Original Research

Technical Skills and Their Roles in Agribusiness Supply Chain Management Education

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Abstract
The integration of advanced technical skills and supply chain management (SCM) tools is critical for the evolving demands of agribusiness. This study identifies the technical competencies, software proficiencies, and educational strategies essential for preparing students to excel in modern SCM roles. Through semi-structured interviews with 26 SCM professionals across US agribusiness sectors, the study highlights the demand for expertise in tools such as SAP, Power BI, and SQL alongside capabilities in data-driven decision-making and adaptability. Despite theoretical preparation, graduates often lack practical experience with industry-standard technologies, underscoring a gap in academic curricula. The findings suggest that agribusiness programs should emphasize hands-on training with software, interdisciplinary approaches, and collaboration with industry stakeholders to bridge this gap. This approach ensures graduates are equipped to enhance efficiency and innovation across agribusiness supply chains, addressing challenges in demand planning, production scheduling, and procurement. The research advocates for an educational paradigm that aligns with the dynamic needs of agribusiness, fostering both technical expertise and soft skills to prepare future SCM professionals for a rapidly advancing industry.

1 Introduction

Supply chain management (SCM) is a relatively new term, not commonly used until the 1980s, but its practice predates money itself. Any time a person acquires inputs from others and uses them to produce a good to trade with others, they are managing a flow of resources with the aim of adding value. The inhabitants of the abandoned Chaco Canyon imported turquoise for fashioning jewelry, which they traded for food, demonstrating an early form of supply chain management. Today, the German company Trumpf also manages a supply chain, but one with 15,000 input suppliers (*The Economist* 2023). Decades ago, the management of a resource flow was compartmentalized into areas such as inventory management, logistics, and the like. Today, though, the network of input suppliers and downstream users is so complex, and the flow of resources so fast, that these areas need to be integrated and managed as a whole; in the process of creating this new approach to management, the term *supply chain management* was born.

As the terminology and nature of business evolves to emphasize SCM, so should a curriculum in agricultural economics and agribusiness (hereafter, agribusiness). Sometimes this requires only a minor change of focus for the same tools, such as teaching optimization programming applied to transportation networks instead of farm management. Other times it requires incorporating subjects rarely, if ever, taught 50 years ago, like master scheduling. For this reason, agribusiness courses increasingly include SCM in their course titles. What, exactly, is SCM, and what topics should be included in an undergraduate curriculum in agricultural economics and agribusiness? A casual glance at alumni in supply chain occupations makes it clear that much of their work involves using software, so we answer these questions by viewing supply chain management from the perspective of the information technology (IT) used.

The purpose of this study is to evaluate technical skills, software proficiencies, and educational strategies to prepare students for successful careers in agribusiness SCM. As the agribusiness landscape becomes increasingly reliant on advanced technologies and data-driven decision-making, it is important to align academic preparation with the evolving needs of industry stakeholders. This research seeks to bridge the gap between theoretical knowledge and practical applications, ensuring that graduates are equipped with competencies to navigate the complexities of modern SCM. The study focuses on the following objectives: (1) to determine the specific technical skills, software tools, and employment skills that are most valued by agribusiness SCM professionals; (2) to explore the role of emerging technologies in the shaping the future of SCM; and (3) to develop actionable recommendations for enhancing agribusiness education. By addressing these objectives, this study aims to contribute to the ongoing development of agribusiness education, ensuring that students are not only prepared to meet current workforce demands but also equipped to drive innovation and efficiency in the industry.

2 Background

SCM has become increasingly complex as firms navigate the fast flow of goods and information across global networks. This has reshaped the skills required to manage operations and continues to put a growing emphasis on technology and data-driven decision-making. The following section provides background on the evolution of SCM and how these shifts have influenced the preparation of future graduates.

2.1 Supply Chain Management in the Modern Age

Supply chain management is described as the flow of resources into a company, within the company as value is added, and out from the company and eventually to the consumer. As such, a popular metaphor for this “flow” is a stream, as shown in Figure 1. The righthand side of the figure illustrates this flow by dividing supply chain activity into upstream, midstream, and downstream channels. These represent the inbound movement of raw materials and inputs, internal value-added operations, and outbound distribution to customers, respectively. The lefthand side of the figure reflects core planning and coordination activities that occur across these stages. These include demand planning, master scheduling, material requirements planning, procurement, and client relationship management. These five areas form a foundational structure for how supply chain decisions are made and integrated across functional units. This visual framework highlights how supply chain flows are not only physical but also informational and decision-based, requiring synchronization between operational stages and management functions. For example, a company is located midstream, receives resources in the form of labor, raw materials, and other inputs from upstream sources. The company creates a good or service that is valued higher than the inputs themselves, which is then sent downstream to wholesalers, retailers, and—ultimately—consumers. Figure 1’s depiction is valid for any organization, for-profit or nonprofit, contemporary or ancient. What is different about supply chain management today is the speed of this flow and the large number of tributaries entering and distributaries exiting the company (Esper et al. 2010).

