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AGRICULTURAL SUPPLY CHAIN MANAGEMENT

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ABSTRACT-

Agricultural Supply Chain Management has become a topic of much deliberation among the researchers, for it has slowly strengthened its hold on how the supply-demand function of agricultural produce works in the modern setting. SCM entails managing the interactions between the entities in charge of the effective production and supply of agribusiness products from the farm to the consumer in order to consistently satisfy consumer demands for quantity, quality, and price. In actuality, this frequently involves overseeing both horizontal and vertical alliances. Traditionally, the agricultural business has been driven in a colloquial fashion by the wholesalers and they have done so without the supervision of a proper legal framework. The large number of players and long-standing traditional methods have had a negative impact on the efficiency of operations and have exacerbated the already plunging economy. Through our extensive research using tools like Mendeley Cite, VOS Viewer etc., we came to the conclusion that there's been a dramatic rise in the importance of SCM due to the rising awareness about the environment, food safety concerns and social security etc. However, just a few farmers participate in actually making a difference especially in third-world countries like India. The backward farmers have negligible faith in marketing agreements and are reluctant to enter into them. The existing system still uses outdated supply and procurement procedures. Aspects like the problems with consumer packaging, branding, and the promotion of organic farming towards sustainable agriculture are lacking in the existing supply chain management. Therefore, it's necessary to encourage farmers to sign production contracts and that requires the participation of both the public and commercial

sectors. The formalisation of the concerned rules and regulation is imperative to the development of SCM in these countries. With organisations like WTO breathing down the necks of these farmers and countries like the USA ready to violate the farmers in these countries, there is a strong need to enforce the already existing laws and make new ones to make sure that the entire supply-chain is integrated and works in a nuanced manner and market information is disseminated efficiently so that the application of SCM yields positive results.

KEYWORDS- agriculture; supply chain; operations; design; technology; efficiency; quality;

1. INTRODUCTION-

Supply Chain Management has been a concept that has existed since times immemorial. However, a more formal connotation has sprung up in the recent times. Talking about its origin-the primary utilization of SCM (Supply Chain Management) is ascribed to advisors *R. Oliver and M. Weber*. They wrote "Supply Chain Management: Logistics catches up with a strategy" in 1982 which got published and “Proposed to think about material flows from producers of raw materials to the final consumer as a component of a thorough system, encouraging it to oversee supply chains.” (Mukhamedjanova, 2020).

1.1 Review of Previous Work

“A smart supply chain basically means having the right product in the right quantity at the right time at the right place for the right price in the right condition to the right customer.” (Luthra et al., 2018). Mentzer defines a supply chain as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.” (Mentzer et al., 2001)

Looking at the term historically, we can associate the term supply chain to a definition given by The Supply Chain Council (presently the Association for Supply Chain Management) in 1997, which calls it a term that is “increasingly used by logistics professionals-encompassing every effort involved in producing and delivering a final product, from the supplier's supplier to the customer's customer. Four basic processes - plan, source, make, deliver - broadly define these efforts, which include managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer” (Association for Supply Chain Management 1997).

“Unlike the marketing channel, a supply chain emphasizes inter-firm communication, the management of lesser inventories, lead time reduction, customer orientation, product as well as process re-engineering, and

long-term relationships between channel members. Other terms like 'value chain' or 'demand chain' are often used instead of 'supply chain', suggesting that a supply chain is an integrated process for producing value for the end consumer." (Aji, 2020).

Based on the complexity of the chain, we can further classify the chain as a 'direct supply chain', an 'extended supply chain' and an 'ultimate supply chain'. This however, is a very bare-bones and modern description of the term. SCM studies "suggest that product integration with customers and suppliers can increase a firm's effectiveness in its product development efforts, and thus lead to increased sales." (Ableeva et al., 2019).

With the advent of advanced technology across the globe and development of several efficient management techniques and performance indicators, the definition of supply chain management is now much more elaborate. A modern- day definition of supply chain would be on the lines of "a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer. The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer." (Kain & Verma, 2018). It can also be defined as the process of planning, implementing and controlling the operations of the supply chain with the purpose to satisfy customer requirements as efficiently as possible. In a similar context, "Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption" (Martins & Pato, 2019).

Within the scope of this research paper, we will be looking at a very specific sector that implements supply chain management – Agriculture. "Agriculture and farming date back thousands of years. In 10,000 BC, the first agricultural revolution happened, which is also known as Neolithic Revolution, and humans transitioned from hunting and gathering to settled agriculture. The latest agricultural revolution was from 1943 to late 1970s, also known as Green Revolution." (Srikanta & Astajyoti, 2017).

According to economists and different research, India and China will control the world in the twenty-first century. For more than a century, the United States has had the world's largest economy, but major changes in the global economy have caused the focus to shift away from the United States, the rich countries of Europe, and the eastern dragons of Japan and Korea and toward the two Asian giants of India and China. Experts project that by 2035, India will be a stronger growth engine than the EU's six major countries, while its effect will be somewhat less than half that of the United States. Within the next ten years, India, which is currently the fifth biggest economy in terms of purchasing power parity, will overtake Japan and become the third major economic power. Liberalization of a 1.2 billion consumer market, a robust higher education policy reinforced by European and American training, and English-speaking communication and management systems are apparent success factors. However, India remains a country of stark differences. Nuclear scientific technology at research facilities contrasted with bullock carts in rural regions. Bullock carts may still be spotted in Bangalore (population 6.2 million), India's IT (Information Technology) capital. Cities in India have seen significant infrastructural improvements in recent years, but the situation is not the same in most rural areas. (Basu & Wright, 2008)

Despite the aforementioned hurdles, India's economic progress in the early twenty-first century has been exceptional. In 2004-2005, the Indian industrial sector grew steadily. The index of industrial output (IIP) continues to rise at a 7% annual rate. The manufacturing sector, which accounted for 80% of IIP, was a key contributor to the buoyancy in industrial expansion. The service sector accounts for more than half of India's GDP. In 2005, the growth rate of India's service exports was 8%, compared to 5% globally. The reason for India's strong growth rate in the service industry is regulatory liberalization and a large demand for low-cost IT, BPO (business process outsourcing), and contact center services. In 2004-2005, India's IT market had a revenue of US $16.2 billion. The IT sector now employs 697,000 people and is expected to grow to 2 million by 2014. The BPO and contact center industry has been developing at a rate of 60-70 percent each year, with a total revenue of $5.8 billion in 2004-2005.

The supply chain and logistics patterns in India are diverse, reflecting the country's various infrastructure, degree of technology, and economic growth. For example, the auto sector adheres to a classic Western and Japanese paradigm for a largely urban and affluent consumer. On the opposite end of the spectrum, fresh food supply is restricted to regional markets. Hindustan Lever, a manufacturer of fast-moving consumer goods, employs a mix of urban and rural logistics by enabling regional wholesalers to stock and distribute branded items to rural clients. Multinational businesses, such as the McDonald's restaurant chain, are progressively leveraging available local infrastructure to their advantage. The following case studies demonstrate the use of appropriate supply chain models in India. (Basu & Wright, 2008)

1.2 Objective of Research Paper & Definition of Terms

The overarching objective of the paper is to trace the history, current trends and potential future directions of growth and development of Agricultural Supply Chain Management while correlating it to the core definition and concepts of supply chain management and operations research. This paper will provide a comprehensive outlook on major keywords pertaining to ASCM.

