
**MODELLING OF CITRUS PRODUCTION AND EXPORT PROCESS:
EASTERN MEDITERRANEAN REGION OF TURKEY**

**TURUNÇGİL ÜRETİM VE İHRACAT SÜRECİNİN MODELLENMESİ:
DOĞU AKDENİZ ÖRNEĞİ**

**МОДЕЛИРОВАНИЕ ПРОЦЕССА ПРОИЗВОДСТВА И ЭКСПОРТА
ЦИТРУСОВ: ВОСТОЧНЫЙ СРЕДИЗЕМНОМОРСКИЙ РЕГИОН
ТУРЦИИ**

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ABSTRACT

Although the citrus fruits grown in Turkey are table fruits with high export values, the incompatibility between the production methods and the standards demanded by importing countries is one of the primary factor limiting the exportability of the citrus fruits. In this context, there is a need for a horizontal organizational model encompassing the co-ops and unions of producers and exporters to improve the effectiveness of exports.

The aim of this study is to determine the effects of integrated planning within the citrus sector to the competitiveness of Turkey and to form a dynamic system model. With the model to be developed, attempts will be made to test the benefits of the alternative integration models in the regional scales.

This study is made on the citrus exporting firms in Mersin province, which was selected as the sampling area of the eastern Mediterranean Region. For this purpose, out of the 55 firms operating within the provincial borders of Mersin, three firms which manage their own operations from production to final delivery were selected. During the face-to-face interviews done with the firms' representatives, a semi-structured questionnaire form with 12 open-ended questions was used. The data were collected through in-depth interview technique.

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It was noted that, despite of certain differences, the firms which were interviewed purchased the fruits needed for exports directly from the producers, before the harvest, and they did the processing in their own facilities. It was understood that, the quality control was done by eye in the orchards, during cutting, at the first entry to processing, and before and during the final loading.

Through the model used in this study, it is concluded that, establishing horizontal integration in regional scales will improve the performances of stakeholders and the time to procure the fruits in the standards demanded by the sector will be reduced when a consolidated purchasing strategy is implemented.

In conclusion, an integrated model where the stakeholders combine their production volumes and strengths in citrus sector will boost the stakeholders' competitiveness and profitability. Since this model will also help reach a certain standard in the production of the fruits, it will increase the amount of fruits fit for exports and help achieve a near-export level of quality in domestic markets, as well.

Keywords: Turkey, citrus, modelling, horizontal integration, exporting, Simio, simulation

ÖZ

Türkiye'de yetiştirilen turunçgil ihracat değeri yüksek sofralık meyveler olmakla birlikte, üretim yöntemleriyle ithalatçı ülkelerin talep ettiği standartlar arasındaki uyumsuzluk turunçgil ihracatının gelişimi önündeki önemli kısıtlardan biridir. Bu kapsamda ihracatta etkinliği artırmak için, içinde üretici ve ihracatçı kooperatif/birliklerin yer aldığı yatay bir örgütlenme modeline ihtiyaç vardır.

Bu çalışmanın amacı; turunçgil sektöründe entegre planlamanın Türkiye'nin rekabetçiliğine etkisini belirlemek ve dinamik bir sistem modeli oluşturmaktır. Geliştirilecek model ile turunçgil işleme süreçlerinde alternatif entegrasyon modellerinin, bölgesel çapta sağlayacağı faydalar sınanmaya çalışılacaktır.

Araştırma Doğu Akdeniz Bölgesi'nden örnek olarak seçilen Mersin ilinde turunçgil ihracatçısı firmalar üzerinde yapılmıştır. Bu amaçla Mersin il sınırları içinde faaliyet gösteren 55 işletmeden, üretimden son teslimata kadarki faaliyetlerini bizzat yöneten üç (3) işletme belirlenmiştir. İşletme yetkilileri ile yapılan yüz yüze görüşmelerde, araştırmacılar tarafından geliştirilen ve 12 açık uçlu sorudan oluşan yarı yapılandırılmış görüşme formu kullanılmıştır. Veriler derinlemesine görüşme tekniği ile elde edilmiştir.

Araştırma alanında görüşülen firmaların ihracat için gerekli ürünü doğrudan üreticiden ve hasattan önce aldıkları, bazı farklılıklarla birlikte; ihraç edilecek meyveleri işleme firmalarının kendi tesislerinde yapıldığı görülmüştür. Kalite kontrolünün bahçede, kesimde, ürünün işletmeye ilk girişi ile yükleme öncesi ve sırasında gözle yapıldığı anlaşılmıştır.

Araştırmada kurulan model ile bölgesel ölçeklerde yatay entegrasyona gidilmesinin, paydaşların performansını artıracığı, ortak alım stratejisi uygulandığında, sektörün gereksinim duyduğu standartta ürünün tedarik süresinin kısılacağı sonucuna ulaşılmıştır.

Sonuç olarak; turunçgil sektöründeki paydaşların üretim hacimlerini ve güçlerini birleştirebileceği entegre bir model tarafların karlılığını ve rekabet gücünü artıracaktır. Aynı zamanda bu model, ürünlerin üretiminde belirli bir standarda ulaşmayı sağlayacağından, ihracata uygun ürün miktarını artıracak ve iç piyasada da ihraç ürünlerine yakın bir kalite düzeyi yakalanacaktır.

