APPLICATIONS OF OPERATIONS RESEARCH IN FOOD AND AGRICULTURAL INDUSTRY

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ABSTRACT

"The concern of Operations Research with finding an optimum decision, policy, or design is one of its essential characteristics. It doesn't look for simply to outline a stronger answer to a retardant than the one in use; it seeks the most effective answer." victimisation scientific strategies and techniques, or aims to achieve the most optimal solution given the situation and constraints. This makes it a very handy tool to use in problem solving.

One industry that can particularly benefit from these techniques is that of food and agriculture. The size and nature of the industry provides immense scope for the application of Operation Research. In this paper we try to characterize how it can and has been used in this industry in the past, its impact, and the outcome. It is a literature review and analysis of a compilation of research papers on this subject matter. More importantly, we analyse how viable are the solutions we obtain in terms of cost, accuracy, implementation and result and their applicability in real life situations.

OBJECTIVES

The paper seeks to review and analyse an accumulation of research papers which study the applications of operations research in the food and agriculture industry. The papers are based on the objective to change or create an optimal production plan such that it minimises the cost and maximizes the benefits.

LITERATURE REVIEW

Operations research is an analytical method of problem-solving and decision-making that is useful in the management of organizations. In research, issuesarede-escalated into basic partssosolved in outlined steps by mathematical analysis.

This paper talks about research in food and agriculture industry. For food industry it tells how least cost method, management sciences, statistical thinking, logistic and supply chain management are been used, it also talks how Operation research has been used in the food delivery sector and also the challenges faced in the food industry. And for the agriculture industry the paper talks about the application of operation research in optimization of agriculture, how operation research is been used in the day to day decisions of agriculture, use of Game Theory and also why the use of operation research is important in the agricultural industry for India? The current debate in the society with respect to the food sector revolves primarily around 3 issues i.e. Food quality, Food safety and Sustainability.

Food provides chains stretch from agricultural producers to customersand frequently involve a producing stage, as well as food service or retail activities. Distribution management usually refers to the physical flows and storage of product from the ultimate production purpose to the client or user. The distribution of food is not

the same as the distribution of other products. Food items show various quality changes during the distribution process, right until the final stage of distribution. Therefore, quality, health, and safety require central consideration in food distribution.

The restrictedperiod of time of food product, requirements with regard to temperature and humidity, possible interaction effects between products, time windows for delivering the products, high customer expectations, andlow profit margins create food distribution management a difficultspace that has solely recently began to receive additional attention within the operations management literature.When looked at from a linear programming point of view, it concerns the short-term planning of distribution operations and mostly deals with planning of deliveries to different customers. It is a transportation problem. Transportation plays a key role and accounts for a significant portion of the costs. Therefore, it is of prime importance to look to maintain efficiencies and minimize transportation costs. Typical decisions involve details of delivery routes; at what exact times, by which vehicle, and in what sequence customers will get their products delivered. Logistic and supply chain management play an important role in food industries. Supply chain in food industries connected with safety, healthy and nutritious begin from primary production to final preparation and consumption.Supply chain risk management refers to risk management with attention on the availability chain and its risk, which have an impact on the company.

Supply chain activities include procurement, inventory management, product design and new product development, manufacturing (planning), order processing, transport (distribution), sales, demand management, customer service. The supply chain management mentioned includes material flow risk, financial flow risk, and information flow risk.

The unique features of the food industry such as the perishable nature of food products differentiate it from other sectors of the economy, and have intensified the need for an efficient supply chain. Because of certain characteristics of food supply chains, the applicability of the concepts is confined. The usefulness of certain information depends on the possibilities of synchronization in the supply chain. The relationships between the quality requirements and products in the food industry and supply chain logistics are of utmost importance, but have only been briefly addressed in management research. In the poultry supply chain, quality requirements limit flexibility. A more intensive collaboration between food technologies and operations management scientists could be worthwhile.

There is a surprising truth about food consumption today is that more than one portion of the total populace has a calorie admission of under 2250 calories/day and that the normal per capita nourishment creation on the planet is really declining. There is no uncertainty that administration sciences will have a huge task to carry out in recognizing the methods for expanding the commitments of the nourishment business to human welfare.

The analysis of alternate providewayswithin theextremely competitive settinginside the food businessgoesto staythe provision of any helpfulrevealeddata to a minimum linear programming models are known to have been applied to the evaluation of procurement strategies for corn, wheat, vegetables, coffee beans, cocoa beans, lard, and edible oils. One of the problems encountered in formulation of such models are flavour and other quality restraints which are more significant in the selection of

ingredients for human consumption than in any other environment. Least cost mix framework in food industry handles the results of two of the eleven plants. The two plants might be looked into as pilot plans for the staying nine factories. The framework has been running effectively for as long as a year at these two plants, and has empowered the organization to hold the selling cost of the feeds. The dry spell the previous summer caused an intense deficiency of ingredients, causing the expense of fixings to take off. Anyway, by controlling the Least Cost Mix bundle, NRM Group figured out how to limit the expansion in cost, empowering costs to be held. The framework has additionally empowered wholesome degrees of the feeds to be all the more effectively controlled - henceforth realizing consistency of substance and larger amounts of value control.

