

“SUPPLY CHAIN MANAGEMENT: FOR THE INDIAN” AGRI FOOD SECTOR

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Abstract- Indian civilization is one of the oldest civilizations, and therefore it has the rich heritage and legacy of the various schools of thoughts. It may really be beneficial to learn from the core principles of the yesteryears so as to extract the standing principles that provided the vitality and the vigour for the Indian civilization to grow and flourish from the time immemorial till today. The present research work reflects the existing supply chain architecture of the Indian Agri-food sector and provides areas where concentration is needed for its improvement. The research work is followed by designing an avant-garde sustainable supply chain model named as “Project Samridh Bharat” for Indian Agri-food sector. The present study also highlights the impact of FDI in Indian scenario and is followed by developing a performance measurement framework for the Agri-food supply chain network by an analytical decision making tool named analytical hierarchy process (AHP).

INTRODUCTION

Every human being has certain desire (needs and wants). Needs being the basic state of human desire that is needed for survival such as air, water, food, cloth, shelter and Wants being the secondary desire for living satisfaction such as cars, processed food, etc. In economic terms these needs and wants creates demands and hence to fulfill these demands someone has to supply the desired things. These creates a never ending process of demand and supply and takes a form of chain known as supply demand chain commonly known as supply chain.

What is supply chain?

A supply chain is an integration of:-All facilities, functions, activities, associated with the flow and transformation of goods and services from backend (production house) to front end (customer base). An integrated group of processes to “source,” “make,” and “deliver” products.

All process which involves the flow of information from backend to frontend and vice versa.

According to Cooper et al. (1) Supply chains are the conduits through which:

1. Products move from producers to consumers.
2. Payments, credit and working capital move from consumers to producers.

3. Technology and advanced techniques are disseminated among producers, packagers and processors.
4. Ownership rights pass from producers to processors and ultimately to marketers.
5. Information on current customer demand and on retail level product preferences pass back from retailers to producers.

Supply Chain Management

In present times, Supply chain management (SCM) has received a great deal of attention from worldwide practitioners and researchers both from academic and industrial background. Due to the emerging trends of globalization and the increasing saturation of markets, competition has become more intense in recent years. These competitive environments have forced companies to collaborate more closely using the concept of supply chain management. Supply chain management is an approach to design value chains or marketing chains by optimizing the inter-organizational flow of material, information and capital in order to reduce the system wide costs and enhance customer value.

A supply chain management is:-

A set of approaches used to efficiently integrate :

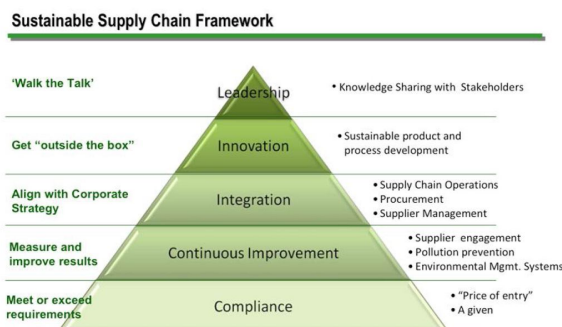
- Suppliers
- Manufacturers/producers
- Warehouses
- Distribution centers
- Consumer base

So that the product is produced and distribute :

- In the right quantities
- To the right locations
- At the right time

System-wide costs are minimized and service level requirements are satisfied.

Indian Agri-food sector



Agriculture was and is one of the largest employment sectors in the world and for India it's the major or the primary source of employment. More than half of Indian population depends on agriculture as their primary source of livelihood. Agriculture is the backbone of Indian Economy. The occupational structure of Indian workforce can be divided into three classes. Agri-food sector constitute the primary sector of the occupational structure. India is the fruit and vegetable basket of the world. India being a home of wide variety of fruits and vegetables holds a unique position in production figures among other countries. Estimates currently suggest that India ranks second in terms of farm output, first being china.

Although there have been a large number of people involved in agriculture in India, still there is a food crisis. In India, agriculture got its dimension during green revolution. This introduced several new scientific methods, which increased the food productivity. But still, In India, 37 % live below poverty line and several hundred die due to malnutrition. Although the green revolution in India led to sizeable increase in terms of productivity that too in certain crops but the overall growth in terms of farmers economic status is unremarkable.

