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Benchmarking of Alternative Business Models in Licensed Grain Warehouses and Capacity Optimization

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ABSTRACT

There have been serious problems in optimizing capacity management due to lacking detailed analysis of the current business model in Licensed Grain Warehouses (LGW) in Turkey. Therefore, the study's objectives were to economically analyze the standard and industrialist business models and examine the capacity management optimization in LGW in Turkey. Research data were collected from managers of warehouses by using semi-structured interviews and observations. Management records of the examined firms were also used to elicit warehouse-level data. MOTAD model was used to generate a capacity optimization plan under risky conditions. Research results showed that the capacity use ratio of two different business models was nearly the same, and both had smaller capacity use ratios than that of the optimum. Inventory turnover of the industrialist business model was higher than that of the standard one (P< 0.01). The amount of loss was lower than 1% in both business models. The gross income of the industrialist business model was larger compared to a standard business model. MOTAD programming results revealed that, with government incentives and support, optimizing the storage organization in the industrialist business model increased the gross revenue of licensed warehouses by 177.27%. Ensuring the optimum capacity management would reduce the need for working capital by 21.69%. The study suggests conversion from a standard business model to an industrialist one and controlling and monitoring inventory turnover to optimize the capacity of LGW.

Keywords: Industrialist business model, Inventory turnover, MOTAD model, Optimum capacity management.

INTRODUCTION

Agriculture is the special sector that touches directly with the people's life and politically, socially, and economically increases the competitive power of countries having strong agriculture. For the last decade, tremendous effort has been presented to set the food safety system with the help of the highly developed logistic sector and succeed in minimizing the effects of politics on the relationship among countries. However, facing Covid-19 pandemics and problems sourced from climate changes have made nations initiate the defense mechanism such as trade limitations or trade ban, increasing agricultural products inventory, etc., and self-sufficiency has been coming into the first order into the agenda of policymakers. Nowadays, many nations tend to increase their agricultural product inventory, especially for grain and pulse, to provide national food security. We have experienced unexpected and extraordinary scenarios all over the world for approximately two years due to the Covid-19 pandemic. China and India have enormously increased their wheat inventory during the beginning of the 2020/2021 production year. China reshaped its grain trade considering the effects of the Covid-19 pandemic on global trade. According to the USDA statistics, wheat

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import of China was 5.4 million tons in 2019/2020 production year, while it reached 8.5 million tons in 2020/2021 production year, in which China's domestic wheat production increased by 2.5 million tons. China increased the amount of wheat import by more than 50%, where wheat production exceeds the wheat consumption and grain inventory is at sufficient level. China has followed the same strategy for maize, and the import of maize has been doubled during this period (USDA, 2020). Similarly, Russia, which exported more than 35 million tons of wheat annually and was a leader country in wheat trade, has put some export limitations to protect domestic markets and to reduce the adverse effect of Covid-19 pandemics. During the first two months of the Covid-19 pandemic, Russia balanced the total amount of wheat via export quota and announced a special tax for grain trade after 2021 February.

Storing the grain in suitable conditions has also become first-order into the policy makers' agenda due to the strategic importance of grain in terms of food security and safety. Balancing between the supply of grains, which is at the maximum value in the harvesting period, and the demand of grains, which disperse throughout the year, has required good quality and accredited storage facility. Licensed Grain Warehousing (LGW) is the most suitable option for overcoming the problems of unbalance between demand and supply of grains. According to the statistics of the Trade Ministry, licensed warehouse investment in Turkey has increased for the last five years, and the total capacity of the licensed warehouse in Turkey reached approximately 7 million tons (MoT, 2020).