Agricultural supply chain management consists of all the events involved in moving products of the agricultural sector from the field to the customer, and is a crucial aspect ensuring the rich contribution of the sector to the economic growth of the nation. The primary objectives of the ASCM are to help farmers get fair returns, reduce the difference in prices between farmers and customers, to ensure product quality and food safety, peer-to-peer productivity (B. B. Gardas et al., 2019). India has a substantial agricultural base, which is attracting multinational companies in the fast food and processed food domains, creating challenges as well as opportunities for ASCM. There is a significant risk of perishability and seasonality of the production, which includes uncertainty of the rainfall and climatic conditions (B. B. Gardas et al., 2019), the supply and demand equations due to complexity, uncertainty, poor coordination and insufficient information causing over-stocking or under-stocking (Luthra et al., 2018). As the “production chain continues, the agricultural market is increasingly volatile, heterogeneous, and sensitive to economic and financial fluctuations in a nation (Borodin et al., 2016a). The centralized storage makes it more difficult to assure quality, rate and origin of the products hence, there is a need of a decentralized system which is transparent and leads to maximum producer- consumer satisfaction” (Madumidha et al., 2019).

"Agriculture Supply Chain Management (ASCM) is defined by Tsolakis as a "set of activities in a "farm-to-fork" sequence including farming (i.e. land cultivation and production of crops), processing/production, testing, packaging, warehousing, transportation, distribution, and marketing."" The agricultural sector is currently under a rising two-fold pressure:

- to be sustainably run
- to provide food, energy and industrial resources to satisfy the demand of a rising world population (Borodin et al., 2016a).

It is also important to understand that the scope of ASCM is not limited to just crops - it also extends to pulses, dairy products, grown vegetables, horticulture, fruits, flora – with different types of products having a different supply chain.

"Essentially, ASMC has its beginnings with the suppliers (i.e., inbound materials and services for farm level operations) and ends with ultimately satisfying the customers through a specific distribution channel" (different distribution channels are being adopted) (Routroy & Behera, 2017; Tsolakis et al., 2014). A comprehensive literature review by Routroy & Behera in 2017 establishes ASCM to be synonymous in terms of terminology and usage with the following terms-

- "Post-harvest supply chain" (Bill et al., n.d.; O'Hare, 2001; Sivakumar & Wall, 2013)
- "Food- supply chain" (Aung & Chang, 2014; Blizkovsky & Berendes, 2016; Bosona & Gebresenbet, 2013; Zirham & Palomba, 2016)

These terms are going to be used frequently in this paper to refer to ASMC and are to be considered one and the same.

Through the course of this research paper – we will be exploring and elaborating on various aspects pertaining to ASMC such as-

- Evolution of Agricultural Supply Chain Management
- Indian History and it's impacts on ASCM
- Key Performance Indicators
- Technology's pivotal role in ASMC going forward
- Potential Areas of Concern and Bottlenecks in ASCM

2. LITERATURE REVIEW-

Through our efforts, we have tried to create a crisp and elaborate structure of Supply Chain Management while factoring in all the new facets and dimension that have revolutionised the game for supply chain managers.(Director, 2007). Paper has predominantly been used to discuss the Indian agricultural supply chain. It has been evaluated using both primary and secondary data and information that was acquired through the use of scientific research methods. This includes case studies, in-depth interview content analysis, the triangulation method, and the observation method for primary data, as well as research methods that were used to devise study designs and conduct research using a variety of methods to assess the objective. (Parwez, 2013) Despite knowing how important supply chain management is in today's global scenario, we still decided to go ahead with the massive untapped potential of the Indian agriculture domain. Intermediaries have played a paramount role since modern agricultural practices cemented their foot in the Indian setting, but the community has suffered immensely due to their unnecessary intervention which restricts a free flow

of supply of goods. (Director, 2007). Due to a lack of internal resources, businesses must rely on third parties to provide a variety of support products and services in order to meet client demand in today's complex marketplaces. According to management jargon, businesses focus on their core products and work with partners to enhance them in areas such as marketing and advertising, inventory control, shipping, and billing, among other areas where having outside knowledge is advantageous(Singh1 et al., n.d.)

It is apparent that supply chain measurements may equally account for both factors. Supply chain considerations are generally met with a lot of criticism in agriculture. The processing industry is currently the driving force behind supply chain optimization, and opportunities for agriculture are lost as a result of this passivity. Due of the close relationship between SCM and ECR (Efficient Consumer Response), these ECR-co-operations would also result in the theme. Unfortunately, the laggard in ECR also include the agricultural sector. (Mau, 2002). After carefully analysing the various research papers we've seen that the interpretation of modern SCM in today's time is extremely reductive and crude and hence in this research paper, we will obstinate from using dispersed sets of information to keep things lucid and comprehensible. (Zhang et al., 2016)

In the pre-consumption period of finished products, "the agricultural sector consists of a number of activities, the main of which are: production, storage, processing and distribution Its effective coordination requires the management of activities from the strategic level to the operational level. So, it's no surprise that one of the most talked about and discussed topics in the agricultural sector is planning. Ahumada and Villalobos (2009) conducted a status quo assessment in the area of production and distribution planning models for various products in the agricultural supply chain. The authors proposed and discussed the classification based on the most relevant characteristics, such as the optimization approach used (linear and random programming), the type of agricultural product. targeted and research target targeted. Still related to agricultural-oriented planning models, another important study has been proposed by Hayashi (2000), which involves multi-criteria analysis." (Borodin et al., 2016b)

Previous studies have also compared non-food lignocellulose with agricultural products Converting biomass into conventional energy sources such as coal and natural gas (Wu et al. 2006; Mu et al. 2010; Zhang et al. 2010; Gust et al. 2011). However, the scope of the lifecycle and assumptions were inconsistent across studies and did not integrate financially and supply data Chain and environmental analysis. Therefore, no product comparison was made prior to this study, it is possible through a literature search. Although it is useful to decide the lowest delivery cost and most viable supply chain system and in-depth discussion of which processes contribute the most to minimising environmental impact. The cost of environmental impact is also displayed.

"The biomass storage step is a very important link in the respective supply chain. In most of the case studies involved, low-cost storage solutions were chosen without considering the positive effects that more complex (and more expensive) solutions might have. Many researchers assumed that the biomass was stored in the field. Ambient and covered storage in the field were also examined." "The field storage method has the advantage of low cost, but on the other hand, the loss of biomass is large, and the moisture content of the biomass cannot be controlled and drops to the desired level, leading to potential problems. in the power plant. technology equipment. "In addition, health and safety issues exist, such as the risk of spore and fungal

formation and auto-ignition due to increased humidity. Finally, farmers may not allow biomass to be stored on-farm for a significant period, as they may want to prepare the soil for the next harvest." (Rentizelas et al., 2009).

2.1 Agricultural Supply Chain Management and India

India's agricultural sector is characterized by small farms, with an average size of one hectare and more than 120 million farmers classified as marginal or smallholder farmers. While agriculture's contribution to India's GDP fell from almost 52% in the 1950s to around 1% in 2011, more than % of India's workforce is still employed in the sector. (Government of India 2016). Although farms are fragmented, India is the second largest agricultural producer in the world (based on FAO data available at http://www.fao.org/faostat/en/#data). Just as being responsible for providing food, sustaining livelihoods, improving nutrition and preparing for rapidly changing environments and markets is equally important to millions of small farmers
(Devalkar et al., 2018).