Agriculture derives its importance from the fact that it has vital supply and demand links with the manufacturing sector. The basic characteristic which is common in agriculture and manufacturing sector is: "Production"

Challenges in Indian Agri-food Sector

According to Hon'ble Union Minister Sharad Pawar, "Agriculture sector is witnessing radical changes and challenges at national and global level. The demand for agricultural commodities is steeply rising; food preferences of the next-generation consumers are changing; and agriculture sector is struggling with decelerating profitability which is dragging its performance. The emerging challenges and opportunities call for a paradigm shift in the innovation driven agricultural research system to connect inventions with all the stakeholders in the entire food supply chain". Two different types of contrasting trends have been noticed in present times with respect to present Indian scenario:

1. India is being recognized as the global power in the key economic sectors with consistent high economic growth and
2. Its slow growth observed in the agriculture sector is causing concerns for the future food and nutritional security of the country.

Agri-food Supply Chain Management

The agricultural sector provides an important contribution in the development of a country due to its contribution in both economic and environmental development. As the backbone of the development in most of the developing countries, agriculture holds important roles in deciding the stability of the

economy of the country itself. Statistical figures show that 70% of the world population lives in rural areas and only 38% of the land in the world is used for agriculture cultivation, depleting from time to time, due to industrial expansion and human population growth (World Bank, 2010). Achieving sustainability in agricultural contexts means meeting three challenges commonly known as 3P's, that are: (a) profit – strengthening the viability and competitiveness of the agricultural sector; (b) planet – the ecological challenge of promoting good environmental practices; and (c) people the social challenge to improve the living conditions and economic opportunities in rural areas. Consumer's wants and preferences are not transmitted directly to the farmers who produce or plant the crops. Hence, there are missing links in connecting consumers at one end, and farmers at the other have summarized the following specific aspects of Agri-food supply chains:

1. Shelf-life constraints for raw materials.
2. Perish ability of products.
3. Long production throughput time.
4. Seasonality in production.
5. Conditioned transportation and storage required.
6. Storage-buffer capacity restrictions, when materials or products can only be kept in special containers.
7. Governmental rules concerning environmental and consumer-related issues (CO₂ emission, food-safety issues).
8. Physical product features like sensory properties such as taste, odour, appearance, colour, size and image.
9. Convenience of ready-to-eat meal.

A general optimization problem related to Agri-food supply chain can be written as:- Objective Function-

1. Minimize the sum of costs of production and transportation.
2. Maximize the profit of farmers.

Constraints-

1. Meeting demand.
2. Respect the available capacity at production.
3. Respect the available capacity at supply.
4. Respect the available capacity at distribution.

There are some rules to be followed for attaining fruition in supply chain design optimization:-

1. Objectives - must be quantified and measurable
2. Models - must faithfully represent required logistics processes
3. Variability - must be explicitly considered
4. Data - must be accurate, timely, and comprehensive
5. Integration - must support fully automated data transfer
6. Delivery - must provide results in a form that facilitates execution, management and control
7. People - must have the domain and technology

expertise required to support the models, data, and optimization engines

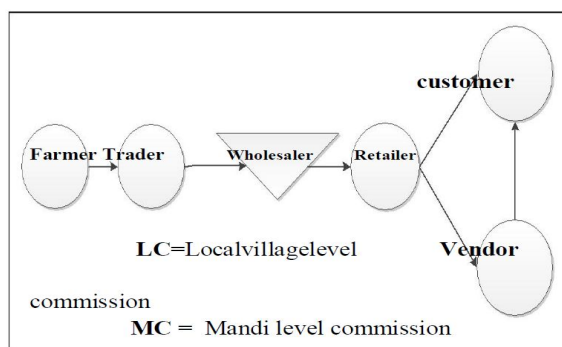
8. Process - must support optimization and have the ability to continuously improve

Review on Existing Traditional Indian Agri-food Supply Chain Network

In the case of the agricultural sector, India's supply chain is one of the most fragmented and inefficient ones in the world resulting in wastage of large quantities of food grains, vegetables and fruits. About 25-30 percent of vegetables and fruits are destroyed before they come to the market. Apart from this, output is procured through unhygienic practices. This means farmers and consumers bear the costs of the wastage. The agricultural markets are not functioning in a proficient manner. Apart from inefficiencies in distribution, including wastage of agricultural produce, the farmers suffer due to exploitation by traders.