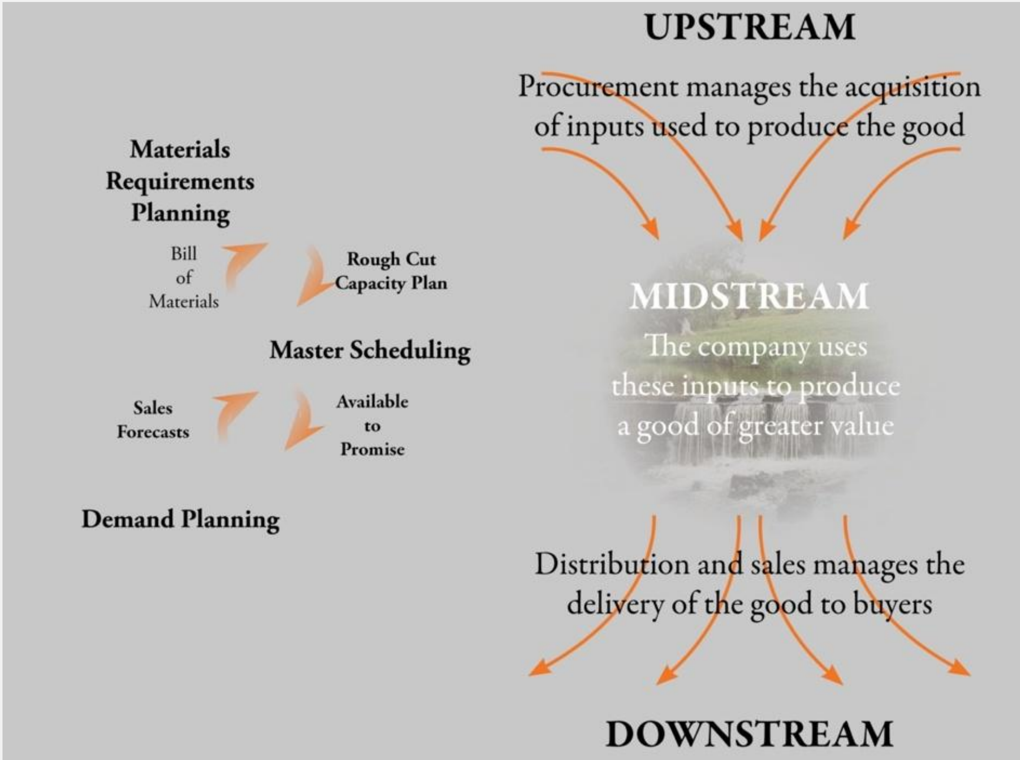

Figure 1. Visualization of supply chain management

For example, John Deere has over 4,000 input suppliers and over 2,000 retail outlets. Plus, considering its 25 brands, numerous product lines within each brand, and the multiple options and amenities available for any one product line, the company sells millions of unique products (Plastics Today 2010; John Deere 2022). A century ago, companies would rely mostly on inventories to manage this flow, but with the introduction of greater transportation speeds, trade liberalization, and computer technologies, companies learned they could increase profits by replacing bulky inventories with smart management of inventories—replacing warehouses with supply chain software and specialists. Lean management and just-in-time management evolved from fringe experiments to standard operating procedures, placing greater emphasis on managing the flow of resources and leading to the creation of supply chain management as a profession (Norwood et al. 2022). The frequent prediction that future CEOs will be chosen from supply chain management officers seems more realistic today given the rising importance of SCM in corporate strategy (Mikhail 2018).

Monitoring such a complex resource flow requires extensive reliance on computers and software. Therefore, one way to understand the nature of supply chain management is through the types of software used and their functions (Luthra and Mangla 2018). What follows is a tour of a general supply chain, informed by interviews with supply chain professionals and focusing on the software type and function needed at each step. The goal is not just a better understanding of supply chain management itself but of the technical skills that undergraduates can acquire to qualify them for careers in the field.

This study reports the findings of interviewees in the context of three important activities in supply chain management: (1) demand planning, (2) master scheduling, and (3) material requirement planning. Demand planning requires a company to forecast future sales of each of its goods, where specific goods are referred to as stock-keeping units (SKUs). For master scheduling, the company must then decide how many units of each SKU to produce in each period while accounting for production constraints, inventory capacity, and the like. Then, companies must check to ensure that the inputs will be available to facilitate production and obtain those resources in what is called material requirements planning. If at any point these three activities are not congruent (e.g., insufficient raw materials to meet planned production), then a new supply chain strategy must be formulated.

This list does not exhaust all the activities that can be placed under the SCM umbrella, but it does capture its core competencies. Notice that this trinity of supply chain management is described as three activities, not three departments. In some companies, they may be separated by department, with sales performing the demand planning, operations management in charge of production, and procurement handling the purchase of inputs. Yet other companies may combine all three activities within a single supply chain management department. For example, one company we interviewed took demand planning away from sales because "salespeople tend to be overly optimistic," giving control of the sales forecasts to supply chain management itself (with input from sales, of course). Other companies may have operations management perform both the master scheduling and material requirements planning; if this is the case, operations management "will certainly seek input from procurement." The point is that supply chain management requires coordination, and this necessitates the lowering of walls between departments. This is true not only in forming the long-term design strategy of the supply chain but also in its daily execution.

2.2 Supply Chain Management Academic Evolution

The evolution of SCM has redefined the technical and software skills expected of agribusiness graduates. Traditionally centered on production economics and farm management, agribusiness programs must now address the complexities of global supply chains, driven by the industry's focus on data-driven decision-making, integrated technologies, and collaborative approaches. Loy et al. (2024) highlights the extensive use of software tools in agrifood supply chain logistics and data reporting, which are now central to modern supply chain management. This knowledge is vital for academics when developing a course to better prepare agribusiness graduates to solve real-world problems.