"Historically, it is a regrettable fact that India's first five-year plan (1951-1956) placed the most prominence on agriculture while all other plans and the economic reforms which followed in the next decades, emphasized largely on non-agricultural sectors, disregarding agriculture. This paramount shift in policy making resulted in major poverty, massive discrepancy and inequality distribution of wealth and income across the nation." (Ganeshkumar et al., 2017).
"The rapid industrialization of agricultural production, the oligopoly in the food distribution sector, the advancement of Information and Communication Technologies in logistics, an increase of governmental food safety regulations for maintaining quality, the emergence of modern food retailer forms, the growing importance of vertical integration and horizontal alliances, and the increase of multinational corporations, are real-world situations that have led to the adaptation of SCM in this industry." (Iakovou et al., 2016).

"In response to a range of economic pressures and increasing levels of competition, agribusiness firms in many countries have moved toward establishing collaborative marketing ventures in the supply chain. This phenomenon has driven the evolution of the chain and encouraged greater vertical and horizontal coordination. Horizontal coordination refers to alliances within a single part or level of a supply chain (e.g., farmer to farmer). Meanwhile, vertical coordination refers to the collaboration that occurs between parts or levels of the supply chain (e.g., retailers with processors with farmers). Particularly within the
agricultural industry, horizontal coordination has existed for ages in the form of farmer cooperatives." (Aji, 2020)

Such horizontal alliances generally have three key driving factors:

- to meet the volume requirements of most customers and increase bargaining power in their business
- to accelerate the pace and reduce the cost of penetrating new markets
to share the costs associated with new product development and creating or adopting innovation (Aji, 2020)

"Agriculture in India has always been heavily dependent on the monsoons and has therefore been an inherently risky business. In different times we also had bad rural taxation under different empires, most recently under the British. Indigenous credit systems must evolve according to demand and seasonal fluctuations to facilitate farmers' consumption patterns during the year. With intermittent monsoon failures and other usual ups and downs of agriculture, rural debt is a serious and continuing feature of Indian agriculture. Due to the high risk inherent in traditional farming, high-interest rates are the norm rather than the exception and often lead to exploitation and misery. Thus, the development of the rural credit system too has proven to be very difficult and, as we shall see, an issue that has continued to be of official concern for more than a century."(Mohan, n.d.)

In India, "the poultry sector is growing rapidly faster than other sectors of the Indian economy and accounts for 100 billion rupees in gross national income Product (BSP). Despite this amazing growth, in the last 30 years, India has used 28 eggs and 0.8 eggs kilograms of poultry meat per year per person in 2000 lower than the global average of 147 eggs, and 11.1 kg of poultry meat (FAOSTAT) per person. According to the Business Portal for India (BPI) report, the shift and meat consumption rate increased to 55 eggs and 2.8. His kg of meat per person in India 2012. or every year." (Gaikwad, n.d.)

The current structure of the rice supply chain in India operates under the "traditional framework which involves many intermediaries at the supply and distribution levels. The current structure of the rice supply chain in India is somewhat inefficient and in need of reform. Traditional supply chain structures face problems with inventory management, where either overstocking lead to obsolescence and increasing supply chain costs or stockpiling varieties in demand leads to loss of revenue. The rice supply chain in India is also facing supply chain issues related to the 2-supply chain, distribution, the cooperation of middlemen and the logistics system needs to be redesigned. A suitable framework proposes an inventory traceability mechanism and visibility in the system, supply and supply of rice, rice processing 3 enterprise activities, distribution system, and sales strategy Retail and logistics systems are essential to make India's supply chain efficient and globally proficient. Despite being the second largest producer in the world and a major consumer of rice, with a significant presence in the global agricultural market, India does not contribute to the global food industry on the level this country deserves." (V. Sharma et al., 2013)

2.2 Agricultural Supply Chain Management in the global scenario

Agriculture has always been a major strategic activity for supplying food. In 2018, "more than 821,000,000 people were suffering malnutrition worldwide and each year more than 10,000,000 people die of starvation hence, the need for a smooth supply chain exists." (Ronaghi, 2021).

"Food production and consumption have major environmental implications, accounting for about 22% of UK greenhouse gas emissions. It is hence important to improve the understanding of eco-innovation in food supply-chains." (Mylan et al., 2015)

The increasing tendency for supply chains to be sourced internationally helps the increased demand for fresh produce that has undergone the least amount of processing. The two paradigms of non-integrated supply

chains are when the producer or grower also acts as the salesperson and when middlemen directly purchase the produce (i.e., merchants, wholesalers).

Fruits and vegetables can be directly sold through on-farm shops, at outdoor markets, or by hired street hawkers. Although relatively popular in less developed rural areas, this kind of producer-consumer interaction has grown more appealing to peri urban growers as well. The latter capitalize on the growing urban population's appetite for fresh produce and frequently do so while selling local goods like asparagus, strawberries, cherries, and so forth. Additionally, the growing proportion of organic agriculture has emerged as a key driver for this market. A new development is the opening of farm markets in urban areas. These stores are carried and supplied by farmer associations, who can provide a wider range of items than individual growers. In the second scenario, products are delivered straight to a wholesaler, who acts as an intermediary. Without building a tighter partnership in the spirit of chain-spanning innovations, the producer only serves as a supplier. (Kramer, 2005)

The phosphorus supply chain encompasses phosphorus utilization in the global food system, from mine to field. It is highly globalized and covers the fields and processes involved in the extraction, transformation and trade of phosphate rock; producing and trading phosphate fertilizers; times of agricultural fertilizer application for crops and pastures; harvest of crops containing phosphorus; food production, processing and distribution; food consumption; and finally manage phosphorus wastewater, food waste and eutrophic water. (Cordell et al., 2015)

“Globally, sugar is produced from sugar beets and sugar cane. The strategic importance of the sugar industry derives from its vital role in land and water use management, food security and rural employment opportunities. As noted, sugar beet is currently the cheapest and least water-consuming source of sugar, as well as an efficient source of biomass (Kolfschoten, Bruins and Sanders, 201). The sugar beet sector is therefore a critical area were minimizing total supply chain costs due to increasingly scarce water supplies will have a significant contribution and economic impact. Different activities in the agricultural supply chain can be classified into three main stages: the agricultural, transport and industrial stages.” (Fikry et al., 2021)

Latin America-

Money “crops such as coffee can also have significant impacts on national economies: they are the largest contributors to agricultural GDP in Latin America, for example. In Nicaragua, coffee generates 1.3% (MAG-FOR 2006) of agricultural GDP. In Mexico, the production of coffee is considered a strategic activity, as it is cultivated on 66,800 hectares, providing work for 700,000 families (ICO 2005). Coffee systems are characterized by the fact that they require a longer implementation time for farmers and business partners to make changes. In these cases, decisions made today will materialize in 8 to 15 years, when the climate may have changed.”(Laderach et al., 2011)