Anahtar Kelimeler: Türkiye, turunçgil, modelleme, yatay entegrasyon, ihracat, Simio, simülasyon

АННОТАЦИЯ

Несоответствие требований к стандартам продукции, определяющихся странами-импортёрами, является главным фактором, ограничивающим возможность экспорта цитрусовых. Данное исследование провозглашает необходимость новой, горизонтально интегрированной модели менеджмента для увеличения конкурентоспособности турецкого цитрусового сектора на мировом рынке.

Исследование сфокусировано на фирмах-экспортёрах цитрусовых в провинции Мерсин, которая была выбрана для репрезентации Восточно-Средиземноморского региона Турции. В ходе переговоров, проведенных с представителями фирм лично, была использована техника полуструктурированного интервью. Сведения были собраны в ходе подробного интервьюирования.

Потенциальные преимущества представленных региональных центров обработки данных в вертикально-интегрированной цепи поставок были протестированы с помощью моделей, созданных в программном обеспечении Simio Modeling Software. Модели сравнили, как двадцать гипотетических фирм с одинаковыми размерами выполняли заказы, получаемые в рамках разных политик заказов. В Модели-1 фирмы старались выполнять заказы обособленно, только из запасов, закупаемых наугад. В Модели-2 фирмы старались выполнять заказы обособленно, исходя только из количеств, указанных в заказах. В Модели-3 фирмы старались выполнять заказы с помощью регионального центра обработки данных, который закупает фрукты бессистемно.

Результаты показали, что фирмы, работающие самостоятельно, смогут выполнять заказы более эффективно посредством плановых закупок на суммы, обозначенные в заказах. Однако закупка обработанных фруктов из регионального центра могло бы сократить время доставки и/или уменьшить количество неиспользованных запасов.

Ключевые слова: Турция, цитрусовые, моделирование, горизонтальная интеграция, экспорт, моделирование, Simio

1. Introduction

The competitive nature of foreign markets has been forcing the producers and exporters to process their agricultural products according to specific global standards. For that reason, those who grow or deal with citrus fruits are now obligated to modify their production and processing methods according to the quality standards demanded by international markets (Paksoy et al, 2016).

Lack of compliance with the production standards demanded by importing countries, such as traces of chemical and pest residues on the fruits, is the primary factor limiting the exportability of the citrus fruits. The standards demanded by the European Union (EU) are especially high, due to the fact that the region is quite self-sufficient, in terms of production, consumption and exportation of citrus fruits. Improving the quality of exported fruits is highly important for entering and/or staying in the EU and other foreign markets.

Turkey's main citrus exports are lemons and tangerines, both of which have been increasing in production in recent years. Besides Russia and Iraq, Turkish citrus exporters are interested in exporting citrus to European countries, but they face strong price competition from other leading supplier countries, especially Spain. According to Turkish exporters, the biggest concern among citrus exporters is the

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export unit price which has been declining for years, despite the increasing product quality (USDA, 2019).

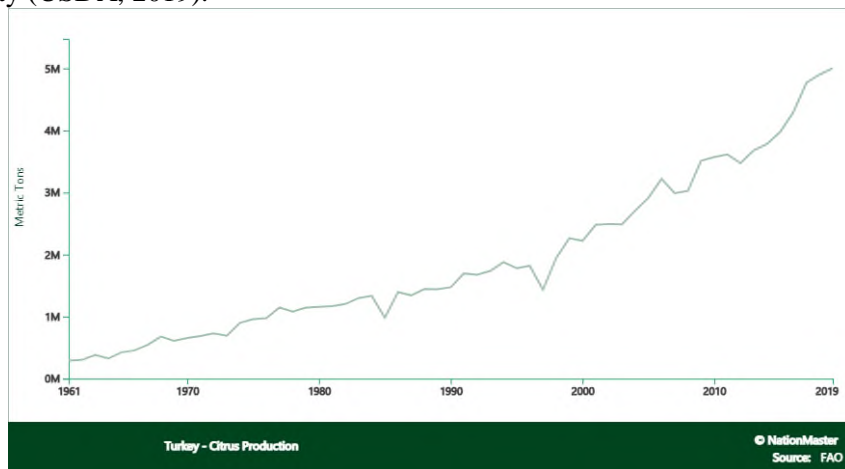


Figure 1. The changes in the citrus production of Turkey across the years (1961-2019)(Nationmaster, 2020)

According to FAO's 2019 statistics, Turkish citrus production grew by 2.1% compared to the previous year, and by 5.8% with respect to the last five years, placing the country at the seventh place among the world producers with a volume of 5,005,524 tons (Nationmaster, 2020). The citrus fruits produced in Turkey are highly exportable, edible types. Turkey's citrus production has increased by 120.6% between the years 2000 and 2018. The breakdown of this production is like 38.8% for oranges (1.9 million metric tons), 33.7% for mandarins (1.65 million metric tons), 22.4% for lemons (1.1 million metric tons) and 5.1% for grapefruits (250 thousand tons) (AKIB, 2019). The changes in Turkey's citrus production volume between the years 1961 and 2019 has been shown in Figure 1. Of the 2.6 million metric tons of citrus exports of Turkey, oranges have the greatest share with 40.1%, with mandarins, lemons and grapefruits following with 29.5%, 22.6% and 7.8% shares, respectively (TÜİK, 2018). According to the last five years' statistics the biggest five importers of Turkish citrus fruits are Russia, Iraq, Ukraine, Romania and Saudi Arabia (AKIB, 2016; AKIB, 2017; AKIB, 2018; AKIB, 2019; AKIB, 2020). Although the production amounted to 5,005,524 tons in 2019, AKIB (2020) reported that exports remained at 1,613,669.7 tons.