Technical skills are fundamental to SCM, supporting decision-making and operational efficiency. Tools such as Microsoft Excel remain essential for forecasting and inventory management due to their flexibility (Gammelgaard and Larson 2001). Enterprise Resource Planning (ERP) systems like SAP and Oracle NetSuite enable real-time data integration, allowing businesses to dynamically respond to disruptions and streamline workflows (Rahman and Qing 2014; Loy et al. 2024).

Software proficiency has expanded beyond traditional tools, with specialized platforms playing a growing role in SCM. Transportation management systems and warehouse management systems optimize routing, track shipments, and improve inventory control. These technologies align with industry needs that emphasize the importance of tools tailored to the complexities of logistics (Christopher and Holweg 2011; Tatham and Wu 2017). Simulation tools have also gained prominence in SCM education, offering students the opportunity to test scenarios and model supply chain dynamics in a risk-free environment (Jordan and Bak 2016).

Despite these advances, a persistent gap remains between academic preparation and industry expectations. While graduates are often well-versed in theoretical concepts, they frequently lack practical experience with the software and technologies used in professional settings. For example, Jordan and Bak (2016) found that graduates struggled with integrating regulatory knowledge, data analytics, and real-world problem-solving into their roles. Moreover, employers have repeatedly emphasized the need for hands-on training with industry-standard tools to better prepare students for the demands of their careers (Prajogo and Sohal 2013).

Building on these concerns, Walden (2017) highlighted that traditional college course approaches often fail to equip students with the applied decision-making skills necessary to handle the frequently changing environments of supply chains, leaving them underprepared. This paper emphasizes that knowledge gaps stem from the lack of exposure to emerging supply chain technologies and regulations. Ganeshkumar et al. (2017) show that supply chain management education often lacks emphasis on business coordination and real-world logistics challenges. Curkovic and Fernandez (2016) highlight Western Michigan University's Integrated Supply Chain Program, which emphasizes the need for educational content to catch up with real-world supply chain advancements, such as the Internet of Things and blockchain technology. This supply chain program addresses some educational deficiencies by using experiential learning models (e.g., academic-business partner projects) to better align industry needs with academic output.

Addressing this gap requires rethinking how universities design and deliver their curricula (Gillespie and Bampasidou 2018). Stronger partnerships between academia and industry can ensure students are exposed to emerging technologies and practical applications. Collaborative efforts could include internships, case studies, and project-based learning, which helps students translate theoretical knowledge into actionable skills (Rahman and Qing 2014). Moreover, incorporating simulations and real-world datasets into coursework can foster the critical thinking and adaptability needed in dynamic supply chain environments (Litzenberg and Schneider 1987).

3 Methods

This study uses a qualitative research approach, which is suited to exploring latent perceptions and organizational dynamics across the agrifood supply chain (Zhao et al. 2020; Raffington and Joseph 2024). We conducted semi-structured interviews (Creswell and Poth 2018) to examine the experiences and knowledge of individuals at agribusiness supply chain firms. Semi-structured interview formats are widely employed in qualitative research to address complex questions and uncover previously unknown information (Dicicco-Bloom and Crabtree 2006; Saunders et al. 2015). This study received approval from the respective universities' Institutional Review Board (IRB applications 22-223 and 11248). The interview guide is provided in Appendix A. All participants received copies of the content form. In addition, participant information is anonymous per the protocols of IRB. Any identifiable information has been removed to protect confidentiality.

Potential participants were identified by examining major agribusiness firms with offices in the United States. A variety of firms were selected to represent various segments of the agrifood supply chain, including production, manufacturing, processing, and retailing. This approach is consistent with other qualitative studies that captured perspectives across different nodes along the supply chain (Oyedijo et al. 2024). The sample included both large multinational agribusiness firms and smaller organizations such as a local beverage retailer and an agricultural machinery dealer. While firms' size was not the primary selection criterion, efforts were made to include a range of organization types to reflect the variety of employment destinations for agribusiness graduates. Contact was made with representatives from 19 firms, with 26 SCM professionals agreeing to interview. Interviews were conducted from August 2022 to May 2023. Interviews were conducted either in person or via Zoom. These interviews averaged about an hour. Each participant was asked the same set of questions, then improvised questions followed based on previous answers. For each interview, themes were identified, explored during the interview, and then summarized. At the request of most of the companies, interviews were not recorded. Instead, notes were taken, then reviewed with interviewees to identify information they felt comfortable publicizing.

4 Results and Discussion

To reinforce how the results align with the study's stated objectives, Table 1 presents a summary of the major findings organized by research goals.

Table 1. Summary of findings by research objective

Objectives	Summary of Findings
1. Identify key technical skills and software tools in SCM	Skills in forecasting, inventory planning, procurement, and data interpretation were emphasized. Tools included Excel, ERP modules (SAP and Oracle), Power BI, and CRM systems.
2. Explore the role of emerging technology in SCM	Firms highlighted automation, dynamic modeling, and integrated data systems. Advanced users employed Power BI, Quantrix, and integrated ERP-CRM platforms.
3. Develop actionable teaching recommendations	Emphasize spreadsheet logic, cross-functional coordination, ranges, and realistic case-based instruction to prepare students for diverse roles.