China-

Moving on to another country with respect to agricultural supply, China in the past due to its vast population, has been one of the countries to consume the most agricultural biomass and food. China is a significant player in the global agricultural industry and the commerce and manufacturing of food. China produced about 2019, 33% of the world's rice, 23% of its maize, and 40% of its sunflower pork produced in the world, the majority

of which was supplied to domestic shoppers. China contributed significantly to shares of the international trade market for several agricultural commodities as an importer of major food items, such as 23% of corn, 21% of sorghum, and 60% of soybean. The virtual water flows generated by China's intra-China trade of these key commodities, such as corn and pork, increased by 40% and 23%, respectively, reducing the carbon emissions contained in China's exports, but interprovincial Carbon transfer decreased. Changes in interstate trade patterns increased the national average land use intensity from 1997 to 2012, increasing land use by 6.3 million hectares in her. (Ye et al., 2022)

2.3 Green Supply Chain Management-

"The general consumer awareness about the impact of food production, processing and distribution on the health has increased, and there is a growing need for integrating green practices into the supply chain management of agri-food products. The Government, industries and non-government organizations (NGOs) are promoting the eco-friendly products for protecting the environment. In addition, the protection of the environment is an ethic itself. The industries are planning their environmental programs by incorporating green supply chain management (GSCM) practices to play their role to avoid long-term damage to the planet and are interested in identifying and evaluating the drivers or performance indicators (PIs) or critical success factors accountable for the GSCM implementation." (B. Gardas et al., 2019)

Few of the indicators are-

- Green design
- Green purchasing
- Green manufacturing
- Knowledge and training
- Regulatory pressure (B. Gardas et al., 2019)

Green supply chain management (GSCM) refers to the concept of integrating sustainable environmental processes into the traditional supply chain to enhance quality and efficiency of the process. The success of GSCM relies on-

- Farmer's knowledge
- Business Processes
- Urban ITS (Rajabion et al., 2019)

2.4 Technology and Agricultural Supply Chain Management -

"Over the last few years, research has been conducted in the field of supply chain management and the use of disruptive, new-age technologies, such as big data, IoT, cloud computing, and blockchain. The distributivity of the blockchain network promotes transparency and tracking of goods and services in the supply chain. These capabilities require accurate data collection and secure storage for reliable data

tracking. The main components of a tracking system include the tag, the tracer, and the sensor" (Ronaghi, 2021). This technology has "been capturing the imagination and bringing challenges and opportunities for both- academics and practitioners. Even though blockchain has advanced considerably in recent years, there is a big gap regarding
mainly empirical and practical studies." (Wamba & Queiroz, 2020)

"The sociology of innovation focuses less on the information and more on the cognitive content of the beliefs of different actors. The social construction of technology (SCOT) approach, for example, argues that early stages of innovation are characterized by 'interpretive flexibility', which means that people have different views and visions about the technology. Discussions, debates, and social learning gradually leads to 'cognitive closure' and the creation of shared meanings, which stimulate innovation by reducing uncertainty." (Mylan et al., 2015)

In recent times, there has been a theoretical introduction of technology in terms of blockchain, IoT, RFID, AI, 3PL and Big Data in order to improve the supply chain management and assure the highest efficiency. The optimization of the carbon emission variables and management of the imperfections in processing makes the models eco-efficient (Alkahtani et al., 2020).

Blockchain-

An obvious application of the Blockchain Technology is in the supply chain logistics. It's also known as 'The Provider-Consumer Network'. In logistics, blockchain gives many options related to shipments. All products could be tracked and traced hence, helping to overcome delays. The technology can be utilized with the Internet of Things (IoT) to track the supply of perishable goods. It also eliminated the need of third-party representatives. "The properties of blockchain quintessentially provides increased capacity, better security, immutability, faster settlement and full traceability of stored transactions records between both parties." (Madumidha et al., 2019).

Internet of Things (IoT)-

"IoT applicability in ASCM can bring $14.4 trillion in value. The technologies are significant in assisting food organization to trace the process or product at every level. The following are five IoT-based technologies in the context of ASCM" (Luthra et al., 2018)-

- Radio frequency identification
- Vibrational spectroscopy
- Bio/wireless sensors/mechanism
- Traceability
- High pressure processing

Artificial Intelligence (AI)-

AI converts the conventional agricultural practice to a smart farming method, which is a sustainable approach, reducing wastage of resources (fertilizers, pesticides) and causing sustainable development. The technologies "predict plant growth and yield, optimize energy consumption across an extensive network, and

automate the inspection of retail packaged food. In addition, AI can assist farmers in understanding soil conditions; including PH level, nitrogen, nutrients, and moisture content." (Rejeb et al., 2022).

Radio Frequency Identification (RFID) –

The RFID technology is one of the most sought-after technologies when it comes to tracking the movements and locations of the crops being transported. This helps in efficient and safe transportation to the destinations and further acts as a shield against Post Harvest Losses. In a more formal sense, "Radio Frequency Identification (RFID) is a technology which provides appealing opportunities to improve the management of information flow within the supply chain and security in the agri-food sector." (Costa et al., 2013)

There are three types of major power supplies in RFID:

- Active
- Passive
- Semi-Passive (Németh et al., 2006)

RFID provides a multitude of advantages in terms of providing transparency and traceability some of which include:

- Individual identification and labelling of each product/item
- Remote Tracking
- Provision of a security feature
- Enhanced Traceability

RFID technology increases supply chains' ability to combat these inventory accuracy issues by capturing realtime data, which allows for greater product traceability. Even using RFID cannot completely prevent errors, they can be rapidly discovered and successfully dealt with by taking this issue into account throughout planning processes.(Sarac et al., 2009)

Third-party logistics (3PL)-

"3PL service providers can play a major role in the agricultural supply chain management for customer satisfaction and cost reduction in managing the chain. A decision-making tool based on multi criteria called hierarchical process (AHP) approach can be used for selection of best 3PL service providers. In India, the concept and utilization of the 3PL is still at a primary stage. However, there is a clear indication of development in the recent years with a CAGR of 21.16% during 2013-2018." (Dixit Garg & Luthra, 2020).

Big Data-

"With the rapid development of innovative technologies, supply chain management generates a huge volume of data in different formats under various business scenarios. Big data, characterized with volume, variety, velocity, veracity, and value, has already been proven to be beneficial for forward supply chain management. Big data analytics (BDA) has received increasing attention, and can be applied in all kinds of supply chains to improve the overall business performance." (Tao et al., 2018)

These technologies will greatly help a developing economy like India to overcome their supply chain constraints-

- A "radio-frequency identification tag (RFID) can automatically record each and every operation of the whole supply chain of agricultural products. It will not only reduce the 'bullwhip effect' but also reduce various costs (inventory/labor costs), which leads to augmented performance and efficiency." (Luthra et al., 2018).
- "A major part of Indian population resides in rural areas that lack not only modern facilities but basic also. Their issues like health, employment, agriculture, women empowerment, education and gender equality can be resolved through the access of ICT tools and services by introducing high-pressure processing, vibrational spectroscopy, AI etc." (Luthra et al., 2018).