This study is born out of the notion that the current levels of Turkish citrus exports fall short of country's production potentials and may not even be sustainable, given the increasingly competitive nature of the international markets. The overall objective is to propose policies that will streamline the supply chains for the citrus fruits and make them more efficient at all stages, from the producing and collecting to the processing, packaging, all the way to making deliveries to the end buyers. For that purpose, the first step will be to examine how some other citrus exporting countries have streamlined or integrated their production, transportation and exportation processes.

Enriquez (1972) notes that marketing of Israel's citrus fruits is under the control of the Citrus Marketing Board. This board is the sole entity authorized and responsible for the sales of citrus fruits in national and international markets and also all the processes associated with the sales. In short, all the movements of the fruits are under the control of the Board. The Board provides for the transportation from the packaging facilities to the ports and finally to the end buyers, by also determining the routes to Europe, Far East, U.S.A. and Canada. This organization is managed through the arrangements between the producers' cooperatives and the Board. Cooperatives collect the fruits from the producers, package them and deliver them to the Board in accordance with the transportation regulations. The Board sets the compulsory standards for the selection, classification and packaging of the fruits, down to the appropriate materials for packaging and binding.

For the Republic of South Africa (Enriquez, 1972), the marketing of citrus products is under the control of the Citrus Board, which handles purchases and sales through the South African Cooperative Citrus Exchange. The Citrus Exchange oversees the agricultural production and meets the growers' needs about the orchards and packaging materials. The citrus fruits are sold in national or international markets through the Exchange. The Exchange controls and manages the supply not only to the global markets, but also to the domestic market. Tight guidelines have been established for all the processes, from the sources of production to making deliveries to the end buyers.

The citrus sector in the United States is largely in the hands of private merchants and growers' cooperatives (Enriquez, 1972). There are two large organizations that handle the production and marketing, in the two regions with the largest production volumes: The California-Arizona Citrus League of the Sunkist Growers and the Florida Citrus Commission. In the overall scheme, the agreements between the merchants and the cooperatives enable the growers to utilize the facilities that will process and market their fruits (Enriquez, 1972). In California, the League of Growers collects 75% of the citrus production and handles the washing, drying, packaging and storing of the fruits (Mülayim, 1992).

Not all countries have integrated their production, processing and sales of the citrus fruits in similar manners. For example, in Pakistan, the citrus fruits sector is dominated by small to medium sized establishments. The sizes of orchards range from 1 acre to 160 acres. In Punjab, the region with the greatest volume of production, the average size is 30.3 acres. The supply chain starts with the producers signing on pre-production contracts. Other actors in the marketing channels of the sector are the commissioners, wholesalers, retailers and the exporters (Siddique, 2018). As noted by Komarek and Ahmadi-Esfahani (2012), the multiple stages of the supply chain in Pakistan, as it is true in Turkey, not only reduces the profitability for the producers, but also makes it difficult and complicated to make decisions regarding the marketing of the fruits.

For Spain, 56% of the total production of citrus fruits go to exports, while 22% is consumed domestically and 17% is processed industrially (Mari and Peris, 2005). Primary buyers of Spain's citrus exports are EU countries, mainly Germany

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and France. Small sizes of establishments create problems that negatively affects the citrus fruit sector in Spain, despite of the competitive advantage in terms of quality. Higher production costs and the lack of mechanization are other negative factors. Cooperatives are effective in marketing of the fruits with a 34% share, but Mari and Peris recommend that cooperatives consolidate the production fields and rethink the overall management for achieving better productivity at lower costs.

With respect to their operational organizations, the firms which export citrus from Turkey are classified as i. producer-exporter, ii. only exporter, and iii. producer-packager-exporter. 55.2% of the firms fall in the producer-packager-exporter category, while 38.3% are only exporters and 6.5% are both producers and exporters. The firms which are closer to production areas generally purchase directly from the producers, while those further away procure the fruits mostly through traders and commissioners (Budak et al., 2016). The most prevalent forms of integration in Turkey are cooperatives and contractual agricultural production (Demirbaş and Tosun, 2005). In the Mediterranean Region where the citrus production is the greatest, 39.3% of the firms rely on contractual production (Budak et al., 2016). However, because the necessary legal arrangements have not been made, contractual production depresses the prices for the producers. The farmers are basically enslaved in their own fields. Those who provide the inputs demand certain amounts of fruits at the prices they set (Yıldırım, 2020).

When it comes to producers' cooperatives in Turkey, it is seen that they are very few in numbers and most of them do not possess sufficient strength in the marketing of citrus products.

