Godavari	864	2	15
2	Anantapur	60	Nil	7	Guntur	378	1	11
3	Chittoor	103	Nil	8	Khammam	382	Nil	11
4	Hyderabad	52	Nil	4	Krishna	381	1	11
5	Kadapa	54	Nil	3	Srikakulam	234	3	15
6	Karimnagar	209	Nil	8	Visakhapatnam	295	3	11
7	Kurnool	113	Nil	2	West Godavari	653	1	10
8	Mahbubnagar	124	Nil	7				
9	Medak	106	Nil	2				
10	Nalgonda	206	Nil	8				
11	Nellore	117	1	4				
12	Nizamabad	187	Nil	4				
13	Prakasam	151	1	3				
14	Rangareddy	77	Nil	11				
15	Vizianagaram	252	Nil	15				
16	Warangal	316	Nil	6				
	Total	2256	2	98		3187	11	84

Table 3: market segmentation for Nagarjuna Urea (District wise)

Source: Company internal records

- Interpretation

Table 3 presents the market segmentation for Nagarjuna Urea. It shows the districts Adilabad, Anantapur, Chittoor, Hyderabad, Kadapa, Karimnagar, Kurnool, Mahbubnagar, Medak, Nalgonda, Nellore, Nizamabad, Prakasam, Rangareddy, Vizianagaram and Warangal has covered more than 500 kms and are covered 2256 destinations and having an average of 6 major rail stations. The district East Godavari, Guntur, Khammam, Krishna, Srikakulam, Visakhapatnam and West Godavari has covered less than 500 kms with 3187 destinations and are having an average of 12 major rail stations.

From this study it is clear that the destinations which are far from the company is having less no of rail and ports for transportation where as the destinations which are near to the company is having more no of rail and ports for transportation. Hence it is suggested that the govt. and the company should follow the suggestions made under this study for ensured smooth flow of product.

Priority to Railways should be given as follows.

- First priority should be given to the destinations which covered maximum distance.
- Second priority should be given to the destinations which are having high and irregular demand.
- Last but not least priority should be given to the destinations where there are no ports and less no of rail stations available.

Priority to road transportation should be given to the immediate (nearest) destinations which cover mass markets as there are regulations in govt. reimbursement.

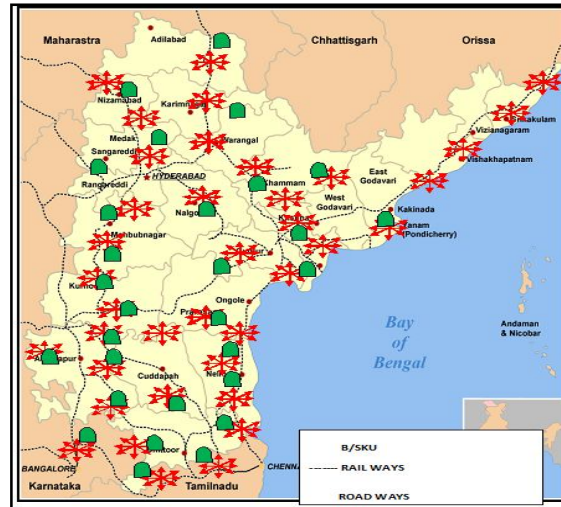


Figure 4: Rail map

Sl. No	Name of the region	No of destinations for Urea	Total Distance covering (km)	Average distance per destination from NFCL (km)	No of ports	No of major rail way stations	No of B/SKUs suggested	Initial Mode of transportation suggested (Rail : Road)
1	Coastal Andhra	3325	597295	179.63	13	95	35	50 : 50
2	Telangana	178	696036	389.28	Nil	67	26	50 : 50
3	Royalaseema	330	189090	573	Nil	20	16	50 : 50
	Total	5443	1482421	1141.91	13	182	77	

Table 4: market segmentation for Nagarjuna Urea (Region wise)

5.1. Why Roads?

Freight reimbursement on account of primary movement of P&K fertilizers (except SSP) by railway shall be paid as per actual on the basis of railway receipts. No freight reimbursement shall be made on account of secondary movement of P&K fertilizers. Freight reimbursement on account of direct road movement of P&K fertilizers (except SSP) shall be paid as per the actual subject to maximum of equivalent rail freight. Maximum allowable distance under direct road movement shall be 500 km. Thus there is no such restriction for Nitrogenous (N) Fertilizer but the freight reimbursed by the government to the road movement is confidential to the company. This is the reason why the company wants to improve its cost effectiveness to gain its competitive advantage. The study related to rail ways mode of transportation is limited in this study as it is 100% reimbursement railway shall be paid as per actual on the basis of railway receipts so the study is limited to the road transportation as it is the only mode of transportation we can make it cost effective and there is great scope of operations as and when it is deregulated by the government. The road map or the road web can help in identifying critical paths. The table gives an idea about the movement and freight for each mode of dispatches of urea. There is no doubt that the road freight only can reduce the transportation cost when compared to rail freight. Nevertheless the government policies on the movement of fertilizers are biased to the railways. It's suggested that if it can deregulates these policies it can help the industry in cost competitive advantage.