4.1 Demand Planning

A major objective of demand planning is to forecast sales of each SKU in future periods, but it involves more than just creating a table of forecasts. Supply chain management explicitly recognizes that these forecasts will be inaccurate, and contingency plans must be established to accommodate prediction errors. Demand planning also requires making decisions about how many resources to devote to different SKUs and customers. For example, companies often perform consumer segmentation, where they "focus on their most valued customers and place a high priority on knowing their needs." This might involve asking the customers to order in advance through contracts and "rewarding them to do so with price discounts." Other customers and SKUs may contribute much less to company profits; in this case, demand planning may simply assume that "future demand will resemble historical demand." The point is that this activity is not just a matter of forecasting future sales based on historical data, though it is part of the process. Demand planners are also tasked with understanding changes in the industry in a way that the time-series models cannot, using this experience to make reasonable judgments about future sales, but also "anticipating all the different ways those predictions will be wrong and their associated consequences" for company profits.

It will not surprise agribusiness instructors to learn that spreadsheets are relied upon to "store, analyze, and communicate historical sales with the intention of predicting the future." It is clear from all the interviews that spreadsheets are "ubiquitous in all stages of supply chain management, and any agribusiness program that neglects spreadsheets is in need of modernization." However, it is also clear that in many companies, the datasets that demand planners access are "too large for spreadsheets to handle," in which case they use either dashboard software or SQL coding. Here, dashboard software refers to programs like Tableau and Power BI that can accommodate large amounts of data within a user-friendly interface containing pivot tables. We refer to Tableau and Power BI as dashboard software because they are dynamic, attractive, and versatile. Both Tableau and Power BI treat data imported as databases that can be linked to one another, where any transformations of the data that take place are made in new database tables. The data are typically analyzed in pivot table fashion, where the user indicates what database fields belong in rows and columns for cross-tabulation, using an unlimited number of filters. These software packages are relatively easy to use and learn, especially if one is familiar with using pivot tables in spreadsheets.

One interviewee in a food retail company uses Power BI on a daily basis. Their company's IT staff set up a series of charts that automatically update as new sales data arrives, so that all they must do is "monitor the dynamic charts." Another interviewee takes advantage of Power BI's powerful time-series functions, which include "canned" forecasting models. When forecasting sales, they often "download the data and filter it to the dates and SKU of interest, and then have the software automatically generate sales forecasts for the future in attractive charts." The forecasting tool has a number of options, like seasonality and adjustments to the smoothing factor used (it uses an exponential smoothing model). This demand planner relies not just on the forecasting model but will "also download the filtered data into Microsoft Excel and perform a more intensive analysis, separating sales by client and accounting" for what clients have told them about anticipated future sales. Here, the forecasting tool is part of the analysis because it is so easy to use, but it would only be used as the sole forecasting source for SKUs that are a relatively minor part of the business.

Two other demand planners dealt with "such large amounts of data that hard coding was required; canned software could not accommodate the data, or if it did, ran excessively slow." One demand planner at a different food retailer opted to "simply learn SQL code for themselves, something they never encountered in college." Through tutorials on the internet, they learned to write SQL code in Microsoft Visual Studio to output customized tables. (SQL is "structured query language" and is the universal code for interacting with databases.) The other interviewee was "in the process of seeking alternatives" at the time of the interview and was leaning toward "learning how to use Python and the SQL language."

Based on these interviewees, we make the following suggestions for an agribusiness program. First, consider providing all students with extensive exposure to dashboard software. They are designed to be user-friendly, and students have shown the ability adapt fairly quickly. A deeper dive into its capabilities, for example, data analysis expression (DAX) functions in Power BI, can be conducted quickly to demonstrate its more sophisticated features. A program without the resources to include DAX functions in its curriculum can still prepare students by ensuring the spreadsheets curriculum addresses functions like DATE, VLOOKUP, and the like.

Agribusiness courses addressing advanced quantitative topics may consider adding SQL coding within existing regression analysis lectures. This approach would benefit students interested in working for large-scale firms (e.g., those requiring SQL knowledge) as well as students who may work at smaller-scale firms where SQL coding is not necessary. We find that most data analysts are not trying to create models but simply "trying to access the data they need," which usually pertain to historical sales for clients in certain time periods. An advantage of teaching SQL is that it arises in other contexts as well. For example, most web pages connect to one or more databases, and those connections are facilitated through SQL. Another advantage of SQL is that it requires many students to perform hard coding for the first time, a skill that should perhaps be universally taught in our age, and one that will aid students later pursuing graduate degrees.

Appendix B provides four video tutorials used by one of the authors to prepare students for demand planning. Each tutorial concerns a data analysis project required of students in a supply chain management class. One uses Power BI, one uses spreadsheets, and one uses Microsoft Access for SQL. These tutorials are specifically designed for students who have never been exposed to the software. The data used in the tutorials is provided in the video description.

4.2 Master Scheduling

Once demand planning has identified a set of sales forecasts for each SKU and future time period, this information will be sent to a different team to establish planned production. This is referred to as master scheduling because the planned production will be entered into a table referred to as the master schedule. For each SKU (in rows) and future time period (in columns), the table will show a variety of information. The exact information listed varies across companies, but typical entries are (1) the forecasted sales, (2) customer orders already placed, (3) projected beginning inventory, (4) planned production, (5) projected ending inventory, and (6) available to promise.