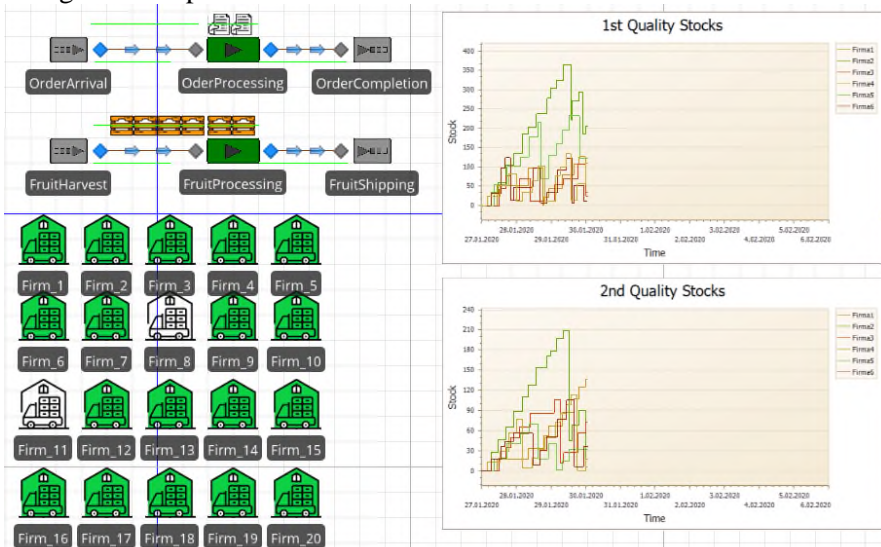


Figure 2 A simplified model of the stock changes of the firms which purchase, process and export independently

Moving from that finding, this study aims at determining how the competitiveness in global markets will be affected by the implementation of a horizontally integrated management model in the citrus sector where the producers

and exporters are highly interdependent. With the direct involvement of the producers' cooperatives and exporters' associations, strict quality standards required by global markets can be enforced not only throughout the vertically-integrated supply chains of individual companies, but also throughout the horizontally-integrated organizations overseeing the production, transportation and the sales of the citrus fruits.

Not being satisfied with the implementations of modern marketing functions, a system that will determine which products are demanded where, and at what price and with what quality can be established through integration. In this sense, horizontal integration means cooperation at a certain stage of the economic activities (Karacan, 1997). Today, horizontal and vertical integration are mostly achieved in agricultural and industrial operations in the world, especially in the EU (Demirbaşı ve Tosun, 2005). Horizontal integration is especially important in increasing the trade volumes and improving the competitiveness in foreign markets, in addition to providing advantages such as the rationalization of production, making it compatible with the markets qualitatively and quantitatively, and helping products reach the markets (Karacan, 1997).

In order to support this proposal, this study will present the diagnoses arrived through the interviews conducted with citrus exporting firms and the conclusions derived from a model of an alternative supply chain where the collection and processing of citrus fruits have been horizontally integrated, at least in a regional scale. It is presumed that horizontal integration of the harvesting and processing of citrus fruits will ensure greater compliance with stricter quality standards at the earliest stages of the supply chain. This will relieve the exporters from the burden of purchasing and processing their own supplies, while also helping them to gain and preserve better positions in the global markets. Regional collection and processing centers will also create a widespread awareness among the producers about the importance of quality standards, while also strengthening their bargaining positions against commissioners and merchants.

Other studies support this notion, as well. According to Aydemir ve Pıçak (2008), through the integration of agricultural and industrial operations, the trade volumes of these sectors expand, the competitiveness of business units improve, and the production becomes more efficient in both the agriculture and the industry. Small business score significant gains by reducing their purchasing and trading costs, as well as their management overhead. Especially in ensuring the integration of agricultural and industrial operations, it is generally accepted that the roles played by the cooperatives within the process will provide socio-economic benefits. Furthermore, it will be easier for the firms to ensure that they will obtain the necessary amounts of products at the desired qualities at the right times. According to Gürler et al. (2000), integration makes it possible to minimize the loss ratios during production and processing and increase efficiency. Furthermore, integration prevents the mutually-destructive competition between exporters. On the other hand, it will be possible to direct the production methods in accordance with the demands

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of the foreign markets, though the farmers may lack the necessary mindset and remain ignorant of the nature of the markets' demands.

In this study, Mersin was selected as the pilot region to study the feasibility of horizontal integration of citrus collection and processing. Having an important place in the agricultural production in Turkey, Mersin is the province with the third highest produce growing capacity. While Mersin province takes the fourth place in terms of the volume of the agricultural and food exports, it is the fifth province in terms of the agricultural income it generates. The agricultural and food products make up the 70% of the provincial exports and 62% of the provincial imports. The province produces 25% of the total citrus production of Turkey (about 1.2 million tons), while its share of the national citrus export volume is 37% (Yıldırım, 2019a). In summary, although Mersin is not the region with the largest production volume of citrus fruits, it has an important position in the citrus sector. As it will be understood from the conclusions drawn from the interviews, Mersin also demonstrates the most prominent problems faced in the collection, processing and the sale of citrus fruits.

2. Materials and Method

This study focuses on the citrus exporting firms of Mersin province, which was selected to represent the Eastern Mediterranean region of Turkey. Three firms were selected from the 55 exporting firms which are the members of Mediterranean Exporters' Association (AKIB, as abbreviated in Turkish). During the face-to-face interviews done with the firms' representatives, a semi-structured questionnaire form composed of 12 open-ended questions was used. The answers to those questions were noted down by the researchers simultaneously. The data were collected through in-depth interview technique.

Establishing regional processing centers is important in improving the logistic efficiency in the sector. Placing these processing centers along the main routes of collection and distribution will reduce the number of routes and trips, as well as distances and times of the trips. Additionally, environmentally harmful emissions by transportation will possibly be lower (Gebresenbet and Bosona, 2012).