The food industry has grown rapidly in the last decade. New restaurants come up every week making the marketplace more competitive by the day. Those who cannot sustain in this competition get eliminated. Price cutting, cost cutting and providing superior service quality to customers has become the basis of competition. This paper explores the use of operations research in food delivery companies. It uses transportation problems to analyse the food delivery industry where the source in the restaurants and they have to be delivered at minimum costs. The restaurants signed up with these companies want to maximize their quantities to increase revenue and the delivery companies look to minimise their cost of delivering food to the customers. It uses LPP to discuss how linear programming can be used to maximise the profits for the restaurants. Meeting competence and productivity targets under low profit margins at the same time as conforming to ever increasing customer demands are the challenges facing today's food manufacturers. The interrelated factors of raw material, final

product and process quality have been the focus of research and commercialisation of many decision-making tools and methods from shop floor data acquisition to enterprise resource planning systems. The main focus here is on two main issues. Firstly, to develop whereverdoable, data acquisition and transfer techniques to reduce dependency on paper work.

Secondly, to enable manufacturers to use market forecasts and consumer requirements for reduced wastage and resource utilisation. Here resources mean operators, machines, material handling systems and logistics. The decision-making process needs to incorporate a number of factors and their associated data, where some of these factors may be conflicting. Hence, it is important to identify suitable algorithms that can deal with large number of highly correlated variables as well as the ability to account for deterministic and random behaviour of a volatile manufacturing environment.

"Agriculture is one of the fields in which OR models were first used and have been most widely applied." Nowadays the OR community devoted to agricultural decision problems is big and quite active, with an increase on the use of OR models, mainly because of the development of personal commercial software programs. The future is even more promising, as scarce resources and environmental pressures will demand for better decisions that should be technically better grounded and better explained. Because we have only one world to feed an increasing number of people, and fertile land is limited and scarce, Operations Research will be in a near future a fundamental science for everybodywanting tocreatechoiceswithin the agricultural sector.

Some examples of successful applications of OR to problems in agriculture, trying to cover the

three levels induced by time scope (strategic, tactical, and operational). These levels are strongly connected to the kind of decision-maker present in the problem. Strategic problems involve usually decisions that have to be made by governments or global financing agencies, while at the operational level decision makers are usually farm managers, producers or local associations of farmers. Somehow transversal to all time horizons is sustainability. Usually looked at as an environmental issue, involving habitat protection of species, chemical fertilizers abuse or soil protection, it is nowadays tackled together with the economic and social dimensions, originating even more complex systems to analyse and harder decisions to make. Therefore, sustainability is present from the long-term decisions to the day by- day livestock rations choice. Agriculture is a low profitability, high risk occupation. This paper deals with the application of operations research to day to day decisions of agriculture. Therefore, decisions like the type of seed grain, farm planning, cost minimization and profit maximisation are of utmost importance. This research paper talks about the application of operations research in optimization of agriculture. The production plan was to increase the net profit without harming the environment. They use many different linear programming models consisting of many constraints and variables. In the past they have not been experienced by the new trends and have not tried any operations research models for the optimization of the profit. Firstly, the quantitative analysis was done which basically helped us know the quantity and resources available to them and the division of the same into different types like deterministic, dynamic, etc. and the block diagram was made to show the analysis of the same. Next they did the qualitative analysis which showed the social demand and policy effects on agricultural

production with fixed resources. After the analysis the model formation took place using the application of linear programming in which first step was the construction of model structure which used decision variables and diagrams. Next step was determining those decision variables using local crop rotations and land arrangements. After that the next step will be determining the objective function and then determining the constraints for the same. Then final step involves calculating the data and finally analysing the final solution for the problem. Once after using operations research we get the final solution to the problem then we go for the implementation of the same in agriculture production to increase the productivity. Past 3 years research has shown that operations research has helped increase the productivity of the crops as the method used have used resources efficiently to provide maximum output. Application of planning models in the agro-food supply chain focuses on different models that are present in the current time. It explains that the practices of the supply chain are under public scrutiny due to the changing attitudes of health-conscious consumers. The main focus is to study about the model used for perishable products, the products in which transportation variability and use of inventory as a buffer against demand is severely limited. Another finding is that while planning models dealing with perishable items planners often tend to incorporate the realistic factors, this is mainly because more realistic scenarios add more complexity in finding the solution.