Different teams are used to construct planned production than those used to forecast sales because the two teams have different information specialties. Companies may have numerous production sites or may even outsource their production, and each of those production centers has different capabilities and constraints. One interviewee described how “they do not own any production sites themselves but instead rely on external producers” described as either tollers or custom manufacturers, the difference being tollers require the company to “provide the raw materials and packaging, and do not provide quality control.” This interviewee spends much of their time taking sales projections and working with tollers and custom manufacturers to determine “where production of each SKU will take place and when.”

Once production is planned, information is then “sent downstream into the company to sales in the form of available to promise information.” This is the amount of planned production that has not been reserved for a customer and can be promised to a client. The salespeople receiving this information may never interact with the master schedulers; to “avoid having to renege on a sales agreement, they need this information in real time.” Moreover, because production may take place in discrete time periods whereas sales occur more continuously, available to promise numbers cannot be calculated as a single formula in a spreadsheet. It requires more advanced programming, and so spreadsheets alone are not an ideal form of information sharing between master schedulers and sales.

There are software packages designed explicitly for master scheduling, and they are typically embedded in ERP software designed as one system that brings together all the data in a company, including planning for supply chain management but also accounting and finance. This software is designed such that the users do not need “hardly any knowledge of spreadsheets or computer coding.” Each company differs in its needs, though, so ERP software typically needs to be customized for the company. The result is that such software can “cost hundreds of millions of dollars.” For this reason, most of the companies we interviewed use less expensive but versatile software for master scheduling, but it is “essential that this software be able to interact with the software used by sales and material requirements planning.”

Although much of supply chain management is computerized, it is important that students understand the concepts programmed into the software. Consider how accounting is integrated into agribusiness curricula. While most accounting activities are performed using software, we still ask students to complete balance and income statements by hand to ensure they understand what the statements mean. Similar exercises can be used in regard to master scheduling. Appendix C provides a sample question, where a partially completed master schedule is present to the student, showing the planned production schedule and demand forecasts for the near future. The student is then asked to complete the project available balance, beginning on hand inventories, and available to promise (ATP).

Appendix B shows an example of an exam question regarding master scheduling. The master schedule table is provided and the forecasts, master production schedule, and beginning inventories are provided, and the student is asked to fill in the empty cells, demonstrating they understand how projected available balances and available to promise numbers are calculated. This is akin to asking students to construct accounting statements like balance and income statements by hand, despite the fact that accounting is almost entirely computerized.

4.3 Material Requirements Planning

The previous section described two-way communication between master scheduling and sales, facilitated by sales forecasts and ATP information. There is also an exchange between master scheduling and material requirements planning. This is the activity of ensuring the raw materials and other inputs like labor and factory space will be available to allow planned production to take place. To calculate the input needed, most companies will have something called a bill of materials, which is a model dictating how many units of each input are needed to produce one unit of output of a given SKU. It is essentially a model of inputs to output. This model will be stored in database form; once a master production schedule is set, the numbers are sent through the bill of materials to the material requirements planners to determine the number of inputs needed at each production facility in each period. Of course, if production plans change—as they often do—then the material requirement planners will need to be notified immediately to ensure the new plan is feasible.

With the exchange of information between production planning and sales, this exchange between production planning and material requirements planning requires software that shows information in table form and is accessible to many users but allows each user to edit only a portion of the tables. This could be accomplished with spreadsheets stored in the cloud and accessible by multiple people, but interviewees expressed concern that "having multiple people with the ability to edit the spreadsheet creates problems." A person might accidentally delete a formula without knowing, resulting in errors that may not be detected for some time. While spreadsheets allow cell protection, it is difficult to clearly allow some users to edit some portions of the sheet but not others.

One company used Quantrix software, which is designed for financial modeling but supports broader scenario planning. The firm developed interlined, spreadsheet-like sheets for demand planners, master schedulers, and material requirements planners. These dynamic tables automatically updated across sheets and time periods while restricting editing access to specific teams. The firm also used a centralized model to calculate input needs from production schedules using bill of material logic.

While only one company in the sample used Quantrix, its structured modeling approach demonstrates how spreadsheet-based skills, like dynamic table design and formula logic, can prepare students for more advanced tools. Teaching students to name tables and use named references in Excel may help them transition more easily to similar modeling environments.

In addition to obtaining the inputs needed for production, master schedulers and material requirements planners may work together (or establish a separate team) to ensure the long-term overall plan is consistent with capacity constraints. For example, a production plan may seem feasible when each SKU is considered separately, but jointly considering production for all SKUs may require more factory space than is available or a quantity of labor that would force the business to pay overtime to workers. To avoid this, businesses often perform something called "rough cut capacity planning" (RCCP), sometimes called capacity bottleneck analysis, where the total inputs, including labor, factory space, machine use, and the like are "calculated merely to verify that the overall plan is possible."

There are, of course, sophisticated software programs a large company can use, and it is likely a company's ERP software will contain one. However, as is typically the case, some companies will "create their own RCCP tool or find one available for free or purchase online that can be adapted to the particulars of the business." A simple web search will reveal many spreadsheet templates available for free. Learning sites like Udemy have inexpensive courses on RCCP with such spreadsheets available for download. These sheets tend to be simple in calculations but sophisticated in their user interface. For example, one sheet has cells adjacent to important calculations (e.g., percentage of factory floor space used) that "show green, yellow, or red lights according to whether the production plan is dangerously close to capacity constraints."