Potential benefits of the proposed regional processing center in a vertically-integrated supply chain were demonstrated through models constructed with the Simio Modeling Software, which was used through an academic license granted to Mersin University. In these models, twenty hypothetical firms with identical sizes filled the orders they received with different purchasing policies: These comparisons, in turn, demonstrated the improvements in the efficiency that could be achieved through horizontal integration of the fruit processing operations in a regional scale.

- In Model-1, the firms tried to meet the orders independently, from the stocks of the fruits which they randomly purchased.
- In Model-2, the firms tried to meet the orders independently, through planned purchases made only for the amounts demanded in the orders.

- In Model-3, the firms tried to meet the orders through a regional processing center which purchased all the fruits as they are harvested.

Each model was run for a virtual time period of thirty days in which multiple runs were performed by varying the following parameters in the same manner across the models:

- The monthly amount of fruits demanded by the orders,
- The average quality of fruits demanded by the orders,
- The monthly amount of the fruits harvested from the orchards,
- The average quality of the fruits harvested from the orchards.

For the sake of simplicity, all virtual firms were assumed to have the same daily processing capacity and equal chances of receiving orders or making purchases. Another simplification was the assumption that only one unnamed type of fruit was traded and it could have only three levels of qualities, instead of myriad combinations of all the relevant characteristics, such as color, texture, flavor, taste, etc.

Testing the models with the parallel variations of the above-mentioned parameters allowed comparisons of the different purchasing strategies that could be followed by independently acting firms and the firms utilizing a regional processing facility.

3. Results and Discussion

The data obtained from the interviews is presented in this table below.

a. Data from Interview Questionnaires

Annual volume of exports	95,000 tons
Annual volume of purchases	100,000 tons
Primary Buyers of exports	Russia, Poland, Czech Republic, Slovakia, Romania, UK, Netherlands, Malaysia, Indonesia, Hong Kong, Iraq (2 nd quality)
Peak Period of Purchases	September-April, with volume varying with current market conditions
Quality Control Performed at	Entry to processing facility
Loss Ratio	1st quality: 4%-5% 2nd quality: 15%-20%
Reasons for losses	Impacts to skin, Bruising by branches, Improper picking Plant disease

Table 1. Exporting Firm #1

Annual volume of exports	24,250 tons
Annual volume of purchases	25,000 tons

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Primary Buyers of exports	Singapore, Malaysia, Indonesia, Poland, Germany, Syria (2nd quality), Iraq (2nd quality)
Peak Period of Purchases	August-September
Quality Control Performed at	Entry to processing facility Start of first fumigation Readying for final shipping
Loss Ratio	1st quality: 5% 2nd quality: 25%
Reasons for losses	Waiting for harvest

Table 2. Exporting Firm #2

Annual volume of exports	30,000 tons
Annual volume of purchases	30,000 tons
Primary Buyers of exports	Europe (60%-65%), Far East, Canada, U.S.A. (25%-30%) Middle East (5%)
Peak Period of Purchases	October-February
Quality Control Performed at	orchard picking entry to processing facility readying for final shipping
Loss Ratio	overall: 15%
Reasons for losses	Plant disease, Spoilage

Table 3. Exporting Firm #3

It should be noted that the firms interviewed for this study purchased citrus fruits directly from the producers, usually through pre-harvest contracts.

According to a report of the citrus sector prepared by the Chamber of Commerce and Industry of Dörtyol County, the first among the sources of procurement of the firms are the firms' own orchards (46%); following those are the purchases from pre-contracted producers (32%) and direct purchases from uncontracted producers (22%).

Despite of some differences in the interviewed firms' supply chains, it is clear that, for all the firms, citrus fruits harvested for exports go through the stages of transportation to processing facility, quality control through initial sampling, primary wash and drainage, fumigation, drying, yellowing, loading on machine, disinfecting in machine, drying, fumigation, initial drying, waxing, intermediate drying, sizing (mechanical or optical), coloring, packaging, cooling, labeling and loading for shipping. The interviewed firms performed all these actions in their own processing centers, at the cost of creating duplicate or redundant processing capacities.

Through the interviews, we also learned the ways the firms utilized manual labor. Though they did utilize skilled workers on payroll for many of the processing stages, such as caring of the contracted orchards and picking fruits from them, transportation, loading, quality control, final shipping, a majority of the workers (almost 10 times the workers on payroll) were employed temporarily. It was emphasized that the over-reliance on temporary workforce led to losses especially in superior-quality fruits which could have a better chance to be exported.

It was understood from the interviews that the quality control was mostly done through visual inspection by human eyes, in the orchard, during the pickings, at the entry points to processing facilities, and right before the final shipping. In this process, a portion of non-standard fruits may escape attention. At the time of delivery, the fruits which do not fit the quality expectations of the buyers may lead to partial or total loss of profits and prestige, due to rejections and returns. The interviewed firms put the ratio of returns between 3% and 6%. They also noted that the buying countries could also specify additional processing states, like Japan expecting an 11-day wait for grapefruit in cold storage, at 2°C (Exporting Firm #3).

b. Problems Noted in the Interviews and in the Literature

The small sizes of citrus orchards, which mostly appear like patchwork, create technical disadvantages in citrus production and raise the production costs (Budak et al, 2016). The firms interviewed for this study admitted that they were not successful in establishing and maintaining certain quality standards in the fruits obtained from the producers.