The application of artificial intelligence (AI) systems in food supply networks are expanding quickly. The context and frames that stakeholders offer to the ethical language are used in relation to food supply and technology. A barrier to technology adoption and a reduction in the value obtained can result in the failure to distinguish between these subtle meanings. The development of AI technologies in the agri-food sector promises to increase efficiency by introducing data and new technology interactions into systems that are relevant to food production and the agricultural sector. These both present new issues while potentially addressing significant ethical conundrums as well as ethical issues that are currently present inside the food system. Climate-smart agriculture Internet of things (IoT)-based agriculture, often known as smart agriculture, term that serves as an illustration of this contextualization. According to these words, the widespread use of technology has also reorganized agricultural systems with a net positive benefit. (Manning et al., 2022)

In addition, agricultural biotechnology is a potential industry that is still in its early phases and where most of the revenues to date have gone to the US. It is a sector that is expanding quickly: The market for transgenic crops reached $8 billion in 2005, up 30 times from the estimated $2.2 billion in global sales in 1999 (Brezonik et al., 1999). "Agricultural biotechnology is concentrated on a few crops in a few countries: in 2000, 99% (on 43.8 million) of the global transgenic crops were grown in four countries: the US (68.6%), Argentina (22.6%), Canada (6.8%), and China (1.1%). In 1999, four crops accounted for over 99% of the global transgenic crop area: soybeans, maize, cotton, and canola. Few large corporations, like Monsanto, Novartis, and Zeneca, control the market, with R&D budgets ranging from $730 million to $2.5 billion in 1996" (Cook, 1997).

Our other example is a leading biotechnology business with over $5 billion in sales and a net income of $250 million in 2004. Company B created breakthrough technology based on relatively recent research and had success marketing their products in the United States, but not so much in Europe or the developing world. In this situation, sustainability challenges were especially complex, and knowledge of interconnected social and environmental aspects was lacking. As a result, the system could not be regarded as a smooth landscape. Although technical, commercial, and organizational considerations were considered, the impact of unknown environmental characteristics was overestimated, and social components were ignored, resulting in a sequence of failures during technology deployment in Brazil, the case's focus. (Matos & Hall, 2007)

The major impetus for characterizing the food chain in this broad sense was an attempt to create an objective method of splitting the food chain into its component stages and processes. It was therefore conceivable, particularly in respect to food safety issues, to assign a specific type of breakdown to a specific operation and stage in the food chain where it happened. The generic method has the advantage of being equally relevant to all types of breakdowns, regardless of the causal agent, i.e., microbiological, chemical, or physical. This generic approach was used to collect data from 8515 food safety breakdowns as part of a UK Food Standards Agency-funded investigation with the goal of providing a more comprehensive knowledge of past failures (reported elsewhere). Such an approach allows for an examination of potential main weaknesses in the chain, pertinent breakdowns, trend detection, and, most crucially, a way to focus research on the topics that will bring the greatest benefit. (Stringer & Hall, 2007)

The majority of agricultural biotechnology research has been concentrated on creating crops that are resistant to pests or diseases in order to increase the growers' profitability. Consumers earned only 7% of the $200 million in annual advantages created by cotton production, compared to 44% for businesses, 42% for farmers, and 42% for consumers. As a result, customers believe that the crops come with hazards and no rewards to offset them.(Falck-zepeda & Nelson, n.d.)

This general model is expected to have broader relevance to other domains where a comprehensive food chain perspective is required. For example, by defining a company's method to traceability, staff will be able to easily identify stages and procedures in the supply chain that are under the company's direct control and those that rely on third parties. It will also provide for a better knowledge of supply chain events when searching for places to increase efficiency and productivity. (Stringer & Hall, 2007)

“Selling products with consumer benefits requires segregation of the genetically modified crop during its transport from farmer to consumer, a procedure that entails selling at a higher price to cover the cost of segregation. Segregation of genetically modified crops is also necessary because of the increasing consumer misgivings about agricultural biotechnology. (Shalhevet et al., 2001)

The mango supply chain in Costa Rica is organised by a vast number of diverse actors (export producers, merchants, and exporters) that are involved in various transactions and geared toward several market outlets. Mango transactions vary in volume, quality, price, and regularity of delivery depending on whether the product is sold at the local open market, through wholesalers, or in worldwide markets through multinational trading firms. A complicated chain of delivery transactions structures relationships between groups of producers (local and worldwide), traders, retailers, and consumers. The purpose of this paper is to investigate the link between mango quality heterogeneity and differences in management practises and control operations among actors in the mango supply chain. The value of evaluating variability in performance in terms of quality and management along the chain is that gaps between local, national, and export market sectors may be improved. Reduced variability may help standardise operations for addressing customer requests. Gaining a deeper understanding of the elements that affect mango quality allows for fine-tuning of management, coordination, and monitoring actions. The rest of the article is organised as follows. First, the variety and diversity in the mango supply chain are presented, with an emphasis on the linkages between quality and management in the context of the global commodities chain. Following that, we describe the analytical framework for a comprehensive examination of the technological and human elements that

influence quality heterogeneity. This is followed by an explanation of our empirical methodology and findings. Finally, we will discuss some practical implications for enhancing mango supply chain operations. (Zúñiga-Arias et al., 2009)

2.5 Issues with Agricultural Supply Chain Management-

The Agricultural Supply Chain Management System is a rather systematic and scientific approach to ensure that all the produce finds an optimal path from the producer to the end consumer. Much like any other system, ASCM too has to deal with a few risks and vulnerabilities in its system. This section will further try and elaborate on the various types of vulnerabilities and try to provide strategies and plans to further optimize the Agricultural Supply Chain Management. Supply chain vulnerability can be defined as "an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain." (SUPPLY CHAIN VULNERABILITY Executive Report on Behalf of: Department for Transport, Local Government and the Regions Department of Trade and Industry Home Office, 2002)
According to a paper by Rosales F, the risks posed to the system can be classified into various categories:

- Risks internal to the firm (productional, functional, financial risks within the firm)
- Risks internal to the agro-industry (laws of demand-supply, choice of chain)
- Risk external to the agro-industry (Government Policies, Climatic Conditions)
- Product Risk (Traceability and QC) (Rosales et al., 2015)

Upon further research, such issues can be attributed to specific issues such as:

- Fragmented Supply Chain
- Ineffective Demand Management
- Lack of Traceability Systems
- Poor Logistics Design
- Lack of Scientific Harvesting Methods
- Lack of Cold Storage Facilities
- Post-Harvest Losses
- Multiple Market Intermediaries
- Quality Checks
- Policy Changes (C et al., n.d.)(Balaji & Arshinder, 2016)

Post-Harvest Losses –
"Postharvest loss can be defined as the degradation in both quantity and quality of a food production from harvest to consumption. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. These losses are generally more common in developed countries." (Kader, 1985). Extensive waste during post-harvest storage and handling due to improper packaging without crates, lack of temperature-controlled vehicles, lack of cold chain facilities to preserve produce, and bulk handling of produce result in huge post-harvest losses in agricultural products. (Sheoran A, 2015). In an Indian context – "the losses in postharvest sector are estimated to be from 10 to 25 per cent in durables, semi-perishables and products like milk, meat, fish and eggs. The estimated losses in fruits and

vegetables are higher and reached from 30 to 40 per cent. These percentages are not acceptable and adversely affect the Indian economy." (Hegazy, 2016). "Though India is the second highest fruit and vegetable producer in the world. In spite of abundant agricultural produce, India ranks below 10 in the export of food products with processing levels in fruit and vegetable sectors at around 2% only" (*Give to AgEcon Search*, n.d.; Viswanadham, n.d.). In another study by Singh and Sharma, a sample size of the vegetables cultivated in Uttarakhand was taken it returned conclusive proof that the post-harvest losses on the grower side were maximum. A few of the contributing factors were improper grading, packing, lack of storage, inadequate transportation facilities, and harvesting at inappropriate maturity. They also suggested the establishment of co-operatives as a countermeasure to reduce post-harvest losses. (G. Sharma & Singh, n.d.) A lot of efforts have been made to understand and optimize the supply chain further to reduce post-harvest losses. (G. Sharma & Singh, n.d.)