Up to now, some academic studies have focused on licensed warehousing. Most previous studies on licensed warehousing have examined the benefits of licensed warehousing systems at both farmers' level and national level based on secondary data. Some of these studies have focused on examining the functions of licensed warehousing in the economy, paying attention especially to the agriculture sector (Ulas, 2007; Roache, 2008; Tektaş, 2008; Vonck and Notteboom, 2012; Tosun *et al*., 2014; Özocak, 2015). These previous studies reported the advantages of a licensed warehousing system and suggested that farmers did not completely adopt the licensed warehousing system due to the vast number of mistrustful farmers, low level of farmers' awareness, scale problems, products classification problems, and quality problems. At the same time, some researchers have been interested in exploring the effects of licensed warehousing on farmers' income (Çelik, 2019; Gün, 2018; Hazneci and Hazneci, 2018; Kaya, 2017; Zakić *et al*., 2014). These studies inferred that storing agricultural crops in the licensed warehouse was not profitable for farmers without government subsidies. On the other dimension, some studies focused on the mechanism of licensed warehousing and its role in trade, the link between the licensed warehousing systems and product market, regulations, and government incentives (Coulter and Onumah, 2002; Erdal, 2018; Karaduman, 2019; Peker, 2019; Türker, 2019; Varangis and Larson, 1996). These previous studies suggested that licensed warehousing positively contributed to the development of the free market, transparency, and standards in agricultural products markets. Kovačević *et al*. (2021) examined the influencing factors for the development of the public warehouse system. They stated that the public warehouses were secure and lender had nothing to worry about the stored commodity, and banks were willing to offer lower interest rates by 25% in Serbia. Capacity optimization is the other dimension of studies related to licensed warehousing. Some pioneer research on modeling inventory, space, and distribution, and storage capacity under a dedicated storage policy in licensed warehousing have been conducted at the beginning of the millennium in developed countries (Ceyhan *et al*., 2018; Coulter *et al*., 2000; Guerriero *et al*., 2013; Heragu *et al*., 2005; Knapp,

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1969; Lee and Elsayed, 2005; Lei *et al*., 2006; Orzechowska and Bazı, 2010; Puspasari, 2014; Wouda *et al*., 2002; Xian-hao *et al*., 2015). These studies proved that providing capacity optimization by modeling production-inventory and distribution in licensed warehouses reduced the cost and increased the revenue. These studies also suggested that the type of management and storage policy directly affected the revenue of licensed warehouses. When glancing at the developing countries, it has been clear that the study focusing on capacity optimization and the effects of business and storage policy on revenue is scarce. Since difficulties for obtaining the warehouse level of management data, researchers have canceled the required conducting studies based on detailed warehouse level management and financial data, which is vital for the sustainability of licensed warehousing. Research gap in the literature about the economic dimension of licensed warehousing and capacity optimization problem that arise in the sector have motivated the research. Since there are still very little or no information on the economic feasibility of the alternative business model, capacity optimization, and sufficiency level of government incentives in LGW, this study intended to reduce these information gaps. We tested the prior hypothesis of whether the different business models used in LGW was economically feasible or not. Then, we focused on the hypothesis of whether managers of LGW used their capacity efficiently or not. Regarding government role in the warehousing system, we also tested the hypothesis of whether the government incentives related to LGW were at satisfactory level or not.

The objectives of this study were: (i) To reveal the structure of LGW, (ii) To economically compare alternative business models of LGW, (iii) To optimize capacity management in LGW, and (iv) To explore the sufficiency of government incentives related to LGW.

MATERIALS AND METHODOS

The bulk of the research data were obtained from 3 different firms having contract-LGW in Kırıkkale, Çorum and Yozgat Provinces of Turkey. All of them were public warehouses based on legal establishment. Licensing procedures is governed by the Ministry of Agriculture and Forestry (MoAF). In Turkey, there are also special inspection services for public warehouses and indemnity funds in charge of compensation under out-of-court procedure to the commodity owners, if the licensed warehouse fails to deliver the good. All the research data collected from the 3 firms were based on the voluntary basis. Time series data covering the period of 2017-2020 for each firm were analyzed in the study. One of the three firms was managed by an industrialist as a part of the value chain, which is called the industrialist business model. In this business model, licensed warehousing is an integral part of the flour value chain. Both are meeting the storage need for intermediate goods for flour production and serving the third-party depositor. The other warehouses conduct their activities by standard business model, in which the warehouse privately serves only the third-party depositor via contract. All the other characteristics of warehouses are almost the same to attribute the differences to the competing business model. Since the demand shaped the firm level of storage physical and economic data, demand factor was embedded in storage characteristics of the firms when optimizing the capacity. When obtaining warehouse-level management data, a detailed study on firm management's records, semi-structured interviews, and observations by using specially structured observation cards were conducted.