Furthermore, not all producers pay the same amount of attention on fruit quality and they are not equally reliable on adopting and maintaining standard practices. These factors make it difficult to fill the orders from international markets demanding top quality fruits. In order to avoid these difficulties, the firms which we have interviewed limit their purchases to small circles of reliable producers of high-quality fruits, at the risk of losing out on bigger orders or not being able to fill the orders in time, in cases of mishaps affecting the contracted producers.

The EU market is especially tough, due to the buyers' insistence on increasingly higher quality demanded at lower prices. Additional expectations of compliance with requirements, like socially responsible production and processing further increase the burden of exporting firms competing in that market.

The lack of standardization and supervision on citrus production make it rather difficult to obtain enough fruits that meet the increasingly higher expectations. Lately, traces of chemical and biological residues have been the more prominent reason for failing those expectations. Damage caused by Mediterranean fruit flies and the residues left by the pesticides used against them have shed a negative light on Turkish citrus exports, hurting not only the exporters' profits, but also the country's prestige. Many buyers in international markets, prominently Russia, have toughened their inspections of the fruits exported by Turkey (Yıldırım, 2019b).

The foremost reason for the continuing residue problem is the absence of standard practices for combating pests effectively and safely. Additionally, the firms which

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were interviewed expressed concerns about the problems arising from the reliance on largely untrained temporary workers, noting that improper picking, selecting and packaging causes additional losses for the fruits which have survived into the harvesting season.

The review of these problems has shifted the focus of this study from modeling a typical citrus processing facility to modeling the process of matching processed fruits to orders.

c. Assumptions and the Evaluation of the Proposed System

The firms interviewed for this study independently maintained their own vertically-integrated supply chains, in the sense that they performed all the work related to the fruits they intended to sell in the international markets, from the time before or at the harvest. The work involved transporting, processing, packaging, and finally, delivering the fruits to the end buyer. Every firm had to deal with the above-mentioned risks associated with the harvest separately. The capacity or the efficiency of the processing facility could ensure quick delivery on the orders, but not guarantee that the quality demands would be met.

Since the risks associated with unmet quality standards were mostly encountered during the growing period and the harvest time, there is a serious need to implement and enforce certain standard practices throughout whole regions where the citrus fruits are grown. These practices must involve standardized methods of soil preparation, consistent care for the saplings and trees, applications of chemicals in manners which will not leave residues by the time of delivery, etc. Independently acting exporting firms cannot enforce such practices on all the small producers they may have to deal with separately.

d. Modeling the Proposed System

In this study, a model of the proposed system with a regional processing center is compared against two models of the present situation with independently operating firms.

As mentioned above, the two models of the present situation involved firms trying to fill the orders by purchasing directly from the producers. In model-1, the purchases are made randomly, whereas in model-2, the purchases are made according to the demanded qualities and quantities. In these two models, the firms utilize their own –identical- processing facilities, whereas in the model of the proposed system they simply fill orders through purchases from the regional processing center.

I should be re-emphasized that, certain assumptions were made to make the comparison easier between the models, and certain parameters were selected to vary in the same manners across the models. These assumptions and selected parameters are explained below.

i. Fruit Quality

In all the models, one generic type of fruit was traded and it had three different quality levels, as 1 being the best quality level and 3 being the worst quality level that could be traded.

It was assumed that any harvest contained fruits with three different quality levels, but the proportion of those qualities within the harvest was specified by a Poisson distribution with the average harvest quality being the main parameter of the distribution. A harvest with an average quality of 1 would only contain fruits with level-1 quality¹, whereas the quality distribution would be like the following graphic for a harvest with an average harvest quality of 1.5:

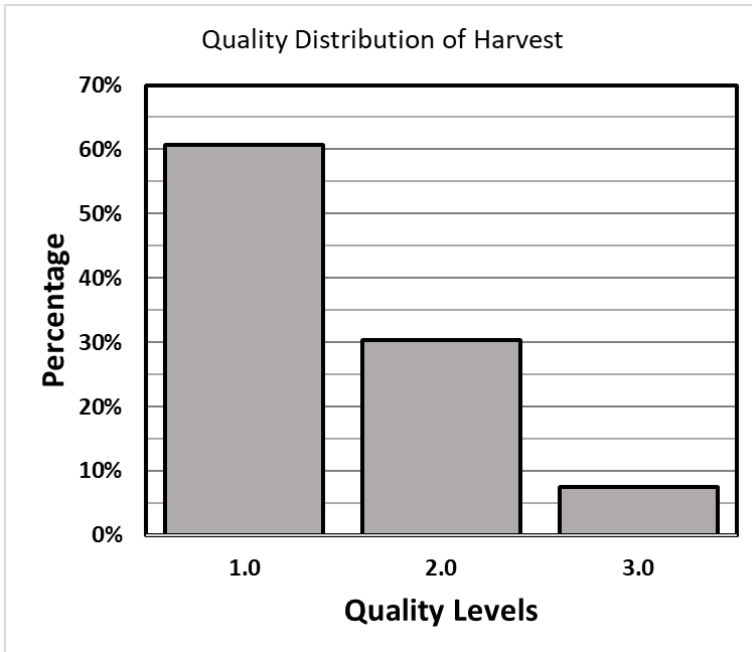


Figure 3. The Poisson distribution specifying the quality variation

It was assumed that any order would demand fruits of the same quality level, 1, 2 or 3. The quality levels demanded by orders in the run period of a virtual month was again dependent on a Poisson distribution. An average order quality of 1 would mean that all the orders received in one month demanded only fruits with level-1 quality. An average order quality of 1.5 meant that the distribution of the demanded qualities would be like in Figure 3.