Problem Analysis Methodology

The present research work is based on a real world problem and then it is modelled in the ideal world with certain assumption in order to meet with the desired criteria. A real world problem is taken, in the present case the traditional Indian Agri-food supply chain network. It is then modelled in the ideal world with certain assumptions and after then it is analyzed with respect to different criteria's (in the present case wastages and supply chain cost). There is no single model of procurement and distribution for Indian Agri-food products. It depends on various factors, such as type of product, place, etc. The Existing traditional Indian Agri-food supply chain network shown below is assumed by the author, by consulting with the vegetable vendor of M.P. (C.G.).



Existing Traditional Model Cost Estimations

Assumptions:

1. Single product type.
2. Costs are calculated on per kg basis.
3. Selling Prices are approximated with the market report.
4. Commission charges are approximated with the market report.
5. Wastage percentage used in the calculation

is an estimate value adopted from various past researches and planning commission data and market survey.

6. Marketing elements in the chain are assumed by interviewing from market.

Disadvantages associated with the Existing model

The disadvantages associated with different elements along the traditional supply chain model can be summarized in the following way:-

At farmer's side:-

1. Low return on investments.
2. Prices delinked from the market.
3. Unavailability of adequate infrastructure.
4. High Credits leading to debt trap or poverty trap.
5. High commission charges.
6. High transportation cost.
7. Lack of marketing option at farm gate.
8. Distress selling.

At commission agent's side:-

9. Non value adding player.
10. Unscientific handling.
11. Quality deterioration.
12. Risk free income.
13. Charges huge commissions from farmers. At trader's side:-

14. No infrastructure for grading
15. Large wastages due to ineffective transportation facilities.

At wholesaler's side:-

1. Large wastage.
2. No control on quality.

At retailer's side:-

- No control on quality.
- No infrastructure for proper storage.

At customer's side:-

1. High prices.
2. Low quality products.
3. Limited alternatives

Proposed model for Indian Agrifood Supply Chain Network Project Samridh Bharat"

FEATURES OF THE PROPOSED MODEL

1. No commission agents involved. Cost effective.
2. Complete supply demand management with software support.
3. Every farmer members are the shareholders.
4. Less handling so less wastages.
5. Proper food grading according to food safety measures.
6. Retail counters at village and city for BPL card holders and NGOs.
7. Proper financial and technical support to farmers.
8. Proper waste management system for entire food wastages.
9. Proper warehousing and inventory management.

Feature and benefits associated with the Proposed

model

The salient features of the proposed model are:-

1. Transportation facilities for farmers.
2. Crop Insurance facilities for farmers.
3. Education and training.
4. Medical facilities.
5. Technical support.

Functions associated with the proposed model

Functions	Traditional Model	Proposed model
Transportation facilities	x	√
Storage facilities	x	√
Automated weighing machine	x	√
Trainings	x	√
Profit sharing	x	√
High ROI	x	√

The benefits associated with the proposed model are:-

1. Optimization in resource use and output management.
2. Increase in farm income
3. Shares on the profit.
4. Reduced storage losses

Cost Benefit Analysis

This section evaluates the performance of the existing model, Modern retail model and the proposed model on the basis of cost-benefit ratio (CBR). A cost-benefit analysis helps in determining the profitability of farmers. The cost-benefit ratio is computed as an indicator of economics of investment criterion. This ratio helps in judging the feasibility of investing in the proposal. The cost-benefit ratio is a simple calculation that depicts the total financial return for each rupee invested in cultivation. If the cost-benefit ratio is 1.50, it means that for every rupee invested in one hectare of land under cultivation for a given produce, the return is about Rs. 1.50 per hectare after the sale of the produce.