Having students use such sheets in class to perform a RCCP analysis can expose them to the high functionality of spreadsheets. Some websites even have tutorials on how to build one yourself. These tutorials often end by showing the user its drawbacks, like its limitations in collaborative use and the time consumed in its construction, then providing the user with better options (that one can purchase from the company that provided the tutorial, of course). Using these sheets allows an instructor to simultaneously convey principles of supply chain management and spreadsheet design, the latter of which is a beginning step toward programming.

4.4 Procurement

Once a supply chain strategy has been set, procurement is tasked with "ensuring the raw materials will be available when needed." This often involves perusing the website of an input supplier and "making purchases as one would shop at Amazon," which consumes an unacceptable amount of time. One interviewee in a small business showed us how he spends hours each week on such a website and how it consumes much of his time because he has "to make frequent purchases due to the perishability of his product and low inventory holding capacity." Larger businesses find this unacceptable and use software to make procurement more efficient.

One company uses software like COUPA or Ariba to create a network of regular suppliers for which an automated order and payment can take place when inventories reach a minimum level. Within these software programs are punchout catalogs, which make procurement as simple as shopping at Amazon. There are also bots that make automating tasks like emails as simple as recording a macro in Excel. Moreover, automation does not just increase the speed at which transactions take place but "improves the quality of the data on historical purchases," allowing procurement managers to better mine data for improving decision-making.

Procurement performance is managed in various ways, utilizing a range of metrics. Some companies hold monthly meetings where they evaluate metrics like (1) which suppliers are delivering on time, (2) how many times are people having to "touch" a transaction and, (3) what type of purchases result in a suspension, meaning an invoice is not paid due to a price mismatch or confusion of delivery dates. Performance metrics are analyzed using software like Power BI, Tableau, SAS Visual Analytics, and Alteryx that make it easy to import data and visualize results in a dashboard format (Giunipero et al. 2012).

It is clear from the interviews that while some software is specifically designed for a single activity in supply chain management, spreadsheets and dashboard software are used throughout the supply chain, emphasizing the need to expose students to both.

4.5 Client Relationship Management

SCM concerns the entire flow of resources, from the raw materials to the consumer, and IT is just as important at the end of the flow, where the company and consumers interact, as upstream locations. Software is important in sales because, like much of the supply chain, it involves teamwork. The organization of sales teams differ, but a stylized version of a modern salesforce can be described as "inbound sales," where the company creates a variety of content designed to draw potential customers to their website or place of business, at which point the sales team makes contact with the prospect.

For example, a company may provide a free online tutorial on how its product works, but watching it requires the user to "register" and provide their email address. The moment the email is submitted, it enters a client relationship management (CRM) software, as will all subsequent activity regarding that contact. The typical inbound sales process involves the prospect interacting with a business development representative (BDR), then an account executive (AE), and finally an account manager (AM), with sales engineers in the background ensuring an effective and pleasant flow for the prospect.

The job of the BDR is to identify leads and make contact to conduct a "discovery call" where the BDR learns about the leads' goals and "pain points." This is not a generic sales pitch but an opportunity to learn the specific challenges faced by the lead in which the product may be useful. All emails and phone calls made to a lead asking for contact will be recorded in the CRM. Even if the BDR encounters them in person, the encounter will be recorded in the CRM. All efforts made to contact a prospect are generally referred to as "touchpoints" and will be recorded in the CRM. Some sales teams even automate the process within the CRM, setting up a sequence of emails to be sent at different times. Clients who receive a "happy birthday" email from a salesperson are usually on the receiving end of an automated CRM process.

If and when the lead agrees to a conversation, the BDR will record notes of the dialogue, and if conducted electronically the entire conversation may be recorded within the CRM. If it is determined that the product being sold can help a lead's pain points, the prospect is then transferred to an AE who will then meet with the lead and further explore their goals and how the product may help, hopefully resulting in a sale. All of this, too, is recorded within the CRM. Once the sale is made, an AM will assist the customer with the product and provide customer service, using the CRM to store information on sales, problems, and conversations. With everything hosted and recorded on the same software, companies can accommodate sales employee turnover without losing much knowledge about the client. A new BDR/AE can take over an account, study its history in the CRM, and keep the company-client relationship intimate and mutually beneficial.

The process will loop back to the AM, as they seek to meet with the client, ensure the product continues to meet their needs, and explore other ways the company can provide value. Before meeting with a current client, the AM will likely refer back to the CRM and utilize its data analysis features (often resembling dashboard software) to study their historical purchases. It is not uncommon for the salesperson to know more about the clients' purchases than the clients themselves, and it is the CRM software that makes this possible.

There are a variety of CRMs, from the popular and sophisticated versions sold as Salesforce to free, more minimalist versions. Most are relatively easy to use, so simply making students aware of the ubiquity of CRMs in sales will help them understand the modern world of sales. An alternative to giving students hands-on experience with a CRM is to note that one of its main benefits is its ability to store and share information within teams whose members can evolve over time. There are other types of software that do the same but are better suited to classroom activities. An example is Microsoft Teams, one of the most widely used platforms for groups of people to share and collaborate. For class assignments that require groups, requiring them to share all their files, meeting information, discussions, and ideas on Microsoft Teams would help prepare them should they join the world of sales and begin using CRMs. When we asked one interviewee which software improved their efficiency the most, they quickly named Microsoft Teams due to the ease in which it allows information and dialogue within a predetermined group of people.