Both the average harvest quality and the order quality was changed from 1 to 2 as the model test parameters. The model runs with these variations helped

¹ Mathematically, this is true for a Poisson distribution around average value of 0.

In these models, level-1 quality was taken to be the mathematical equivalent of 0.

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determine how well the horizontally integrated system would perform when the quality levels of harvests and orders did or did not match.

ii. Processing Capacity

In order to avoid superfluous variations resulting from disparities, all the firms were assumed to have equal chances of receiving orders and making purchases. In the two models where the twenty virtual firms operated independently, each had the identical processing capacity of 300 tons per day, which was the actual capacity of one of the interviewed firms.

In the third model with the regional processing capacity, the firms were assumed not to have separate processing facilities. In that model, the daily capacity of the regional processing facility could vary as the equivalent of 10, 15 or 20 firms' total capacity. The results from the model runs with these variations helped determine if a regional processing center would work more efficiently than independently operated processing centers.

iii. Sizes of Harvests and Orders

In the virtual region where the models were run, the size of a harvest varied from 30 tons to 100 tons, according to a triangular probability definition peaking at 50 tons. These values were selected to resemble the harvest sizes estimated in the interviews, but no attention was paid to how well they resembled actual harvest sizes, because the focus of the study was on how the virtual firms performed in the model runs.

The size of an order, on the other hand, varied between 50 and 200 tons, again according to a triangular probability definition, this time peaking at 100 tons. These values were also selected to resemble some estimates from the interviews, but again, their approximation to real values were not important.

The total monthly size of harvests was used as a test parameter of the models that changed from 100,000 tons to 200,000 tons. The total monthly order was another test parameter that changed from 100,000 tons to 150,000 tons. The model runs with these variations helped determine how well the horizontally integrated system would perform when the total harvest volume did or did not match the total volume of orders.

iv. Observed Parameters

The performance of the proposed system model was tested by observing two parameters from the test runs:

- **Order filling time:** The time that it took to fill an order (excluding the time of final delivery) was an important criterion for deciding if the integrated system would help the firms finish the orders faster.
- **Unused stock ratio:** Since all the harvests contained a distribution of three quality levels, some fruits whose qualities did not fit an order would be left in stock. Although, in real life, firms would somehow redirect or dispose of their stocks, the ratio of the unused stocks was selected as an indicator of how efficiently the purchased fruits were utilized to fill the orders.

4. Results of the Model Runs

It is easy to see that the leftover stocks would be the largest when the average quality demanded by the orders exceeded the average harvest quality. This is the reason why the first runs of the models were done by varying the average order quality.

When the average harvest quality was 1.5, six runs were performed with the average order quality took values from 1 to 1.5.

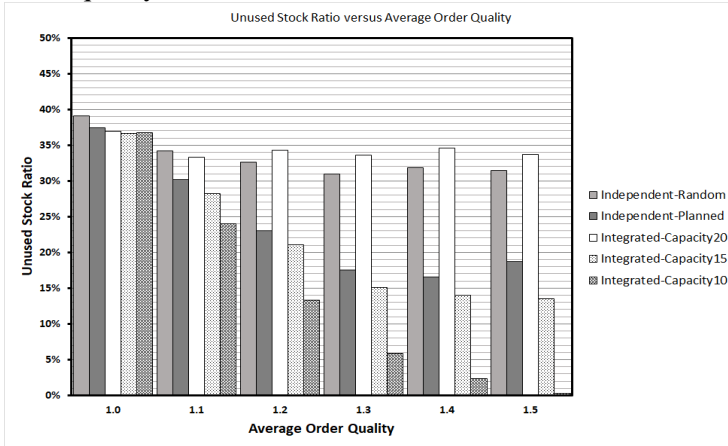


Figure 4. The changes in the unused stock ratio versus the average order quality, when the average harvest quality is 1.5.

As in Figure 4, when the average order quality was 1 (i.e. when only fruits with level-1 quality were demanded), the unused stock ratio was the greatest. The reason is clear: Many harvests also contained level-2 or level-3 quality fruits which were left undelivered. The unused stocks got smaller as the average qualities of harvests and orders got closer, because then lower quality fruits could also find buyers.

In cases the firms processed their fruits independently, planned purchases (buying only in the amounts demanded by the orders) helped reduce the unused stocks as much as 50%. Nevertheless, even with planned purchases, the unused stock ratio was not below 18%.

An integrated processing center performed worse than independently operating firms, when it had the total processing capacity of 20 firms, but it worked much more efficiently when its capacity was reduced. As it is seen in Figure 4, the unused stock ratio was always the smallest for a regional processing facility with the total processing capacity of 10 firms. In fact, when the average quality levels were matched for the harvests and orders, the unused ratio was practically zero.

The unused stock ratio also depends on how well the total volume of orders matches the total volume of harvests.

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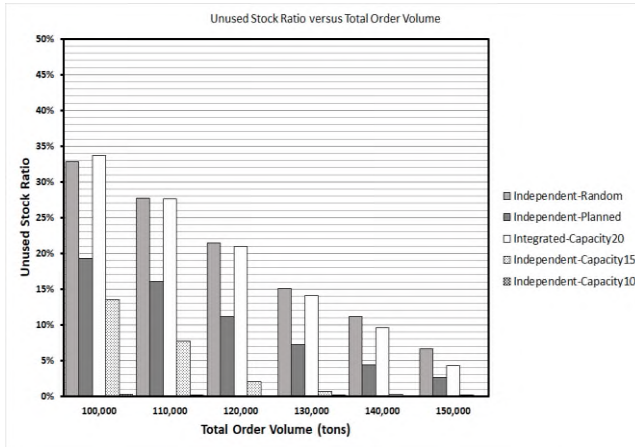


Figure 5. The changes in the unused stock ratio versus the total order volume, when the total harvest volume is 150,000 tons.