India is associate agro-based economy with the agriculture sector providing employment for quitehalf the country's largepopulation.However, the sector contributes only 18% to the nation's Gross Domestic Product. India ranks second within the world in production of agro-based food things. Indiahassuperb numbers as so much as agriculture thinks about.However, these

numbers are very discouraging if compared with other countries.

Despite the large utility of agricultural sector to Indian economy, researches on India's agro-food industry in general and supply chain issues of Indian agriculture in particular, are very limiteddue to the immensely unorganized characteristic of the arena, complicating the process of primary data collection for researchers and policy-formulators.

Agricultural provide chain management engulfs set useful activities leading toremodelling agricultural commodities from their raw stage to consumption part.These activities could embrace acquisition or acquisition of agricultural raw materials, production course of agricultural commodities and the process of marketing, storing and dispensation of agricultural commodities.

Agriculture in India suffers from improper resource management and lack of modernisation. This paper attempts to throw some light on modernising the approach towards agriculture via OR techniques. There is use of linear programming or programme planning as it may be called in order to optimize agricultural produce and optimal running of resources. It has been used for the problem of minimization of cost of feeds, choice of crop rotation plan, determining optimal crop pattern. It also makes use of linear fraction programming to maximize macroeconomic determinants like growth rate, per capita income etc. with respect to agriculture. This paper uses network analysis, which is primarily used for planning, scheduling and estimation of projects in industries, to agriculture. Using OR would potentially not just reduce costs but allow farmers to maximise the utility of their land. It would suggest which crops are best suited for which climate, which state, production patterns etc. The research paper analyses uses of Assignment Problems to allot crops to states based on secondary data (to deduce a trend) that shows the crop production of all the states of India.

It represents a techniquewhich might be wont toestablishthat crops ought to be preponderantlymatureduring which state.

It willfacilitateto maximisethe assembly of crops within the country, maximize the profits and scale back land usage within themethod.

The first assignment problem helps to decide which on the 4 chosen crops (Rice, maize, cotton sugarcane) is to be grown in which state so as to maximize their profit and production. This data is derived from secondary data of the yield per hectare of crops available for the states. The second assignment helps to decide which crop should be grown in which state so as to minimize the land under cultivation while reaping the maximum benefit from it. The objective of the second assignment problem was to maximise the profit per quintal for the given crops. This was done by making an opportunity loss table and solving it using row and column minimization. From the results of these above problems, it was conclusive that if farmers can make us of OR techniques they can maximize their capacity to generate revenue while maintaining efficiency. The scope of this paper is however limited to a very small sample, with data collected from secondary sources. Real life situations involve more complex problems, subjected to many constraints which may affect the results of this particular study. Game theory was used to devise an optimal plan which was least sensitive to changes in weather conditions. The lesser the variation in benefit that weather causes under a plan, the better the plan is. The idea was to minimize the role of weather conditions in the optimal production plan to get a more accurate result. The application of operations research in

devising an optimal agricultural production structure increased productivity and reduced risk in management of agriculture. With appropriate crop rotation and multiple crops index, balance was achieved between utilization and preservation of land, which increases the output while maintaining soil fertility. The result was that the net profit from the crops increased by 12.35% and produce from livestock increased by 53.77%. However, the optimal production structure is not eternal. Changes must be made in the mathematical model and its parameters from time to time to accommodate changes in natural and economic surroundings.

India is known for being the largest producers of crops across the world but along with that it is also known for being one of the largest waste producers of the world. This is mainly caused due to absence of formal and informal risk management options available. The main problem is with the perishable product which has a limited inventory as a buffer against high demand. There are different models for different items and all these models need to be integrated to reduce waste. But the problem with making these models is that not all the realistic factors are taken into account. Even of everything is considered the integrated models become complex and it is practically impossible to execute those plans.

Nowadays with growing technology digital models are aiding the supply chain models. A lot of data can be analysed by the different analytical tools that are available. Artificial intelligence is used to find out solutions for specific problems, it is also used to foresee declines so that decision can be taken accordingly on how much stock has to be maintained etc.

The concept of maturity model can be one of the most effective solutions. It says that work should

be broken down into specific skills and further assignment needs to be done to different groups to get the optimal solutions it provides a basic framework which helps in developing and enhancing performances.There are 4 different levels of supply chain maturity

Level 1: Reactive store network executives

Level 2: Internal supply chain network combination with planned buffers

Level 3: collaboration crosswise over expanded inventory network

Level 4: Dynamic production network adjustment and adaptability

Customisations is an important factor for maturity models

The companies need to understand it's not only just about maintaining financial parameters but it's also about contributing towards sustainability. They should not only think about the profit margins that they lose due to the wastage but also the damage that is caused to the environment a few noteworthy aspects of sustainability benchmarking are : first – by creating indicators that reflect three elements of sustainability – natural, social and monetary after an idea of triple bottom line; second – by applying the property indicators to totally different provide chain stages from production to retail; third – by incorporating strategic property target setting through scaling indicators according to desirability of property performance; fourth – by crucial relative importance between indicators across property dimensions and provide chain stages.

