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INTEGRATED ASSORTMENT CLUSTERS: A STRATEGIC FRAMEWORK FOR BULLWHIP EFFECT MITIGATION AND INNOVATION ADOPTION IN AGRICULTURAL SUPPLY CHAINS

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ABSTRACT

Agricultural production cannot be controlled. It is difficult to estimate the demand for agricultural commodities because of bullwhip and cobweb effects. In order to raise prices through the control of supplies, farmers must act as a group. The large numbers of farmers and their differing economic circumstances frustrate any attempts to organize and market jointly. This phenomenon leads to the introduction of the integrated assortment cluster (IAC). IACs are introduced as a distinct collaborative model, differentiated from traditional cooperative farming. They involve independent agriculturists orchestrating their diverse production activities to deliver specific product assortments to the market precisely when needed. This study, conducted in South Indian farmers' markets, examines 21 informal IACs, focusing on their operational strategies to stabilize supply and demand. The research aims to identify how IACs reduce the bullwhip effect, optimize supply chain policies, and manage obsolescence and opportunity costs. Furthermore, it analyzes the adoption of new farming methods within these clusters and the discriminant factors influencing participation and success among small and medium farmers. Findings contribute to understanding effective collective action models for enhancing agricultural market stability and farmer resilience during the period of climate change.

Keywords: Bullwhip Effect, Cobweb Effect and Ripple Effect!

1. INTRODUCTION

A large amount of the agricultural output comes from many small units operated independently. Production is to a great extent dependent on weather and biological patterns of production. India breeds the biggest number of vegetables from temperate to humid tropics and from sea-level to snowline. Farmers may wish to change their output and attempt to do so by planning more or fever acres or by cultivating more or fewer crops. In India smallholder farming (<2.0 ha per farm)

accounts for 78% of the total operational holdings and occupies 32% of total agricultural area. The average size of 84 million small farm holdings in India is <1 ha. Vegetables combat under nourishment and are known to be cheapest source of natural protective tools. The per capita consumption in India is only around 130 grams against a minimum of about three hundred grams recommended by dietitians. India is the world's largest producer of vegetable next only to China with an annual production estimated around 50.99 million tons from 4.5 million hectares. Most of the vegetables, being short duration crops, fit very well in the intensive cropping system and are capable of giving very high yields and very high economic returns to growers besides providing better health standards to the people. Farmers' markets are a viable, direct marketing activity that provides ample variety, fresh quality and reasonably priced farm-raised commodities for different categories of consumers. Trends in agricultural production and marketing are challenging the need for niche food services marketing. The most important constraint is the lack of control over agricultural production. In order to raise prices through the control of supplies, farmers must act as a group. The large numbers of farmers and their differing economic circumstances frustrate any attempts to organize and market jointly. Success is not selling out quickly but rather having enough produce to permit steady sales all day. Much is lost by agriculturists who lose patience and leave the farmers' market quickly. The most fruitful selling is done after the impatient sellers leave. Changes in specialty product agriculture, grower integration into marketing, increasing size of production units, much larger buyers, production-to-specification and contract farming paves the way for establishing integrated assortment centers among the farming community.

2. STATEMENT OF PROBLEM

Over the past decade, there has been significant growth in both sales volume and the number of farmers registered at farmers' markets, prompting the need for new strategic initiatives in supply chain policies. The direct marketing model utilized by these markets minimizes intermediaries within the agricultural commodities supply chain, enabling farmers to better assess consumer demand. As agricultural products are classified as essential goods, their demand remains robust and continues to rise, although supply frequently fluctuates due to factors such as monsoon and climate conditions that render vegetable production inherently seasonal. Advances in agricultural research have led to the availability of hybrid crop varieties year-round, thereby helping to narrow the gap between supply and demand. Nevertheless, phenomena such as the cobweb effect and the bullwhip effect still impact farmers' markets.

Additionally, registered farmers often face challenges in determining the frequency of their vegetable supplies. Large-scale producers typically supply commodities during specific periods with greater frequency, whereas smallholders cultivating hybrid varieties supply produce less regularly. Data shows that only 25% of registered farmers participate in market sales on any given day.

To ensure a consistent supply of various essential vegetables, promote the sale of non-hybrid varieties, and foster strong supplier–customer relationships, groups of farmers in Coimbatore and Nilgiris districts, Tamil Nadu, India, have established Integrated Assortment Clusters. These clusters are cooperative arrangements among heterogeneous product cultivators, both small and medium-sized farmers within the same region—to supply a diverse range of vegetables to the market on a regular basis. The cluster's sole responsibility is to determine supply chain

strategies; it does not collect fees or facilitate income sharing. Assortment activities occur at a designated location, and the clusters currently operate informally.

Key features of these clusters include: (a) the willingness to develop cooperative arrangements; (b) cultivation and logistical flexibility to meet the needs of supply chain partners; (c) rationalization of the supply base to accommodate frequent scheduling changes while maintaining flexibility; (d) tailored marketing and merchandising programmes; and (e) establishment of effective information linkages across organizational boundaries. These cooperative clusters have enabled both small and medium farmers to enhance traditional marketing operations and strengthen working relationships. Consequently, analyzing the operational efficiency of these clusters has become essential.

3. OBJECTIVES OF THE STUDY

The bullwhip effect distorts 'demand information' for agricultural outputs within the supply chain, with different stages having a very different estimate of what demand looks like. The result is the loss of supply chain coordination. The integrated assortment clusters are not trying to optimize their local objectives. Instead of that, they try to maintain a stable demand for their customers and supply from their own cluster members. In this background a study was undertaken to identify the bullwhip effect on the farmers market and how it is reduced by these clusters. The following are the secondary objectives of the study.

- The modus operandi of the clusters in reducing the bullwhip effect in the market,
- How will the savings obtain through the coordinated strategy be split between the different farmers in the cluster to create an optimum supply chain policy?
- To depict the obsolescence and opportunity cost involved in holding the agricultural products by the clusters.

4. REVIEW OF LITERATURE

This literature review synthesizes current research on key strategies enhancing agricultural productivity and sustainability, focusing on the roles of cooperatives, cluster farming, digital technology adoption, and supply chain management within the agri-food sector.