The supply chain's optimality also takes a big hit by the presence of multiple intermediaries between the producer and the consumers. This presence does not only decrease the net profits made by the growers, but also causes skyrocketing of the final prices at which the consumer purchases the product. Moreover, this issue also contributes to a big chunk of post-harvest losses. Due to the aforementioned reasons, it becomes essential to choose the right supply chain for a particular product based on its own conditions and merits. The ideal supply chain for a product lies in the answers of two very important questions:

- Is the product functional or innovative?
- Does the supply chain have to be responsive or efficient?

For most agricultural/livestock products – the nature falls under the 'functional' category. As a consequence, the corresponding supply chain has to be 'efficient'. This facilitates cost cutting and maintaining a tight supply chain. (Marshall L Fisher, 2011). Moreover, there needs to be a sense of social awareness and responsibility from every member of the supply chain to minimize the losses and optimize the supply chain. For this change to occur, the two dimensions that need to be given emphasis are:

- Distance
- Transparency (Awaysheh & Klassen, 2010)

Another dimension that plays a vital role in the overall optimality of the supply chain management is the overall quality of the product.

Furthermore, a comprehensive SWOT analysis by Rakesh Patidar, Sunil Agrawal and Saurabh Pratap puts out a few other weaknesses of the Agricultural Supply Chain to be:

- Large Number of Small Farm holding Partners
- Poor design of the Supply Chain
- Poor Infrastructure of Redistribution points
- Lack of Modern Technology
- Lack of Grading and Sorting Technologies(B. B. Gardas et al., 2017a)
- Lack of transparency/tracking
- Lack of awareness in producers (Patidar et al., 2018)

A lot of efforts have been made to understand and optimize the supply chain further to reduce the post-harvest losses. Some of those include:

- Tracking and tracing systems of vehicles in ASCM
- Development of an Information Technology model to connect different stakeholders of the supply chain
- Development of an optimal info sharing model to meet demand(Patidar et al., 2018)

3. RESEARCH METHODOLOGY –

This research paper falls under the category of SLR – Systematic Literature Reviews. In accordance to the nature of this paper, the authors of the paper have tried to put their best foot forward in reading, researching and analyzing various works in the chosen fields (Agriculture; Supply Chain Management; Operations Research). All the content included in the research paper is an amalgamation of direct citations from extensively well-researched papers/articles from pertinent fields and/or the authors' understanding of the content. The research work has been apportioned among the five authors proportionately. Work on the paper has been carried out in three phases (i) Development of the Introduction and the Literature Review, (ii) Fine-Tuning of the Literature Review and documentation of the Research Methodology, (iii) Conclusion and Analysis. The primary research and information scouting took place in the following phases:

- A systematic division in the searching/scouting of research papers and information based on decades (first round) and subtopics (second round).
- Post that, a comprehensive excel sheet was used to create a database of the papers – along with their keywords and fields. This step was also used to cross-verify and eliminate any redundancy in the papers.
- The literature review is a section filled with interpretations of the mentioned works or direct citations. The primary focus in this SLR was to review as many works as possible – to get a good sample size which would enable us to draw a clear conclusion thereby getting a better picture about ASCM.
- From a research perspective, the authors have focused primarily on the keywords and shortlisted relevant papers by the virtue of their introduction and research objective.
- 'Mendeley' Software was utilized for the compilation and proper citations of the relevant research papers. The software was also used to update and create a comprehensive and detailed bibliography. All citations were done in the APA Format.
- A lot of research papers were sourced from websites like 'Elsevier', 'Research Gate', 'Google Scholar', 'ZLibrary', 'Library Genesis' and 'Sci-Hub'
- For the 'Analysis' and 'Conclusion' sections, the 'VOSViewer Software' was used to develop maps and charts – this step enabled the creation of physical and depictable statistics that lend a sense of credibility and authenticity to the research.
- The research approach was very 'theme-focused' with almost all research paper having a direct correlation with the subject of the paper.
- All inferences drawn from this SLM have been depicted in the graphs, statistics and charts referenced in the paper.

4. ANALYSIS-

A co-citation occurs when two references appear in the same publication at the same time. The number of co-citations between two documents determines their content similarity. The degree of resemblance between two papers increases with the number of co-citations in each. Co-citations occur more frequently when two references or publications have a stronger relationship with one another. In a co-citation network, nodes stand in for the cited articles, and linkages between nodes signify the frequency with which citations appeared next to one another in the dataset's articles.

Our clusters mainly explain the field of research we have done and the areas that are mostly covered in the paper along with the areas for future discussions.

The left side of the map mainly highlights the supply chain management aspect of this paper, and the right side showcases the agricultural aspect.

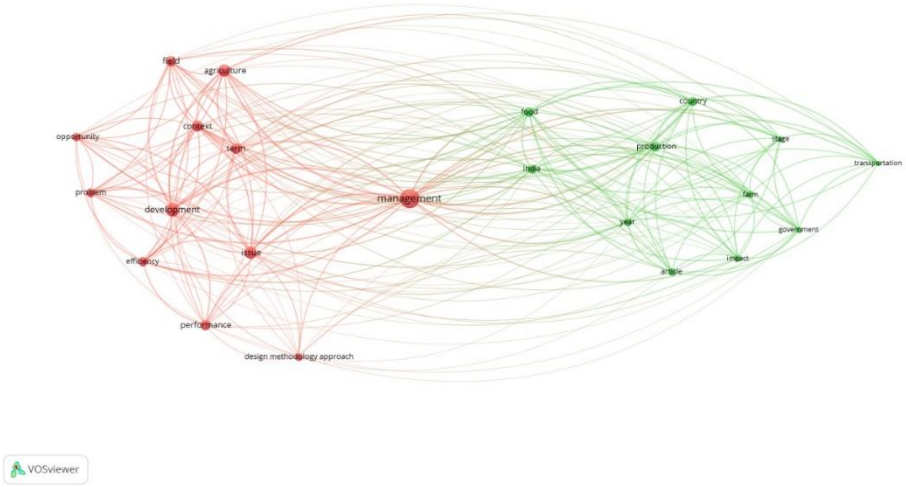

Figure:1

Nodes in a co-citation network represent cited articles, while linkages between nodes reflect the number of times citations appeared together in the dataset's articles. We created co-citation networks for journals and authors in this study. The first step was to create a network of important keywords and definition terms for our analysis. Figure 1 mentions the following data in terms of keywords for papers published in the investigated dataset.

In addition to the number of citations, the number of papers published in each publication is shown. Keywords are not limited to single words; they also contain keywords made up of numerous words. The topic mapping overlay network of article keywords is depicted in Fig.1. Relevant words in this network in terms of keyword recurrence include food supply chain, food waste, sustainability, food safety, supply chain, supply chain management, food industry, traceability, agriculture, life cycle assessment, and food security.

The following section discusses research on topics represented by these terms. Food waste, an important study topic in the discipline, is a big worldwide concern not just ethically and socially, but also environmentally and economically. (Caldeira et al., 2019)

Waste is classified into two types, according to the literature: waste from inputs such as water or fertilizer, and waste from incomplete conversion or processing of resources in the supply chain, from crop production to food consumption. (Belaud et al., 2019)

Management plays a key role in the research as we can see majority of the actions like government, development, agriculture is all linked through it.