5 Conclusions and Recommendations

This study highlights the necessity of equipping students in agribusiness SCM with the technical skills and practical knowledge required to navigate the complexities of modern supply chains. The findings reveal that demand planning, master scheduling, and material requirements planning are integral activities that demand proficiency in tools like spreadsheets, SQL, and dashboard software. Such tools allow for precise forecasting, resource allocation, and production planning, reflecting the emphasis on data-driven decision-making in SCM (Tsolakis et al. 2014). The interconnected nature of these activities, where changes in one area affect others, aligns with the concept of integrated supply chain strategies that prioritize communication and coordination across departments (Pagell and Wu 2009). Furthermore, the study's focus on hands-on experience resonates with the need for students to work with real-world data and advanced technologies, as highlighted in research on using visualization tools like Power BI and Tableau to enhance decision-making and improve supply chain visibility (Saberi et al. 2019). These findings emphasize the importance of teaching technical competencies alongside fostering an understanding of strategic integration to prepare students for the multifaceted challenges of agribusiness supply chains.

Extending SCM all the way downstream to the consumer involves CRM software, an almost ubiquitous form of software used by sales teams. While this is more difficult to involve in classes that are not exclusively about sales, other software designed to facilitate the sharing of information and hosting discussions like Microsoft Teams can be used. Microsoft Teams has the added advantage that, not designed specifically for the field of sales, it can be used as a platform for other segments of the supply chain. For example, students can be placed into groups representing (1) demand planning (2) production planning and (3) materials requirement planning, with each group required to agree on an overall plan and share information without ever meeting in person, but through software like Microsoft Teams.

This study highlights critical skills and tools for agribusiness SCM but has some limitations. It focuses on demand planning, master scheduling, and material requirements planning, which do not encompass the full scope of supply chain activities such as logistics or supplier network optimization (Tsolakis et al. 2014). The reliance on insights from a small number of interviewees may limit the generalizability of the findings, as the perspectives reflect specific organizational contexts (Pagell and Wu 2009). Additionally, while the study emphasizes technical skills like SQL and dashboards, it does not address the importance of interpersonal skills such as collaboration and leadership, which are critical for managing cross-functional supply chain operations (Saberi et al. 2019). Expanding future research to include a broader range of supply chain activities and perspectives would provide a more comprehensive view of the skills needed in the field.

The results of this study are supported by existing research on the critical components of agribusiness supply chain management education. Tsolakis et al. (2014) describe the hierarchical decision-making framework in agrifood supply chains, which underscores the importance of aligning strategic, tactical, and operational activities. This framework validates the focus on demand planning, master scheduling, and material requirements planning as integral processes that must be managed cohesively. The study's findings, which emphasize the need for technical skills like data analysis and proficiency in tools such as spreadsheets and dashboard software, are also consistent with the emphasis on data-driven decision-making in agribusiness supply chains.

Saberi et al. (2019) highlights the importance of advanced tools like Power BI and Tableau for improving supply chain visibility and supporting real-time decision-making. These tools facilitate efficient communication and allow for the analysis of large datasets, aligning with this study's findings on the importance of equipping students with these technical skills. The ability to create dynamic dashboards for forecasting and performance analysis prepares students for the demands of a data-intensive industry. Pagell and Wu (2009) validate the emphasis on cross-functional integration, stressing the necessity of coordination across all supply chain processes. The interconnected nature of demand planning, production scheduling, and procurement described in this study mirrors the integration required to manage supply chain complexity effectively. This demonstrates the importance of preparing students to understand and manage the relationships between these processes. Additionally, the study's focus on experiential learning aligns with Ivanov and Dolgui (2021), who emphasize the importance of practical tools and methodologies in building supply chain resilience. While this study does not address digital twins or similar advanced technologies, its emphasis on hands-on training with SQL and spreadsheet-based modeling provides a parallel approach to preparing students to tackle real-world supply chain challenges. Exposure to such tools ensures that students can bridge theoretical knowledge with practical applications, enhancing their readiness for professional roles.

The findings related to procurement and supplier evaluation are supported by Tsolakis et al. (2014), who highlight the role of performance metrics in managing supply chain relationships. By teaching students to analyze procurement data and assess supplier reliability, educational programs address a critical area of SCM that impacts cost efficiency and operational success. The study's conclusions are validated by these findings, which reflect the evolving demands of agribusiness supply chains. By focusing on technical skills, collaborative decision-making, and practical training, educational programs can effectively prepare students to excel in the complex and dynamic field of SCM. While many of the tools and systems discussed are used by large-scale agribusiness firms, the core principles of supply chain management—such as forecasting, procurement planning, and coordination—remain critical for small and medium-sized businesses. These firms rely more heavily on foundational software like Microsoft Excel, Google Sheets, or QuickBooks, and SCM roles may be filled by generalists rather than specialists. Emphasizing transferable skills in SCM education can better prepare students for a broader range of career paths, regardless of firm size.