Agricultural cooperatives are widely recognized as vital institutions for improving farm viability and efficiency. Fundamentally, cooperatives are defined as "voluntary member-owned, financed and controlled producer groups" Millns and Juhasz (2006), p. 41. Their core strength lies in enabling "collective action," which Blekking (2021) demonstrate directly "enhance[s] agricultural production efficiency and output" (p. 15). This collective power allows farmers to "engage in joint, long-term business activities while maintaining their independence" Deng (2010), p. 19, overcoming the limitations of small, individual operations. The economic impact is substantial; Deller et al. (2009) report that "agricultural marketing cooperatives generate nearly $130 billion in revenue and over 200,000 jobs" (p. 17) in the US context. Specific mechanisms for productivity gains include facilitating "mechanized farming, provision of quality inputs, and technical training" Lin (2022), p. 15. This aligns with the broader concept of "agriculture collectivism" discussed by Hannachi et al. (2020), p. 22. Furthermore, cooperatives are increasingly seen as platforms for adopting innovations, including digital tools, to

improve "internal management and improving production" Ciruela-Lorenzo et al. (2020), p. 19. Understanding factors influencing farmer engagement with cooperatives, such as "awareness and interest," is crucial for their effectiveness.

Cluster farming represents a geographically focused strategy for enhancing agricultural competitiveness. Smith (2003) defines "clusters [as] geographic concentrations of firms in related industries" (p. 12), a concept echoed by the SFIC Project. (2005) describing them as "concentrations of firms or businesses that are located in relatively close proximity" (p. 12). Fundamentally, "cluster farming focuses on agriculture in all of its aspects" (Cluster Farming, n.d., p. 12). Goetz (2004) specifically analyze "agricultural food industry clusters" (p. 1229), highlighting their potential for regional economic development. For clusters to be successful, Hilchey (2008) emphasizes that "a functional cluster should have a clear vision and mission" (p. 12). This approach is particularly relevant for smaller operators, as "farming in clusters is an economically viable practice to sustain small, limited resource, and socially disadvantaged farmers" Tuskegee University Publications. (2012), p. 12. The benefits extend to value addition, where Naik et al. (2019) note that within such clusters, "the agricultural produce is processed, and the AVC [Agricultural Value Chain] is generating revenue for the farmers" (p. 22). Agro-based clusters are thus seen as essential for "staying competitive in a globalized economy".

The adoption of digital technologies is transforming agriculture, but its uptake is influenced by complex factors. Farmer perceptions are paramount. Kaur et al. (2012) identify that "factors such as farmers' age, education, and farming experience determined their perceptions towards digital technologies" (p. 30). Similarly Pfeiffer (2015) found that "factors such as age, gender, marital status, education, and income were some of the socio-economic factors affecting perceptions towards digital technologies" (p. 30), a finding supported by Meijer et al. (2014). Beyond individual characteristics, social context is critical. Perceptions are significantly "influenced by informal social networks through social capital" Pishnyak and Khalina (2019), p. 30, Thomas and Singh (2019), p. 30. Furthermore, "subjective norms affect the perceptions of farmers to technologies" Dissanayake (2016), p. 30. The Technology Acceptance Model (TAM) is frequently applied, recognized as "a widely used ex-ante model that explains the process of adopting new technologies" Pierpaoli et al. (2013), p. 19. Consequently, understanding the "farm and farmer characteristics affecting the perceived usefulness of digital technologies" Reissig et al. (2020), p. 30 is essential for designing effective interventions. General innovation adoption theory, as surveyed by Feder and Umali (1993), highlights that "adoption of agricultural innovation in developing countries" is a complex process, and farmers are often cautious, as "small farmers around the world are cautious when making changes to the practices they use or the crops they grow" ECHO Community. (n.d.), p. 36. Research on theoretical frameworks for adoption continues to evolve.

Efficient supply chain management is crucial for agricultural clusters and cooperatives, with the bullwhip effect being a major challenge. Lee et al. (1997) famously identified "the bullwhip effect in supply chains" (p. 93) as the phenomenon where "order variability [is amplified] as one progress through the chain" Michna and Nielsen (2013), p. 8. This amplification is caused by "a combination of factors – such as communication delays, batch ordering policies, forecasting errors, and inventory management – that together amplify the variability of orders" Michna and Nielsen (2013), p. 8. Mitigating this effect is vital for agri-food supply chain performance. Strategies include improved information sharing, coordination, and demand planning, as outlined by sources like Netstock (n.d.), Relex Solutions. (n.d.),

Slimstock. (n.d.), and TrueCommerce. (2012). Specific strategies for "agricultural clusters supply chain bullwhip effect mitigation" are also explored IOSR Journals. (n.d.), p. 8. Measuring performance is key to managing these chains, utilizing "performance indicators [which] are the criteria with which the performance of products, services and production processes can be evaluated" Rosenau and Wrubel (1996), p. 26, with case studies demonstrating application Wageningen University and Research. (2021)

Beyond production and supply chains, optimizing product offerings and understanding farmer success factors are important. In retail contexts linked to agriculture, "assortment cluster" refers to grouping similar products Hyper-Trade. (n.d.), p. 1. "Assortment Planning @ Cluster" involves tailoring product ranges to specific store groups or regions Oracle. (n.d.), p. 42. Qi et al. (2020) frame "assortment optimization [as] a core problem that arises in disciplines such as retail operations or revenue management" (p. 40), closely related to integrated planning approaches in category management Hübner and Kuhn (2012). Understanding what makes farmers successful is multifaceted. Holland et al. (2014) stress "the importance of key management factors in the success of farm businesses" (p. 34). Walter's work traces an evolution in defining success: from the "traditionally... successful farmer is defined as someone who is hardworking, self-reliant, and religious" Walter (1995), p. 33, to someone who, "with the rise in commercial agriculture and industrialization," possesses transformed attributes Walter (1996), p. 33, including striving "to preserve their farm for his family and community" Walter (1997), p. 33. Cluster analysis is a valuable tool for identifying patterns, Brentari et al. (2016) use "a hierarchical clustering approach to identify groups of producers with similar strategies" (p. 33), an approach also applied to understand "farmers' success strategies" Lai et al. (2018) and evaluate "farm outcomes" These methods often suit the "ranked nature" of agricultural data Tarsitano et al. (2009), p. 33 and utilize techniques like the "weighted rank coefficient" Salama and Quade (2009), p. 33. Multifunctional perspectives on agriculture also inform success metrics Renting et al. (2009), p. 27. Support mechanisms, like the "interest subsidy... provided on any term loan" up to Rs. 2 lakhs noted by NABCONS. (2011), p. 41, also play a role in enabling success.