The current method of freight master used by NFCL is doing well in addition to the current method it should consider the following to the more cost effective. In Andhra Pradesh there are 4,89,379 goods vehicles are there So prefer high capacity trucks for transportation as there are 6tns, 8tns, 10tns, 12tns, 14tns, 16tns, 18tns, 20tns and 25tns capacity trucks are available<sup>5</sup>. So that bulk amount can be distributed for the same cost of transportation. And Prefer new trucks than old trucks so that km/liter increases and the TPL will quote for less as vendors are invited through tenders and sealed bid quotations. If the firm can maintain its own vehicles it works more cost effective than TPL.

<sup>5</sup> AP RTO Records 2011

Financial year	Production (MTS)	Rail coeff. (%)	Rail freight in Crs.	Rail freight per MT (Rs)	Road coeff. (%)	Road freight in Crs.	Road freight per MT (Rs)	Difference between rail and road freight per MT in Rs.
2001 - 02	1221944	80	29.47	301.47	20	6.92	283.16	18.31
2002 - 03	1187259	82	36.15	371.32	18	7.21	337.38	33.94
2003 - 04	1193960	81	38.24	395.41	19	7.53	331.93	63.47
2004 - 05	1392538	81	44.03	390.35	19	7.99	301.99	88.37
2005 - 06	1379220	80	45.46	412.01	20	8.24	298.72	113.3
2006 - 07	1324054	82	61.55	566.9	18	9.12	382.66	184.2
2007 - 08	1354490	89	78.8	653.67	11	9.48	636.27	17.41
2008 - 09	1378162	89	80.44	655.82	11	7.45	491.43	164.4
2009 - 10	1482103	78	81.37	703.87	22	6.65	203.95	499.9
2010 - 11	1655042	77	92.71	727.49	23	6.89	181	546.5
Average	1356877	81.9	58.822	517.831	18.1	7.748	344.849	172.98

Table 5: Nagarjuna Urea Production V/S Dispatches & Railway V/S Road Freight for 10 Years

Source 5: Company internal records

- Interpretation

Table 5 Presents the Nagarjuna Urea Production V/S Dispatches & Railway V/S Road Freight for 10 Years. It shows that in the years 2001 – 02, 2002 - 03, 2003 - 04, 2004 - 05, 2005 - 06, 2006 - 07, 2007 - 08, 2008 - 09, 2009 - 10 and 2010 – 11 the urea production (MTs) is 1221944, 1187259, 1193960, 1392538, 1379220, 1324054, 1354490, 1378162, 1482103 and 1655042 respectively. The rail coefficient (%) dispatched is 80, 82, 81, 81, 80, 82, 89, 89, 78 and 77 respectively. Whereas the road coefficient (%) dispatched is 20, 18, 19, 19, 20, 18, 11, 11, 22 and 23 respectively. And Rail freight per MT (Rs) is 301.47, 371.32, 395.41, 390.35, 412.01, 566.9, 653.67, 655.82, 703.87 and 727.49 respectively. Whereas the Road freight per MT (Rs) is 283.16, 337.38, 331.93, 301.99, 298.72, 382.66, 636.27, 491.43, 203.95 and 181 respectively.

From this study it is clear that the average Rail coeff (%) is 81.9 and Road coeff (%) is 18.1 for dispatches and the average Rail freight per MT (Rs) is 517.831 whereas the average Road freight per MT (Rs) is 344.849 shows an average Difference between rail and road freight per MT in Rs. 172.98 for 10 years. Hence it is suggested that the govt. and the company should dispatch more through the road transportation.

## 6. Conclusion

On the basis of inferential analysis made from the inbound and outbound logistics in Nagarjuna Fertilizers and Chemicals Limited and in the fertilizer industry it is concluded that the present supply chain management system in Nagarjuna Fertilizers and Chemicals Limited and the fertilizer industry should be modernized with a new model which is more cost effective and efficient in the modern agriculture. The whole study was based on the secondary data available with the company as there is less scope of primary data and it is the limiting factor.

## 7. References

1. Ministry of Fertilizers of India
2. News Letter Ministry of Fertilizers
3. FAI New Delhi
4. NFCL Annual Reports 2011