Another factor that can improve the conditions is increasing the network and communications between different levels included in the supply chain. Many writers have recognised this increased need for collaboration, stressing out

the establishment of closer and long-term working relationships- even partnerships with suppliers at various levels in the chain, as the way to construct ever a lot of economical and responsive provide chains, in order to deliver exceptional value to customers.

However, collaboration in the supply chain isn't always easy to achieve, notwithstanding when past correspondence limitations, even when past communication restrictions, regarding efficient data and information exchanges between supply chain members, have been more or less surpassed by the Information and Communication Technology revolution and the development of e-business applications. A number of factors related to the business environment, the specific industry features, and endogenous firm characteristics, may still influence the series of dyadic business relationships, which constitute the supply chain, enabling or deteriorating this manner collaboration opportunities.

METHODOLOGY USED

The methodology which has primarily been used is Linear Programming, Transportation problems and assignment problems. Using these simple OR techniques we try to understand how to achieve cost minimisation, profit maximization and optimal production plans taking into account as many externalities as possible. The simplex methodology is another technique of sorting out the corner positions (extreme values) during this methodology, the slack variables, introduced to convert the inequalities to equalities and also the coefficients of those slack variables in c vector square measure zero.

ANALYSIS

Using Operations Research would potentially not just reduce costs but allow farmers to maximise the utility of their land. It would suggest which crops are best suited for which climate, which state, production patterns etc. Assignment problems were used to solve the problem which helped get the best output at minimum cost and it was used in both agriculture and food industry.

The scientific techniques used gave good results related to optimality of supply chain and transportation for different food and agriculture industry. We have characterised all the optimality based on the travelling cost and other supply and inventory management factors.

The proposed systems have efficiently fulfilled in providing the required output for the different industries taken into consideration.

The analyses of various data about the selected articles used for reference included different research settings, units of analysis, methodologies and theories.

APPLICATION OF APPLIED MATH

Linear programming finds its application in a very large array of fields. Since its beginning, research is being used for

1) The matter of diminution of prices of feed: The optimum performs becomes the entire price incurred whereas the costs and quantity become the constraints.

2) On the selection of a Crop Rotation Plan: The model is wont to decide associate degree optimum crop rotation pattern to realize most profit whereas the price incurred at manufacturing them becomes the constraints.

3) Field of feed-mixing for organic process requirements: The model uses varied mixtures of introduce order to get associate degree optimum

feed combination keeping in mind the organic process necessities for the animals.

QUANTITATIVE MEASURES

☐ Optimum crop pattern and production of food crops with most profit is vital data for agricultural coming up with using improvement strategies. Crop yield, man power, cost and physical soil sort square measure needed to create the strategy.

☐ This method is extremely helpful for individual farmers if the quantitative live, as mentioned on top of, of various alternative strategies and resource use is provided. Moreover, if enforced properly the advantages obtained from the implementation exceeds the price incurred by the farmer for implementing the aforementioned technique

☐ Spatial applied math analysis will facilitate studies associated with put down regional production and major crop changes. Transportation models square measure the only of applied math models applied in agriculture.

CONCLUSION

Operations research is gaining more visibility as a competitive advantage, especially in thisdigital age. Operations research transforms business decision-making and this is beingincreasingly recognized by companies around the world and in India.

Logistic and supply chain management play an important role in food industries. Supply chain in food industries connected with safety, healthy and nutrition, begins from primary production to final preparation and consumption.

Supply chain risk management refers to risk management with attention on the availability chain and its risk, which have an impact on the company. In the poultry supply chain, quality requirements limit flexibility.

A more intensive collaboration between food technologies and operations management scientists could be worthwhile. Agriculture in India suffers from improper resource management and lack of modernisation. Using OR would potentially not just reduce costs but allow farmers to maximise the utility of their land.

LIMITATIONS

1. Due to lack of accurate primary data, secondary sources of information have been used as a medium to collect information thus findings may be influenced by conclusions of previous research papers.

2. Since secondary resources are being used, the authenticity of information on the internet is questionable. Consideration of resources chosen is thus imperative.

3. While factual figures or representation of certain documents may be reliable, different sources may present varying information on the same topic.

4. The analysis is done using assumptions and the mathematical models prepared are not equipped with actual data thus the scope of the research paper is limited

5. There are chances of attribution, exaggeration in prior research studies.

6. Biases may have played into the conclusions of previous research papers forming our source for data.

7. The use of the different problems is based on certain assumptions like fixed quantities and only a few parties involved which may not hold true in real life thus making the decision making and the problem more complex.

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