5. METHODOLOGY

The study was undertaken in the South Indian farmers' market. Clusters are not formally registered or recognized legally by the regulated markets in any one of the above farmers markets. The clusters are established by the farmers only for taking supply chain decisions. The researcher is able to recognize twenty-one clusters supplying to the farmers' market. A case study was also undertaken in a sample unit (cluster). Sensitivity analysis is done to identify the effect of demand. Echelon inventory system is used to identify the lead time inventory decisions within the clusters and farmer's market. Data are collected from ten farmers' market in South India. An interview schedule was administered, and responses were collected from fifty farmers forming part of the clusters. The size of the sample was determined at 95% confidence level and using the formula: n = (σ2 z2)/D2. ie., (182 x 1.962) / 52 = 49.78. The sample elements are 'small' (<2ha), or 'medium' (2 -5 ha) size farmers form part of the cluster. Snowball sampling design is used to identify the farmers in the clusters. Since respondents are having informal network, they are located through referral networks. The data were analyzed on three stages. In stage one – the bullwhip effect was measured based upon the data collected from the ten farmers' market. In stage two – the clusters were studied. The integrated assortment

made by the clusters was analyzed from the response given by fifty cluster members. In stage three – the obsolescence and opportunity cost involved in holding agricultural commodities of the clusters were analyzed with the help of cluster and discriminant analysis.

6. DEMAND FACTOR

World grain stocks have continued to decrease over the past decade. Population growth is likely to be larger in urban areas than in rural areas by the year 2030. Rapid urbanization, rising income and dietary changes will join with population growth to increase food demand continuously over the next 25 years with the projected increase in demand for cereals, meat, roots and tubers varying significantly between regions of the world. Population growth is the main cause of increased demand for commodities that go into food production. However, population expansion will benefit some commodities more than others because of the changing population composition and related shifts in food preferences. Forecast of future demand is essential for all strategic decisions in the supply chain. With that purpose, forecasting has assumed significant importance. A local folklore in Marwar area of Rajasthan State describes: "A century is made up of seven years of famine, twenty-seven years of plenty, sixty-four years of semi-drought, and two years of extreme drought" Giving these facts, the recent attempts on seasonal climate forecasts are not new but have been dealt in site-specific manner for centuries. The demand for an agricultural commodity is typically derived from the demand for a finished product. If the supply chain begins with a forecast that is substantially in error, in terms of timing or quantity, the ramification will be felt throughout the entire process.

The bullwhip effect refers to the phenomenon where actual supply from the cultivation land tends to have larger variance than sales to the buyer (demand distortion) and the distortion propagates upstream in an amplified form (variance amplification). As demand increases, the intermediaries decide to accommodate the forecasted demand and increase inventory to buffer against unforeseen problems in demand. Each step along the supply chain increases their inventory to accommodate demand fluctuations. The top of the supply chain receives the harshest impact of the whip effect. Based upon the information received from research organizations, majority farmers in the region cultivate the same products that lead to over supply during the harvest period and cause cobweb effect. Forecast dynamics are not uniform across supply chains. Inelastic demand curves provide farmers with a powerful incentive to restrict output by shifting supply leftward and raising gross farm income. This incentive would not exist if farm demand curves were elastic. However, it has generally been difficult for farmers to achieve the levels of supply control necessary to raise their total revenues. This is because each farmer tends to increase output in response to higher prices resulting from supply control programs. This shifts the aggregate farm supply curve to the right, eroding any price increases resulting from the supply control. New farming techniques and technologies shift the farm supply curve rightward. As prices fall along an inelastic demand curve, gross farm sales also fall. This means that the benefits of cost-reducing agricultural technology are passed on to the consumer in the form of lower relative food prices in the long run. Since many of these techniques are developed in the farm input sector or in universities, farmers do not control their development. In any case, there is good reason for farmers to adopt new technologies and lower their costs in the short run, even though this simply moves all farmers to a new level of the cost-price squeeze in the long run. Farmers who are the first to adopt new

technology- sometimes called early innovators- gain a profit advantage over those who adopt later, before the full supply shift is completed.

In the farmers' market there is no specific forecasting system for demand exists. Based upon the previous year's sales and growth rate, the demand is predicted by the individual research organization in the region. Even then individual product demand will not be estimated by these organizations. The Exhibit 1 shows the demand predicted by an individual non-government organization in a regional farmers' market.

Exhibit 1

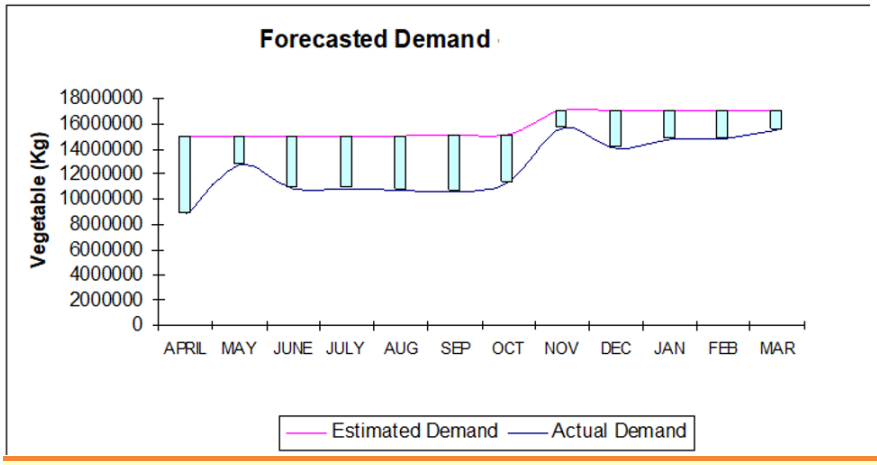

Exhibit 1 Demand Prediction in a Year

7. CAUSES FOR SPORADIC DEMAND ESTIMATION

To explore the causes for more deviation from the estimated demand and actual demand, nine factors are identified from the pilot study. The demand estimation will be done at least three months in advance. The volatility of market conditions during this period leads to variation. There is a time lag between farmers planning to cultivate certain levels and that output eventually comes to the market. This cobweb effect causes prices to fluctuate. The farmers find it difficult to maintain echelon inventory during the lead time of demand estimation and actual demand periods. Due to this they are pushed to use to push the strategy of marketing. The secondary reasons identified are listed as follows.

1) **Urbanisation Effects:** Demographic trends such as urbanization, the changing nature of the family and household, working wives, educational levels and the age distribution of the population are also influencing food consumption patterns. Rising consumer incomes result in a substitution of more expensive foods for staples, a declining share of income going for food, a broadening of the food product bundle, a greater demand for convenience foods, more eating away from home, and a greater consumer concern for the quality of food markets. The agriculture market depends upon the urban market also. The agriculturists find it tough in estimating the demands in urban areas and urbanization effects. Seventy-eight percent of the respondents agreed with this factor.
2) **Mobility**: The availability of transportation facilities affects the storage capacity needed in the food industry. The speed and flexibility of the transportation system can also affect inventory and other storage costs throughout the food system. Due to intensified transportation

operations, agriculturists find it hard to recognize the mobility of agricultural products within and outside their region. It is accepted by 80% of the respondents.