The cost-benefit ratio is defined as:

$$\text{Cost-benefit ratio (CBR)} = \frac{\text{Gross Returns}}{\text{Cost of Cultivation}}$$

Where: Gross Returns = Yields * Selling Price

Description of the Models

The models used for the cost benefit analysis are described below:-

MODEL-1

Farmer → Local Commission Agent (Village

Level)→ Trader (Mandi)→ Commission Agent (Mandi Level)→ Wholesaler → Retailers→ Consumers

MODEL-2*

*Retail Chain Market

Farmer → Trader → Retail Chain → Consumers

MODEL-3 (Proposed Model)

X*= Farmer Owned Co-Operatives with Government-Private Partnership

Farmers → X*→ Local Vendors/Retailers → Consumers

Cost Benefit Table

The cost benefit ratios for the above three models are calculated in the tabular form.

Assumptions:-

Product = Tomato

Quantity Handled= 2600kg

Cost of Cultivation is assumed by consulting with farmers of M.P. (C.G).

Cost-Benefit Analysis

Model	MODEL 1 (Existing Traditional Model)	MODEL 2 (Modern Retail Chain)	MODEL 3 (Proposed Model)
Marketing Chain	F-C _L -T-C _M -W-V-C	F-T-R _C -C	F-X [*] -V-C
Quantity Handled (kg)	2600	2600	2600
Cost Of Production(°)	3172	3172	3172
Farmer SP(°/kg)	4	4	4
Commission Charges(% of SP)	8-10	-	-
Price Received By Farmers(°)	4784	10400	10400 + Share in Total profit
Farmer Profit(°)	1657	7273	7273
Producers Net	4784/2600	4	4
Price (°/kg)	=1.84		
Wastage (%)	25-30	10-15	5-10
Customer CP (°)	10-15 (12.5)	10-12 (11)	8-12(10)
Wastage (°)	2600*0.25*12.5 =8125	2600*0.1*11 =2860	2600*0.1*10 =2600
Farmer Share In Customer Rupee	(1.84/12.5)*100 =14.72	36.36	40
Cost-Benefit Ratio	4784/3172 =1.51	10400/3172 =3.27	> 3.27

From the above table it is clear that proposed model outperforms more compared to the other models, when all the features of the proposed model are considered.

FACTORS AFFECTING SUPPLY CHAIN EFFICIENCY

Modeling of Supply chain efficiency can be done by following way:-

$$Z = f (X1, X2 \dots XN)$$

Where, Z = Supply Chain Efficiency (%) X1 = Price received by farmers (Rs.) X2 = Price paid by consumer (Rs.)

X3 = Wastages in monetary term along the supply chain (Rs.) X4 = Marketing cost (Rs.)

Desired outputs include multi objective functions with conflicting objective. Desired output includes

High profit on farmer side with Low cost price on customer side.

Introduction to Supply Chain Performance Measurement Supply chain performance measurement is a management strategy that helps companies to enhance their performance levels in all the desired areas of the supply chain network. The idea behind the performance measurement technique is to first optimize the desired goal then to prosper, to get high operational excellence. Proper measurement leads to high market share and correspondingly continuous improvement of the organization. The variables to be measured are known as performance indicators. The choice of variables depends upon the supply chain network under consideration. The performance indicators can be qualitative (customer satisfaction, producer satisfaction etc) and quantitative (total supply chain cost, profit etc).

SUPPLY CHAIN PERFORMANCE MEASUREMENT

Supply chain performance measurement is a management strategy that helps companies to enhance their performance levels in all the desired areas of the supply chain network. The idea behind the performance measurement technique is to first optimize the desired goal then to prosper, to get high operational excellence. Proper measurement leads to high market share and correspondingly continuous improvement of the organization. The variables to be measured are known as performance indicators. The choice of variables depends upon the supply chain network under consideration. The performance indicators can be qualitative (customer satisfaction, producer satisfaction etc) and quantitative (total supply chain cost, profit etc). The tools or the models used for performance measurement also vary according to the data available and the goals to be evaluated.