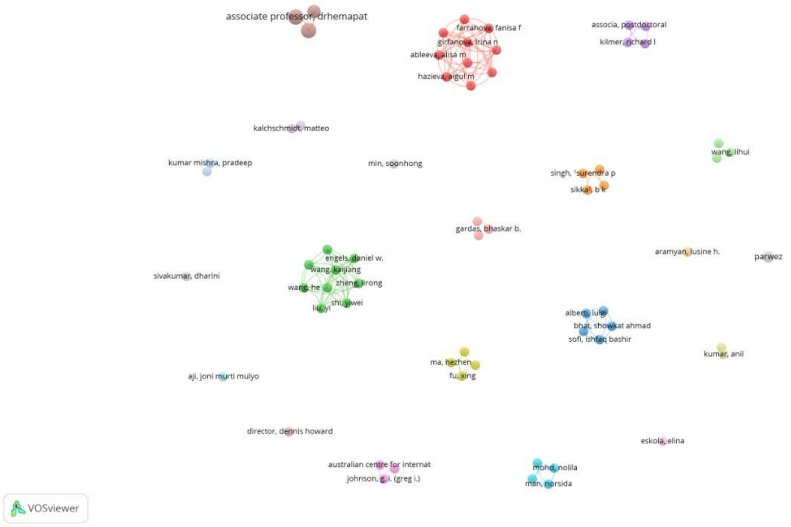

Figure: 2

In addition to the above-discussed citation-based and co-authorship networks, co-occurrences of keywords have also been studied. The number of co-occurrences of two keywords is the number of publications in which both keywords occur together in the title, abstract, or keyword list. In this study, keywords were extracted from the author-supplied keyword list of publications. Fig:2 shows the authors' co-citation network. Three major clusters can be observed above figure. These particular authors have the most number of citations and are seen as an essential part of the research.

"It is difficult to make a merit list for authors" (Sahoo, 2016). Some productivity measurements, however, take into consideration not just the overall number of publications but also the quality of the researchers' work. The h-index and the i-10 index are two of these measurements. The h-index is an author-level indicator that assesses his or her productivity as well as the citation effect of his or her works. It is often regarded as the most well-known and widely utilized scientific performance for researchers. If h of an author's articles have at least h citations each, and the remaining papers have no more than h citations each, the author has an h-index of h. As a result, this index is based on an ordered list of the researcher's most cited works as well as the number of citations obtained in other publications.

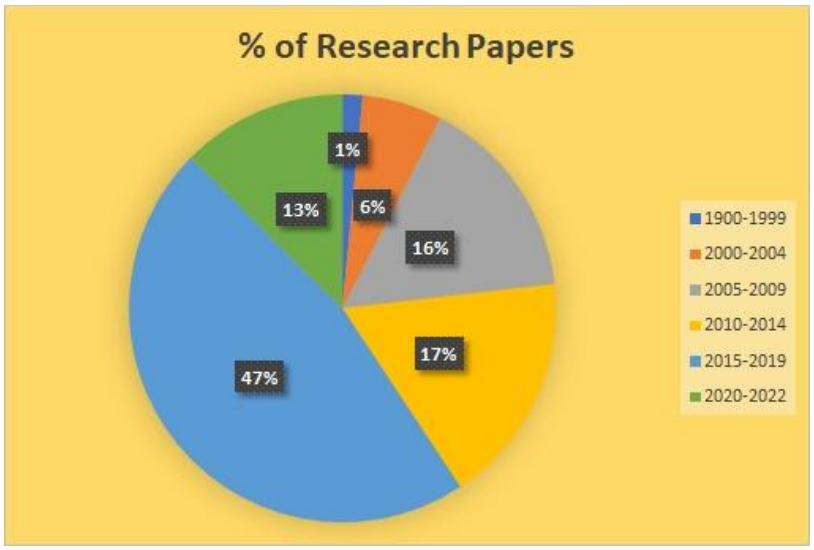

Figure: 3

This is a pie chart analyzing the percentage of research papers related to our area of research according to the different timelines. Merely 1% of the total research papers were found during the first period. The percentage rose to 6% during 2000-2004 as more appropriate resources were available. Post this, it was 16% and 17% for the period 2005-2009 and 2010-2014 respectively. We can see a big leap in the number of research papers during the 2015-2019 timeline and lastly finally drops down to 13% in the 2020-2022 period.

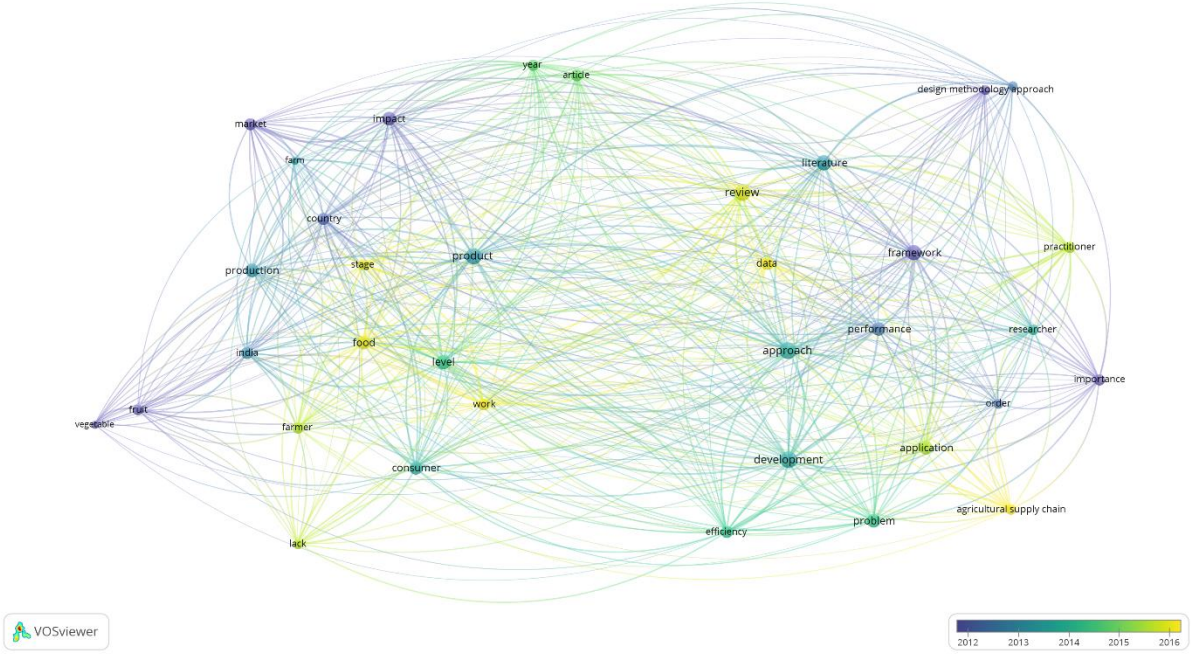

Figure: 4

In the above figure, dark blue represents the more conservative terms which were used in previous decades. They constituted of primitive ideologies such as literature, country, production, market and farms.

Yellow represents the modern era (post-2015) and talks about quality, efficiency, food security, performance, IT and development. This indicates a shift in the approaches and broader mindset of AMSC research.