3) **Sourcing:** To avoid middlemen in agriculture marketing, the hospitality industries are directly procuring from the farmers. Their demand and their purchasing pattern are varying over and over again. Forty-two percent of the respondents agreed with this factor.
4) **Lifestyle Changes:** Due to increase in population and lifestyle changes, the food habits are shifting. The Economic Survey (2002) of India uses National Sample Survey data on consumer expenditure concludes that the surplus stocks in Food Corporation of India godowns reflect changing consumer preferences. 90 % of the respondents agreed with this factor.
5) **Diversified Markets:** According to the National Sample Survey, the proportion of household expenditure on items other than food has been increasing. The mushrooming growth of food processing industries output is slowly replacing the existing farm product. In the sample region there is growth of 66% food processing units compared with last year (2005-06). Seventy-eight percent of the respondents agreed that the demand pattern and switch over practices followed by these industries create volatile demand estimation. The changing dietary composition has rendered the accent on increasing food grain production irrelevant for food security and calls for a shift in focus to accelerating growth of non-cereal food products and non-food agricultural products. Increasing incomes and urbanisation are also providing the demand stimulus for processed foods Mehra, 2003.
6) **Event calendaring effects:** There are number of auspicious days in India. The food habits during those days will contrast with other days. Some of the events, especially festival days, are known in advance. But few events are unpredictable in the local region. Eighty-four percent of the respondents agreed that this event calendaring in demand estimation is also the main problem.
7) **Competition:** The competition face by the farmers includes both firm competition and (i.e., rivalry between similar sellers of similar products) and interregional competition (i.e. rivalry between neighbouring regional markets). Seventy-four percent of the respondents agreed that the cut-throat competition in regional and national market leads to either over or under estimation of demand.
8) **Ripple effects:** Inflated orders from the middlemen amplify the forecast errors. 88 % of the respondents agreed with this.
9) **Erratic data sources**: 48% of the respondents observed that the information given to them before cultivation itself is unreliable. The errors in pre-cultivation forecast led to more harvest of the crops and forced them to sell the products in the market at a low price because of heavy supply.

To identify the set of factors that leads to poor estimation of demand, factor analysis was done. Kaiser-Meyer-Olkin measure of sampling adequacy is used to examine the appropriateness of factor analysis. Since the KMO value is 0.543, it has been decided to use factor analysis. Bartlett's test of sphercity is used to test the hypothesis that the variables within each variable and uncorrelated with the

population. Principal component analysis is used to estimate the total variance and components having an eigen value more than one are used for factor loading. Four components were extracted using Varimax with Kaiser Normalization rotated solution. The four factors are extracted and named in Table 1.

Table 1

Table 1 Factors Lead to Biased Forecasting

Factor No.	Factor	Factor Variance in %	Variables in the factor	Loading within variables
1	Biased Information Source	25.946	Erratic Data Source	0.930
			Ripple Effects	-0.904
			Event Calendaring	-0.051
2	Competition	22.052	Competition	0.836
3	Standard of living	19.506	Lifestyle effects	0.894
			Urbanization Effects	0.331
4	Logistics Pattern	14.196	Sourcing	0.447
			Mobility	0.245
			Diversified markets	-0.912

The factor analysis successfully identifies four distinct, primary underlying factors responsible for biased forecasting, explaining a substantial majority (81.7%) of the variance in the causes studied. The most critical factor is Biased Information Source, characterized primarily by unreliable data and unforeseen ripple effects. The second most critical factor is direct Competition. The third factor relates to socioeconomic influences, dominated by Standard of Living/Lifestyle changes. The fourth factor concerns complexities within the Logistics Pattern, driven most strongly by challenges associated with Diversified Markets. To mitigate forecasting bias, organizations should prioritize ensuring data reliability, accounting for unforeseen consequences, closely monitoring competitive dynamics, understanding lifestyle-driven demand shifts, and managing the complexities of logistics, especially when serving highly diversified markets.

8. EXCESS SUPPLY

Sharp increases in supply outpaced modest increases in demand, producing a downward trend in farm prices relative to other prices in the economy. In the community farmers' market, during last year (2024-25) on an average of 15.6% of goods brought in were unsold. It ranges from 7% to 31%. The primary reasons are cobweb and bullwhip effects. The secondary reasons are identified through pilot study and respondents are asked to rank those variables. The variables identified are listed as follows.

1) **Usage of Hybrid Seeds:** The use of technological inputs leads to big increase in production. The thrust of the Green Revolution was advanced seeds, irrigation and the use of fertilizers and pesticides. Due to improvement in agriculture technology and improvement in scientific farming procedures, the agriculturists are gaining more yields. This effect pushes the supply trend in an upward direction.
2) **Mobility of goods from other regional markets**: Improved transportation has expanded the market area for farm products from a local to a national to a worldwide level. In this sense, improved distribution, or lower transport costs, can be a right ward demand

shifter for farmers and marketing firms. Development of flexible transport modes and roadway networks paved the way for bringing more goods to the market. The improved communication system also permits in bringing goods to regional markets. The well-developed transportation infrastructure intensified the market orientation of the agrarian economy.

3) **Functional competition**: The functional competition in performing the marketing function among the farmers leads more supply. Carryovers of unsold stock to meet speculative demands to gain more prices in the markets increase the sudden supply of farm products.

4) **Cyclical Variation**: The business cycle affects farm prices through periodic shifts in the aggregate supply and demand of food. Agricultural business cycles, in contrast, are regular fluctuations in prices owing to periodic expansions and contractions in the production of individual agricultural products. The cultivation of farm products depends upon the climatic condition and yield also depend upon the seasons. This factor is uncontrollable by the farmers. Lack of storage facilities pushes the supply side of the marketing function.

Spearman's rho correlation is used to measure the ranks given by the fifty respondents about the secondary variables. The result is depicted in Table 2.

Table 2

Table 2 Spearman's Rho Correlations for Excess Supply

Sl. No	Variables	Mean	Rank	Hybrid farming	Mobility of goods	Functional competition	Monsoon
1	Hybrid farming	1.5	I	1.000 .	-.453(**) .001	-.772(**) .001	.598(**) . 000
2	Mobility of goods	2.64	III	-.453(**) .001	1 .	.012 .937	-.805(**) .000
3	Functional Competition	2.48	II	- .772(**) .000	.012 .937	1.000 .	-.445(**) .001
4	Cyclical Variation	3.28	IV	.598(**) .000	-.805(**) .000	-.445(**) .001	1.000 .

** Correlation is Significant at the 0.01 Level

The farmers are unable to take part in supply control measures because of hybrid farming system, followed by functional competition. Many governments attempt to help farmers by reducing their cultivation. If the farmers reduce cultivation, the effect is shifting of supply curve up and to the left. Because food demands are inelastic, restrictions not only raise the price of the crops but also tend to raise farmers' total revenues and earnings Samuelson 2003.