Instructors can enhance skill development in agribusiness SCM by incorporating hands-on training with tools that reflect real-world industry practices. Teaching students to use dashboards like Power BI or Tableau can help them analyze large datasets, visualize trends, and create actionable insights for decision-making. Practical assignments such as building dashboards for forecasting sales or segmenting customers based on demand can provide students with technical experience while reinforcing their ability to think strategically (Saberi et al. 2019). Including projects that involve querying databases using SQL can also strengthen students' data management capabilities, an essential skill in modern supply chains. Instructors should emphasize integrated learning by designing exercises that simulate cross-functional supply chain coordination. Projects could involve aligning demand forecasts with production schedules and ensuring the availability of raw materials through material requirements planning. These exercises can mimic real-world scenarios where collaboration across demand planning, scheduling, and procurement is critical (Pagell and Wu 2009). Group-based activities can also provide students with experience in teamwork and communication, which are vital in managing interconnected supply chain processes. Providing exposure to advanced technologies used in agribusiness supply chains, such as ERP systems, can further prepare students for professional roles.

While access to proprietary systems may be limited, instructors can simulate their functions using accessible tools like spreadsheets or specialized software for inventory management and procurement analysis. Assignments focusing on supplier performance metrics or inventory optimization can give students insights into how these systems support strategic supply chain decisions (Tsolakis et al. 2014). Table 2 summarizes the software discussed and options to integrate them into agribusiness curriculum. Finally, educators themselves should stay informed about emerging trends and tools. Participating in professional development programs, collaborating with industry professionals, and inviting guest speakers can help instructors bring up-to-date practices into the classroom. These connections can also provide opportunities for students to engage with professionals, enhancing their understanding of current challenges and opportunities in agribusiness supply chains. By focusing on these strategies, instructors can create a dynamic and practical learning environment that equips students with the technical and strategic skills needed to excel in supply chain management. This approach ensures that graduates are prepared to contribute meaningfully to the evolving landscape of agribusiness supply chains.

Table 2. Integrating SCM software in curriculum

Software	Resource Value	How to Include in Curriculum
Microsoft Excel (advanced functions)	Widely used for forecasting, budgeting, and inventory management; familiar interface for students	Use in assignments involving breakeven, cash flow, and scenario planning using `VLOOKUP`, `IF`, and date functions
SQL (Structured Query Language)	Industry-standard for querying relational databases and managing large datasets	Introduce in agribusiness analytics courses; assign query-building tasks using sample databases
Power BI / Tableau (dashboard tools)	Enables interactive visualizations for sales, inventory, and supply chain KPIs	Use for visual assignments in marketing, logistics, or data management classes
ERP Simulations (e.g., SAP, Oracle demos)	Models integrated data flows across production, inventory, and procurement functions	Incorporate ERP role-play or free online demo cases in SCM or operations modules
Microsoft Teams / Google Drive	Facilitates team-based communication and information sharing across supply chain roles	Use for collaborative group projects (e.g., demand vs. procurement coordination) across planning scenarios
CRM Software or Simulated Forms	Tracks customer interactions; improves understanding of sales processes and client management	Use free platforms to simulate CRM flows or map out sales funnel activities in marketing courses

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Appendix A: Teaching Supply Chain Management and Logistics Through Computer Software Semi-structured Interview Guide

Thank you for meeting with me today. As we discussed, we are interviewing industry professionals to garner information about how they use software to model, analyze, and solve supply chain and logistical issues in food and agriculture sectors. We hope to learn your perspective on how helpful these tools can be for students pursuing careers in these and similar roles.

Your name will not be associated with any information reported from this research, or future research. We will assign you a pseudonym, so all of your responses will remain confidential. If there is a question you prefer not to answer, please just say so.

(1) What is your main focus when interviewing a newly graduated college student? i.e., what knowledge are ERP, SCM, or software do you ideally want them to have?
(2) Coursework is focused on concepts of SCM. However, students often lack knowledge and understanding of the specific software. What are some of the softwares you use? i.e., what softwares should new professionals be familiar with to get a "leg up" in the job market?
(3) How much time in a given week would you say you work in Excel versus other software? What are the main software you utilize in your role?
(4) Wrap up question: Are we missing anything? Are there any questions we should have asked that you believe is important?

Appendix B: Publicly Available Computer Exercises Regarding Demand Planning

Assignment Type	Tutorial Video Address (data used in tutorial provided in video description)
Prepare for a sales call by downloading and reviewing historical demand data for a specific customer using Power BI	https://www.youtube.com/watch?v=NZiBHtZ1nc4
Conduct ABC segmentation for different SKUs using spreadsheets	https://www.youtube.com/watch?v=nc-jvO2xz2Q
Create optimal input inventory management strategy for different input SKUs in Power BI	https://www.youtube.com/watch?v=XiNnm2mhn-M
Retrieve historical sales data using SQL in Microsoft Access	https://www.youtube.com/watch?v=f8nBp6RUC8E

Appendix C: Sample Question Regarding the Master Schedule

It is currently the **beginning of March**. Complete the Master Schedule below by filling in the blank cells. *Forecasts have already been adjusted for customer orders. You do not need to consume the forecast.*

Master Schedule	March	April	May	June	July
Forecasts (units per month, forecasted sales above orders placed)	234	271	441	700	400
Customer orders	0	50	0	50	0
Safety stock	n/a	n/a	n/a	n/a	n/a
Master production schedule (units produced per month, also called *scheduled receipts*)	300	300	400	1,200	0
Beginning on-hand inventory (units)	20				
Projected available balance (units at end of time period)					
Available to promise (ATP)					

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