As it is apparent in Figure 5, independent firms would be left with smaller stocks by making planned purchases, but again, an integrated processing facility would perform more efficiently, leaving almost no stock unused with the total capacity of 10 independent firms.

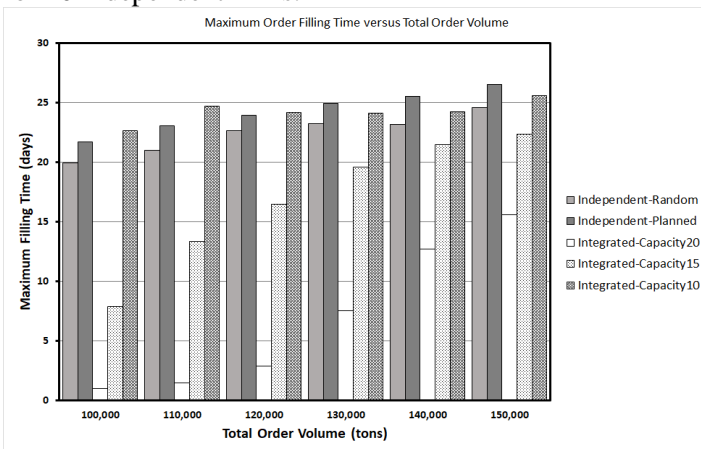


Figure 6. The changes in the maximum order filling time versus the total order volume, when the total harvest volume is 150,000 tons.

When it comes to filling time of orders, an integrated processing facility again performs far better than independently operating firms, especially when it has a large processing capacity. As it is seen in Figure 6, an integrated processing facility with the total capacity of 20 independent firms reduces the maximum order filling time by 50% or more, while it performs as well as the independently operating firms with a total capacity of just 10 firms.

5. Conclusions

The small sizes of citrus production fields in Turkey lead to technical disadvantages in collecting and processing the fruits and increase the costs. The need

to comply with increasingly tougher standards imposed by international markets require close supervision of the citrus production, which is the reason why exporting firms of Eastern Mediterranean Region, which are members of the trade organization AKIB, prefer pre-harvest contracts for 39.3% of their purchases and monitor the production in the contracted fields (Budak et al, 2016). However, contracted and supervised production is not the norm for citrus fruits, as well as in other annual crops (Akbay et al, 2005).

Consolidating the production fields would largely alleviate these disadvantages, but also eliminate the small producers: A better solution is to create regional or national organizations, such as cooperatives to oversee the citrus production and processing. A producers' association or a cooperative will be the perfect authority to oversee and supervise the production in national or regional scales, and also find it easier to implement and enforce the required practices, such as safer application of pesticides and other chemicals.

Thus, the notion of horizontal integration is born.

- Horizontal integration of the fruit purchasing and processing operations eliminate the need for the individual firms to set aside resources for these operations.
- Horizontal integration strengthens the supply positions to meet the changing markets demand.
- Through horizontal integration, firms eliminate the risk of not finding the proper amounts of products with the desired qualities at the right time.

The horizontal integration that we propose will start at the production stage. A regional association of producers or a producers' cooperative will make it easier for the producers to implement and maintain proper growing and safer pesticide practices, without consolidating the citrus orchards in the form of large fields. This association or cooperative will reciprocate the producers' compliance by giving them a better and stronger bargaining power in selling their fruits. The merchants and the firms will buy the fruits from one regional body representing the producers of the region, but they will be guaranteed to find the fruits with the desired qualities to fill orders of any size, even if some fields were adversely affected by weather. Furthermore, the firms will be relieved from the burden of processing the fruits, because the processing stage will also be horizontally integrated in regional centers. A commonly used processing center will also be easier to augment or modernize, provided that a reasonable agreement is achieved among the stakeholders.

In this study, we constructed models that compared the performances of a number of identical firms making independent purchases directly from the producers or from a regional processing center. The results have shown that, independently operating firms would fill orders more efficiently by making planned purchases, for the amounts demanded in the orders, but purchasing processed fruits from a regional center would shorten the delivery time and/or reduce the unused stocks.

In summary, horizontally integrating the operations of citrus harvesting and processing will help the producers and the firms in several ways:

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- Producers, especially small producers, will not be at the mercy of whichever merchant or firm is inclined to buy their fruits. They will receive the right price for the right quality.
- The premium prices paid for the best quality fruits will entice more producers to adopt and follow the standard practices.
- There will be one regional authority for workers to apply to find jobs at picking or processing fruits and get training.
- The skilled labor force will no longer be in the minority and they will be trained and maintained in one place.
- The merchants, especially the exporting firms, will be guaranteed to find the fruits in the amounts and quality demanded in the orders.

In this context horizontal integration at regional level will boost the performance and productivity of producers and exporters. Gathering under a single roof will empower small-scale producers, insure the sustainability of production and promote the quality of the product. It will also assure the generation of permanent jobs, boost the competitiveness and market share of exporting firms.

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