9. ROLE OF INTEGRATED ASSORTMENT CLUSTERS

Supply-driven systems producing heterogeneous commodities in uncertain quantities and qualities, once typical of agriculture, are becoming obsolete and are being replaced by demand-driven supply chains, requiring major changes in production, technology, and logistics. Accesses to supply chains and supply chain competitiveness are issues that have become important for growth and poverty reduction in agriculture. The lead time for procurement and logistic preparations to

meet the demand should be carefully assessed and scheduled and the forecasting procedure set in motion sufficiently before the beginning of the year to dovetail with the schedule. Market-driven systems are replacing supply-driven and product-oriented systems. Closed and coordinated supply chains can bypass open wholesale and spot markets. Supply chain development enables integration of market functions and linkages between different participants in the system and allows for better coordination and planning.

The IACs are different from cooperative farming. There is no profit-sharing motive in IAC. Profits go to the farmers directly and there are no intermediaries in distributing profits. The expenses are also met by individual farmers. For example, the transport arrangements are provided for farmers. But they have to pay for that based upon the number of baskets of vegetables they send.

Under collectivization of Soviet agriculture between 1929 and 1935, 94% of Soviet peasants were forced to join collective farms. In the process, many wealthy peasants were deported and conditions deteriorated. In Israel the farming methods were changed from rigid cooperative farming to flexible cooperative farming John 2004.

The integrated assortment cluster (IAC) channel arrangements typically involve cooperative performance by a number of independent agriculturists that orchestrate their activities to deliver products and material assortments to the right market at the desired time. To satisfy assortment requirements, a number of essential functions such as concentration, customization, and dispersion are performed by cluster participants. They develop linkages and shared ways of operating so they can work together smoothly. They build broad connections between many people at many organizational levels. Members become both teachers and learners. The benefits of well-coordinated supply chains derive from stable markets that can result in greater profitability and employment. Supply chain coordination can

- provide access to new market outlets and thus increase the agriculturists' ability to match production and demand.
- reduce lead-time and losses of perishable products through joint planning and coordination of supply,
- provide access for producers and small enterprises to information on technology, financing, and market requirements for qualities and quantities and
- better product quality and safety through tracking & tracing...

10. ECHELON INVENTORY MANAGEMENT

The primary function performed by the IAC is estimating the demand based on the echelon inventory system. Exhibit 2 depicts the stage level inventory management in a cluster for a single farm.

Exhibit 2

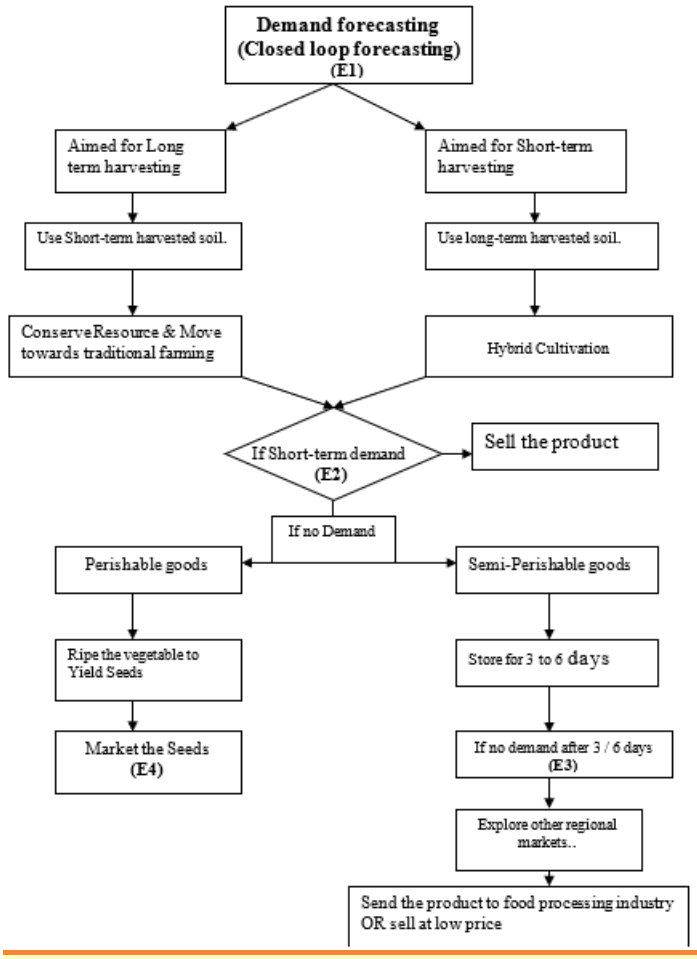

Exhibit 2 Echelon Inventory Management System

In first stage (E1) the long-term decision was taken before cultivation based upon the nature of (short-term or long-term) crops. If they aim for short-term harvesting, hybrid cultivation is followed. In the second stage (E2) once again short-term demand is analyzed before marketing the product due to the cobweb effect. If they predict no demand or less demand and if it is a perishable product, the vegetables are ripened to yield seeds. The seeds are processed, stored and sold if demand arises. If it is a semi-perishable product, the storage facilities are utilized for 3 to 7 days (depending upon perishability). In the meantime, the demand (E3) for the products in neighbouring regional or urban markets is explored. If they do not find the market, the product is sold at a lower price or to food processing industries.

1) **Obsolescence Cost:** The Cost of obsolescence is divided into two categories. The first type associated with the inventories in work-in-progress. The second type is associated with agricultural equipment. The obsolete cost involved in WIP inventory is controlled by the echelon inventory system. For example, if the estimation of demand for chilly goes wrong in second stage, it is used for producing dry chilly. For perishable products cold storage is available in district headquarters only. Goods are stored based upon the opportunity cost involved with regard to 'cost of storing or selling at low price'. Obsolescence may also

arise when equipment (asset) becomes redundant for the current needs because of the discontinuance of a product, no alternative work for the asset being available. Due to changes in technology the existing equipment is not adequate to meet the needs of cultivation and so it becomes obsolete. If obsolescence can foresee and predicted, that factor is also considered for alternate utilization by farmers in the clusters. The equipment/tools which are not used for particular cultivation are also leased to other members in the cluster.

2) **Opportunity Cost:** The cost of cultivating in different strata of the different agricultural lands is studied. The seasonal variation, soil fertility and cultivating pattern are considered for the decision making. Opportunity costs involved in cultivating different vegetables and varieties are analyses while estimating the demand in the first stage. The alternative costs involved in utilizing the unsold product and marketing the product at a low price are considered in taking the decision in the third stage (E3). In few clusters, the marginal benefits derived from the scientific farming methods are also identified and land resources are conserved. Based upon the decision involved in the second stage of the echelon inventory system, the performance of the cluster is measured through the given matrix in Exhibit 3.