Performance measurement is critical for companies to improve supply chain effectiveness and efficiency. Adequate performance measurement indicators must be identified for the supply chain network under study and a proper methodology is to be developed for better result. The main purpose for developing this framework is to obtain feedback relative to the desired set of goals and once loopholes are evaluated, the company can change its strategy for getting higher shares from market. Performance measurement affects the decision making through the evaluation of past trends and benchmarking techniques. The choice of appropriate supply chain performance indicators is rather complicated due to the presence of multiple inputs and multiple outputs in the system. This issue becomes even more problematic in the field of food and agribusiness due to specific characteristics of Agri-food supply chains. The answer to the above question can be given in following points:-

1. To set desired performance goals.
2. To evaluate the performance gaps.
3. To understand the actual market demand.
4. To develop supply chain priorities.
5. To compare theoretical limits and actual needs.
6. To obtain market feedback.

According to Lambert & Pohlen a well defined supply chain measurement system increases the chances for success by aligning process across multiple firms and targeting the most profitable markets and obtaining a competitive advantage through differentiated services and lower cost.

AN AHP APPROACH FOR DEVELOPING THE INDIAN AGRI-FOOD PERFORMANCE

Measurement Framework

The analytic hierarchy process (AHP) is a quantitative tool for making decisions with multi-criteria developed by Saaty and has been applied to a wide variety of managerial decisions and socio-economic judgment process. The AHP is a commonly used tool because it can solve unstructured problems in different areas of human needs and interests, such as political, economic, social and management sciences

The Analytic Hierarchy Process (AHP) involves pair wise comparisons of criteria's. The weightage is given according to nine point priority scales. The comparisons are made using priority scale of absolute judgements that represents how much more one element dominates another with respect to a given attribute. The judgements may be inconsistent, and how to measure inconsistency and improve the judgements, when possible to obtain better consistency is a concern of the AHP.

Marketing Agent Selection by AHP

This portion is related with the selection of a marketing agent from farmer's point of view. The analytical tool used for making the decision is AHP. The objective is to select the marketing agent from three alternatives available on the basis following criteria. The various criteria are:-

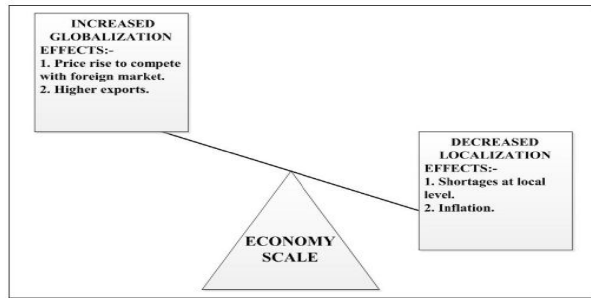
Price- Farmers want high price for their products.

Credits- Sometimes farmers need credits to purchase farm equipments and other farming needs.

Trainings- Trainings are given by certain Governmental bodies or NGOs with respect to farming and cultivation techniques in order to raise the productivity and other measures.

Summary

The topic of performance measurement is encountering increasing interest in both the academic and managerial areas. Also, there is a need of real time research work in those sectors of the Indian scenario which directly affects the economy of the country



CONCLUSIONS

The industrial engineering and management concepts can play an important role in designing and developing a sustainable supply chain network. Following are the list of objectives that can be suitably evaluated and attained by effectively applying the industrial engineering and management concepts in the domain of Agri-food supply chains:-

- Efficient Agri-food supply chain network design.
- Effective planning of food distribution system.
- Handling logistics issues.
- Development of performance measurement system for Agri-food supply chain.
- Integration of IT support for developing effective planning strategy.
- Quality control along the chain.
- Design of distribution networks.
- Marketing agent selection.
- Food Supplier selection.
- Warehouse management.
- Vehicle routing along the chain.
- Warehouse location problem.
- Production system design. .
- Effective supply chain Cost accounting using ABC including time constraint.
- Optimization of production system.
- Logistic network design and planning.
- Designing cold storage infrastructure.
- Enhanced packaging and grading techniques.
- Cost benefits analysis using RFID technique for

Indian agri-food supply chain network.

- Simulation tools for real time modeling.
- Design of effective management information system and decision support system.
- Effective post harvest management by local warehousing.

There is a vast area for research to be carried out with reference to Indian scenario. Various multidisciplinary approaches can be applied to a common problem for obtaining sustainable results.

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