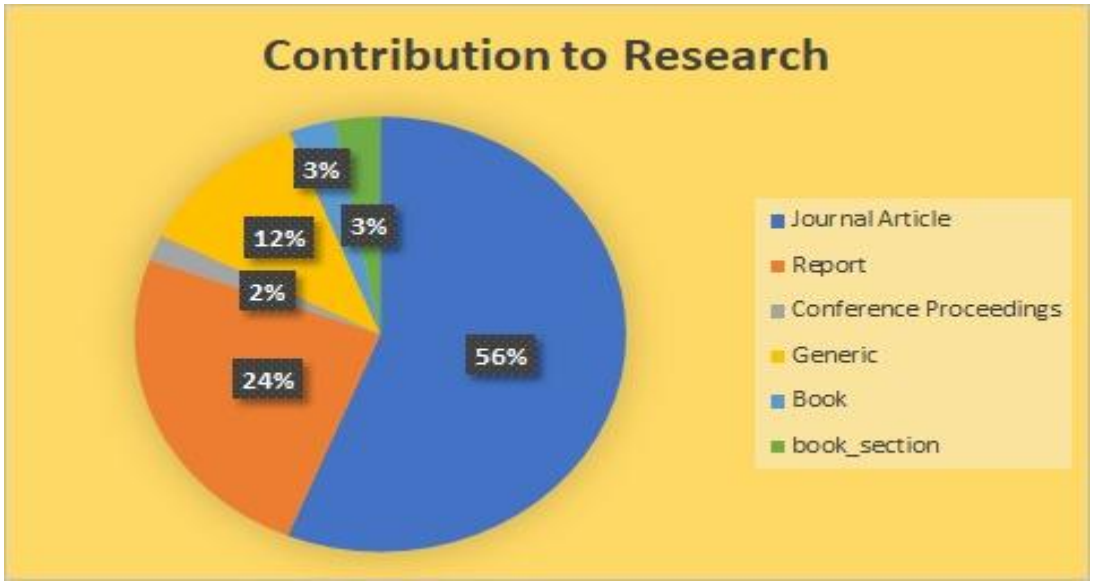

Figure: 5- Contribution of various sources to research

This diagram is an indicator of various avenues of work utilized for the citations and research in this paper. A major chunk of the information and inferences (56%) are obtained from journal articles written by various researchers in this field. Furthermore, reports on findings by independent authors/organizations have also been utilized to get a clearer understanding of the history and the current trends of ASCM. Another major source for content was generic websites which contributed to around 12% of the total content. Finally, we have also taken a few points from Books, a particular section of books and Conference Proceedings.

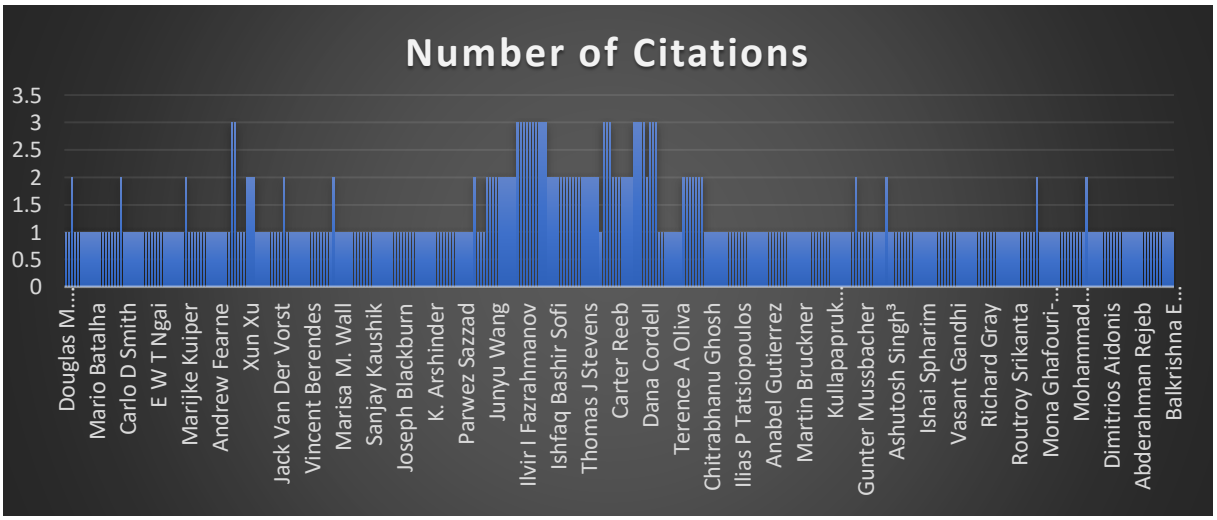

Figure: 6

This chart is essentially a measure of the frequency of the citation of authors. There are 300+ quoted authors out of which multiple authors have been quoted at a maximum of 3 times. This data analysis includes the

names of those authors who have multiple research papers in the same field (published in similar/different years) thereby increasing the number of times they have been cited as well. Moreover, this data also includes citations from Organizations and Journals.

Identifying fresh and hot research topics was used to discover research patterns. New words are terms that were only recently utilized as keywords. Hot research topics are those that have been thoroughly examined and debated in highly cited journals. The title and abstract of published papers were mined to identify fresh and hot research ideas, which were then shown using overlay visualization networks. We employed a time-based overlay visualization mapping for all titles and abstract terms from 1995 through 2022 to find fresh research subjects. The color of a node in Fig. 1 reflects when the term was added into the network. To distinguish between new and old themes, the phrases were matched with the publication year of the article from which they were mined. To represent ancient and modern issues, the colors span from dark blue to yellow. Older subjects are represented by colors ranging from blue to dark green. New terms are indicated by words ranging from light green to yellow. The older the phrase, the closer it is towards blue. New terminology includes food waste, food loss, carbon footprint, contract, blockchain, IOT, resilience, short food supply chain, cold chain, and sustainable supply chain, as depicted in Fig.1. Some of these terms were also detected in the previously disclosed word network for author keywords.

5. CONCLUSION-

Despite the fact that there has been a multi-fold increase in the development of SCM, there are various factors that still need consideration. The various technologies that are being used, come with their own negatives and downsides and sometimes lead to a net negative impact on the supply-chain of agricultural produce.
Even though the blockchain technology has grown significantly in recent years, there is still a massive vacuum in research that is mostly empirical and practical. We identified the following problems in the Agricultural Supply Chain:

- Large number of small farms owning partners; poor supply chain design; and shoddy redistribution point infrastructure
- Lack of modern technology, a lack of technologies for grading and sorting, a lack of transparency and traceability, and a lack of producer awareness.

We have seen that. Whenever we talk about the usage of AI in ASCM and how it's going to revolutionise the ASCM sector, we never consider the problem of adopting such an intricate and complicated technology, especially in poor countries where the education level is considerably low amongst the farmers. The various problems that are not technology-centric like –

- Numerous partners holding small farms
- Shoddy supply chain design
- Poor Redistribution point infrastructure
- Modern technology is lacking
- Lack of technologies for grading and sorting (B. B. Gardas et al., 2017b)
- Lack of tracking and openness
- Unawareness among producers

Also, raising pertinent questions about the future of ASCM in India and other countries; though the process of getting used to the new technology is slow and various technologies like RIFD
and IoT still having their own little flaws, the future of ASCM is in safe hands as the rate at which people are accepting these techniques is incredibly promising and shows the true potential of ASCM once technology is incorporated within it.

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