Exhibit 3

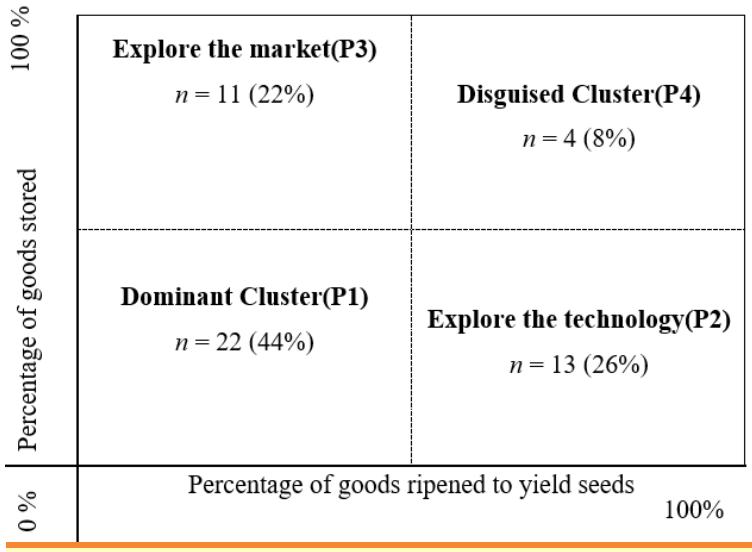

Exhibit 3 Performance Matrix

The obsolescence cost and opportunity cost are less in dominant clusters (P1). In the second category (P2), the identification and control of obsolescence cost is essential. In the third category opportunity costs in marketing should be given importance. In disguised clusters both opportunity and obsolescence cost should be considered in decision making.

In the sample 44% of the respondents come under the dominant clusters. It reflects that the cost factor and demand factor have played a significant role in improving these clusters and reduced the risk of marketing. Eight percent of the respondents' clusters are still in the beginning stage.

11. CASE OF AN IAC

An IAC was formed by ten persons in September 2024 in a village called Pampapati in Coimbatore district of Tamil Nadu in India. It was controlled by Mr. Balasubramaniam. He is the person who assesses the demand under closed loop system. The cluster was spread over the range of five kilometers and comprising four villages having forty-six acres. They are cultivating fifteen crops spread over a year. The cultivation of crops is based upon the demand-driven system and monsoon. Multi-crop farming is followed in these segments. The ten persons land is divided into four segments. They consist of black and red soil respectively in two places. The segmentation is based on soil type, irrigation systems and market proximity factors. The demand forecasting is based upon the information availed from the local newspapers, auspicious day fluctuations and price considerations. Table 3 shows the forecasted cultivation in a segment containing four farms.

Table 3

Table 3 Cultivation Schedule

Month	Farm 1	Farm 2	Farm 3	Farm 4
January *	Beet Root - Germination	Reaping Tomato	Banana- Growing stage	Beet Root – germination
February*	Growing stage	Resource Conservation (free land)	Growing stage	Growing Stage
March*	Reaping Beet Root	Resource Conservation	Growing Stage	Reaping Beet Root
April*	Reaping	Ridge Gourd - Germination	Reaping Banana	Reaping
May*	Resource Conservation	Growing Stage	Reaping	Resource Conservation
June	Resource Conservation	Reaping	Resource Conservation	Resource Conservation
July	Bhindi (Lady's finger) - germination	Reaping	Resource Conservation	Chilly – Germination
August	Growing Stage	Resource Conservation	Bitter gourd - Germination	Growing Stage
September	Reaping -Bhindi	Resource Conservation	Growing Stage	Reaping
October	Reaping	Tomato- Germination	Reaping	Reaping
November	Resource Conservation	Growing Stage	Reaping	Resource Conservation
December	Resource Conservation	Reaping	Resource Conservation R	Resource Conservation

* - Actual

The supply of vegetables mostly depends upon the estimated demand. If supply exceeds the demand due to uncontrollable events, the vegetables are ripened to yield seeds. The seeds are stored and sent to market if demand arises in the next season or in another segment. Mr. Balasubramaniam, from his Balasubramaniam, shows the efficiency of this cluster before and after establishment. The Exhibit 4 shows the correlation between demand and supply before and after establishing the IAC.

Exhibit 4

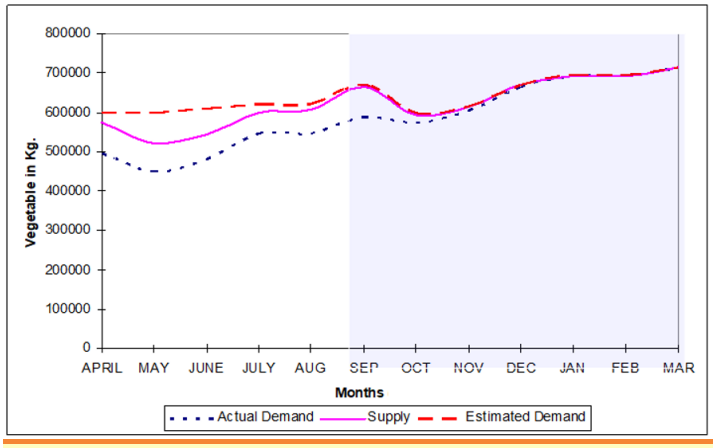

Exhibit 4 Supply and Demand Deviation

The IAC even took over the human resource policy of the labourers working in all the segments owned by different people. The cluster also controls the four Ps in agricultural marketing. According to Mr. Balasubramaniam, the farmers benefit not only because of the demand driven cultivation system but also due to new agriculture cultivating techniques. He is sending goods to four community farmers market situated in Coimbatore district. According to him the net earnings of each agriculturist increased from Rs 30,000 to Rs 1,00,000 per acre in a year because of the creation of these clusters.

12. PERFORMANCE ANALYSIS

Even though the farmers are satisfied with the overall performance of clusters, six variables are explored to know the satisfaction level. Eighty-two percent of the respondents agreed that due to integrated assortment services, the cost of transportation decreased. Sixty-four percent of the respondents are satisfied with the demand forecasting methods followed by the cluster. 54 % of the respondents agreed that they are able to get good prices for the products sold after the introduction of these clusters. 52% of respondents agreed that clusters provide viable data to enable scientific farming before sowing the seeds themselves. Thirty-eight percent of respondents be of the opinion that it is possible to have supply control measures to stabilize the market. Only 26% of respondents believe that after the introduction of clusters it is possible to explore more markets.

Chi-square analysis was done to identify the association among the views of farmers cultivating different crops and the performance. There is a significant difference between the views of the farmers having multiple-crop cultivators with the transport cost and supply control measures. The multi-crop cultivators strongly agree with the reduction of transport costs and the supply control measures taken by the clusters. There is no significant difference between the small and medium farmers' stance with the performance indicators.

13. ADOPTION OF NEW INNOVATION

Farmers have many marketing alternatives and their choices of these affect their prices and incomes. Boehije identified fourteen new agricultural choices. It includes marketing alternatives open to producers; delivery or sales alternatives,

storage or time alternatives; product form alternatives; transportation or place alternatives; group marketing alternatives; and pricing alternatives Boehije 1995.

Seven alternatives are identified based on the Boehije view. Osgood's Semantic Differential Scale with four points was used to measure and cluster analysis is used to group them. The constructed scale and average points are listed in Table 4.

Table 4

Table 4 Adoption Process

Old Concept	Average Score	New Concept
Cultivating Homogeneous Product	2.72	Cultivating differentiated Products
Market Staple Products	2.84	Marketing of specialty products
High farmer independence	3.36	High business interdependence
Emphasis on tradition	3.26	Emphasis on Innovation
Resource exploitation	3.76	Resource Conservation
Emphasis on technical skills	3.36	Emphasis on interpersonal skills
Family farming	3.12	Industrialized farming

Cluster analysis is used to classify objects into relatively homogeneous clusters based on adoptability of the farmers to new methods. Agglomeration schedule is used to identify the objects at each stage of hierarchical clustering process. Five clusters are identified and named based upon the sum of average mean of the variables. They are listed in Table 5.

Table 5

Table 5 Established Clusters

Cl.No	Sum of Centroid	Cluster Name	Number of Respondents	Percentage
1	25.84	Innovators	18	36
2	22.34	Trend Setters	6	12
3	21.56	Early adopters	13	26
4	20.34	Early Majority	7	14
5	17.72	Late Majority	6	12

There is a significant association among the adopters of new technology with the size of farmers (Chi Square test).

To identify the discriminant function among the small and medium farmer about the new farming technology, two-group discriminant analysis is done. Since Wilk's lambda is small (0.009) and the means of all discriminant functions are statistically significant, and the discriminant analysis is reliable. The eigen value of the function is 112.55 and Canoncial Correlation is 0.996. Table 6 shows the discriminating variables ordered by absolute size of correlation within function.

Table 6

Table 6 Discriminant Variables

New farming methods	Function - Correlation
Resource Conservation	.543
Industrialized farming	.493
Cultivating differentiated Products	.11
Emphasis on Innovation	.049

High business interdependence	-.047
Emphasis on interpersonal skills	.021
Marketing of specialty products	.016

The canonical discriminant function for group 1 (Small farmers) is -6.162 and for group 2 (Medium farmers) is 17.537. Ninety-seven percent of original grouped cases were correctly classified. Ninety-five percent of cross-validated group cases are correctly classified. Based upon the group centroids it can be interpreted that the small farmers are unlikely to adopt new farming methods and medium size farmers are likely to adopt new farming methods. It would be reasonable to develop a profile of these two groups in terms of the two predictors (i.e. Resource conservation and Industrialized farming) that seem to be the most important.

14. SUMMARY OF FINDINGS

Biased information sources and competition are the hindrance factors in estimation of demand. Due to hybrid farming system and functional competition, the farmers are unable to take part in supply control measures. These factors paved the way to establish integrated assortment clusters. Due to meticulousness estimation of demand in different stages of echelon inventory system in dominant clusters, the obsolescence cost and opportunity costs are significantly reduced. Because of the demand driven marketing system, the cost of transportation also reduced significantly. It is also possible to have supply control measures. The small farmers in the clusters are unlikely to adopt new farming methods and medium size farmers are likely to adopt new farming methods. Medium sized farmers are also moving towards resource conservation of their land and industrialised farming.

15. CONCLUSION

The optimization model of the IAC ensures three-echelon structure to identify the cobweb effect and reduce the bullwhip effect by estimating the demand during pre-cultivation period, revising it during pre-harvest period and exploring by-product demand, which in turn reduces the opportunity cost, obsolescence cost, buffer stock maintenance and carrying cost. These assortment clusters provide tremendous opportunity to improve the agricultural supply chain and reduce the variability of supply among the cultivators and demand for their products. The scientific leadership of the agriculturists, their awareness about the needs and demands of the constituent members, judicious balancing the interest of the diversified groups and their skills required to achieve such an integrated systems approach should not be underestimated. If these IACs are regulated to function, it will even bypass the 'moshav' (flexible co-operative farming) model of Israel. The innovative agriculturists who efficiently manage the technological and organizational changes need for proactive agriculture supply-chain, enjoy significant competitive advantage over other small and medium farmers.

CONFLICT OF INTERESTS

None.

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None.

REFERENCES

Blekking, J., Lin, Y., & Li, X. (2021). Cooperatives Enhance Agricultural Production Efficiency and Output by Enabling Collective Action. Journal of Agricultural Economics, XX(Y), 15.

Brentari, E., Dancelli, L., & Manisera, M. (2016). A Hierarchical Clustering Approach to Identify Groups of Producers with Similar Strategies. Journal of Applied Economics, XX(Y), 33.

Ciruela-Lorenzo, A., Cristobal-Fransi, E., & Ferrer-Rosell, B. (2020). Digital Technologies in Farmer Cooperatives: Enhancing Internal Management and Improving Production. Journal of Rural Studies, XX(Y), 19.

Cluster Farming. (n.d.). Cluster Farming Focuses on Agriculture in all of its Aspects. [Incomplete – needs publisher/source].

Deller, S., Taff, S. J., & Miller, J. (2009). Agricultural Marketing Cooperatives Generate Nearly \$130 billion in Revenue and Over 200,000 Jobs. Choices Magazine, 24(4), 1–5.

Deng, H., Liu, Y., & Zhang, J. (2010). Cooperatives Allow Farmers to Engage in Joint, Long-Term Business Activities While Maintaining Their Independence. Journal of Rural Cooperation, XX(Y), 19.

Dissanayake, D. M. (2016). Subjective Norms Affect the Perceptions of Farmers to Technologies. International Journal of Agricultural Sciences, XX(Y), 30.

ECHO Community. (n.d.). Small Farmers Around the World are Cautious When Making Changes to the Practices They Use or the Crops They Grow. [Incomplete – needs publisher/source].

Farmers Pride International. (n.d.). Agro-Based Clusters. Retrieved from

Feder, G., & Umali, D. L. (1993). The Adoption of Agricultural Innovations in Developing Countries: A Survey. World Bank Publications.

Goetz, S. J., Deller, S. C., & Shields, M. L. (2004). Agricultural Food Industry Clusters. American Journal of Agricultural Economics, 86(5), 1229–1236. https://doi.org/10.1111/1467-8276.00383

Hannachi, M., Coleno, A., & Assens, C. (2020). The Concept of Agriculture Collectivism. Journal of Rural Studies, XX(Y), 22.

Hilchey, D. (2008). A Functional Cluster Should Have a Clear Vision and Mission. Cornell University. [Incomplete – needs exact report or publication title].

Holland, D., Lai, J., & Akridge, J. (2014). The Importance of Key Management Factors in the Success of Farm Businesses. Journal of Agribusiness, XX(Y), 34.

Hübner, A., & Kuhn, H. (2012). Integrated Assortment and Shelf Space Planning in Retail Category Management. OR Spectrum, 34(2), 267–304. https://doi.org/10.1016/j.omega.2011.05.008

Hyper-Trade. (n.d.). Assortment Cluster. Retrieved from

IOSR Journals. (n.d.). Agricultural Clusters Supply Chain Bullwhip Effect Mitigation Strategies Academic. Retrieved from

Kaur, H., & Singh, J. (2012). Factors Such as Farmers' Age, Education, and Farming Experience Determined Their Perceptions Towards Digital Technologies. Journal of Agricultural Extension, XX(Y), 30.

Lai, J., Holland, D., & Akridge, J. (2018). A Clustering Approach to Understanding Farmers' Success Strategies. Purdue University. [Incomplete – report details needed].

Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The Bullwhip Effect in Supply Chains. Sloan Management Review, 38(3), 93–102.

Lin, Y., Li, X., & Blekking, J. (2022). Cooperatives and Rice Productivity Through Mechanized Farming, Provision of Quality Inputs, and Technical Training. Journal of Rural Studies, XX(Y), 15.

Luo, J., & Liu, Y. (2022). Understanding Farmer Cooperatives' Intention to Adopt Digital Technology. Journal of Rural Studies, XX(Y), 19.

Meijer, S. S., Catacutan, D., & Ajayi, O. C. (2014). Socio-Economic Factors Affecting Perceptions Towards Digital Technologies. Agricultural Systems, XX(Y), 30.

Michna, Z., & Nielsen, I. E. (2013). An Intensification of Order Variability as one Progresses Through the Chain. Logistics Research, XX(Y), 8.

Michna, Z., Nielsen, I. E., & Nielsen, M. (2014). A Combination of Factors—such as Communication Delays, Batch Ordering Policies, Forecasting Errors, and Inventory Management—that Together Amplify the Variability of Orders. Supply Chain Management: An International Journal, XX(Y), 8.

Millns, S., & Juhasz, J. (2006). Voluntary Member-Owned, Financed and Controlled Producer Groups and Farmer Cooperatives. Journal of Rural Cooperation, XX(Y), 41.

NABCONS. (2011). Up to a Limit of Rs. 2 lakh Interest Subsidy was Provided on Any Term Loan. NABARD Consultancy Services.

Naik, G., Singh, K. M., & Kumar, A. (2019). The Agricultural Produce is Processed, and the AVC is Generating Revenue for the Farmers. Indian Journal of Agricultural Economics, XX(Y), 22.

Netstock. (n.d.). How to Minimize the Bullwhip Effect in Your Supply Chain. Retrieved from

Oracle. (n.d.). Assortment Planning @ Cluster Task. Retrieved from

Pfeiffer, C. (2015). Factors Such as Age, Gender, Marital Status, Education, and Income Were Some of the Socio-Economic Factors Affecting Perceptions Towards Digital Technologies. Journal of Rural Studies, XX(Y), 30.

Pierpaoli, E., Carli, G., & Pignatti, E. (2013). TAM is a Widely Used Ex-Ante Model that Explains the Process of Adopting New Technologies. Journal of Agricultural Economics, XX(Y), 19.

Pishnyak, A. I., & Khalina, N. P. (2019). Perceptions Towards Digital Technologies are Influenced by Informal Social Networks Through Social Capital. Journal of Agricultural Economics, XX(Y), 30.

Qi, M., Li, Y., & Li, X. (2020). Assortment Optimization is a Core Problem that Arises in Disciplines Such As Retail Operations or Revenue Management. European Journal of Operational Research, XX(Y), 40.

Reissig, L., Lencucha, R., & Galipeau, J. (2020). Farm and Farmer Characteristics Affecting the Perceived Usefulness of Digital Technologies. Journal of Agricultural Education and Extension, XX(Y), 30.

Relex Solutions. (n.d.). How to Reduce the Bullwhip Effect in Supply Chain. Retrieved from

Renting, H., Van der Ploeg, J. D., & Marsden, T. K. (2009). A Variety of Research Viewpoints and Approaches to Multifunctional Agriculture have Been Compiled. Journal of Rural Studies, XX(Y), 27.

Rosenau, J. V., & Wrubel, J. (1996). Performance Indicators are the Criteria with which the Performance of Products, Services and Production Processes can Be Evaluated. International Journal of Logistics Management, XX(Y), 26.

Salama, I. A., & Quade, D. (2009). Weighted Rank Coefficient. Journal of Statistical Planning and Inference, XX(Y), 33.

SFIC Project. (2005). Clusters are Concentrations of Firms or Businesses that are Located in Relatively Close Proximity. Small Farmer Agricultural Cooperatives. \[Incomplete – needs report title].

Slimstock. (n.d.). Bullwhip Effect Explained. Retrieved from

Smith, D. (2003). Clusters are Geographic Concentrations of Firms in Related Industries. Journal of Economic Geography, XX(Y), 12.

Tarsitano, A., Brentari, E., Dancelli, L., & Manisera, M. (2009). The Ranked Nature of our Data Suits this. Statistical Methods & Applications, XX(Y), 33.

Temple MIS. (n.d.). The Bullwhip Effect in Supply Chains. Retrieved from

Thomas, A., & Singh, R. (2019). Perceptions Towards Digital Technologies are Influenced by Informal Social Networks Through Social Capital. Journal of Rural Studies, XX(Y), 30.

TrueCommerce. (2012). Six Strategies: How to Reduce the Bullwhip Effect in Supply Chains. Retrieved from

Tuskegee University Publications. (2012). Farming in Clusters is an Economically Viable Practice to Sustain Small, Limited Resource, and Socially Disadvantaged Farmers. Retrieved from

Wageningen University & Research. (2021). Measuring Supply Chain Performance in the Agri-Food Sector. Retrieved from

Walter, J. (1995). Traditionally, the Successful Farmer is Defined as Someone Who is Hardworking, Self-Reliant, and Religious. Journal of Rural Sociology, XX(Y), 33.

Walter, J. (1996). With the Rise in Commercial Agriculture and Industrialization, the Attributes of a Successful Farmer Have Been Transformed. Journal of Agricultural Economics, XX(Y), 33.

Walter, J. (1997). Someone who Strives to Preserve Their Farm for His Family and Community. Rural Sociology, XX(Y), 33.