Methods for Revealing Economic Performance

Capacity use ratio, turnover ratio, product loss, fixed and variable expenses, gross income, and net income per silo were used as a benchmarking criterion. Firm or plant

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level of economic performance was also explored and calculated to reveal the economic performance of the two competing business models. Revenue of the LGW included rent revenue from warehouse and laboratory, loading and unloading revenue, sieving revenue, interest revenue, and miscellaneous revenue. Costs were divided into two broad groups as variable and fixed costs. Interest payment, insurance cost, personal cost, maintenance cost, depreciation cost, premium payment, and taxes were in the fixed cost group, while transportation cost, energy cost, chemical cost, the maintenance cost of the vehicle, loss, and bank commissions were assigned to variable cost group. When revealing the profitability of the examined warehouse, profitability measures such as Gross Income (GI) and Net Income (NI) were used. Profitability measures were calculated associated with turnover ratio and grain species.

Methods for Generating Optimum Capacity Plan

Optimum capacity plans for industrialist business model and standard business model under risky conditions were generated by using Minimization of Total Absolute Deviation (MOTAD) mixed-integer programming model by Hazell (1971) since distribution of the decision variables was normal, and the correlation among the decision variable was low. Hazell (1971) inferred that the MOTAD model, as a linearized version of Quadratic Programming (QP), is better adapted for the post-optimality analysis, and MOTAD may lead to much smaller problems for complex farm organizations. The MOTAD linear approximation of the QP and combinations obtained with MOTAD are an acceptable proxy for the Expected-Variance (E-V) combinations obtained from quadratic function (Hardaker and Troncoso, 1979; Lambert and McCarl, 1985; Önal and McCarl, 1989).

To derive efficient Expected-Variance (E-V) plans, the distribution of the mean absolute gross revenue deviation was used. The variance of plans was calculated by using Equation (1) suggested by Hazell (1971) to generate E-V efficient plans.

$$\frac{1}{s-1}\sum_{h=1}^{s}\left[\sum_{j=1}^{n} c_{hj}x_j - \sum_{j=1}^{n} g_j x_j\right]^2 \quad (1)$$

Where, $h = 1$, s denotes the s observations in a random sample of gross revenue, g_j is the average value of the sample, $\sum_{j=1}^{n} c_{hj}x_j$ is the total gross revenue of a particular warehouse plan generated with observed gross revenue for the h*th* warehouse, and $\sum_{j=1}^{n} g_j x_j$ is the total gross revenue for the same plan generated with the sample mean gross revenue.

D matrix that reflected the deviations of the gross revenue of activities from expected gross income was constructed by using 3-year historical data covered from 2017 to 2020. The MOTAD programming model used in the study is shown below.

$Minimum\ Ld^-$

Subject to

$$AX \leq B \quad (2)$$
$$DX + Zd^- \geq 0 \quad (3)$$
$$C'X = \lambda \quad (4)$$
$$X, d^-, \lambda \geq 0 \quad (5)$$

In equations, *X* is the level of activities, *A* is the matrix of input-output coefficients, *B* is the vector of resource constraints, *C* is the gross income of activities, and *D* is the Deviations of the gross income of activities from the expected gross income each year. The vector of d^- denotes yearly total negative deviations summed overall risky activities. Ld^- represents the summed total negative deviations overall years. λ is a scalar parameterized from zero arbitrarily to a large number based on sensitivity analysis.

The restrictions of the MOTAD programming models developed for the industrialist and standard business plans were silo capacity, labor, working capital, and amount of initial investment of licensed warehouse per m^2. Net income for each

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stored crop associated with turnover ratio, labor hiring, credit, and warehouse investment per m^2 were the activities of MOTAD programming models.

In the initial matrix, labor requirements per ton for standard and industrialist business models were calculated separately for 0.7 and 0.75 hours. Labor requirements per ton for standard business model was calculated as 0.7 hours, assuming ten-person worked 313 days in a year and 9 hours in a day for 40 thousand tons. When calculating labor requirements for the industrialist business model, it was assumed that 12 persons worked 313 days in a year and 9 hours in a day for 45 thousand tons, and the labor requirement was 0.75 hours in the initial matrix. For the hiring labor, the wage of workers was calculated by using the weighted average value of the wages of blue and white-collar workers, which was US $ 3.09 per hour.

Methods for Evaluating the Sufficiency Level of Government Incentives

The study comparatively analyzed the standard and industrial business model in terms of age, labor, size, working capital, total asset, net firm income, and profitability indicators. When comparing the two different business models, a student t-test was used

Statistical Analysis Methods

When comparing the two different business models, the student t-test was used since the examined variables were continuous. Before testing the mean value of the variables belonging to the two different business models, normality of the distribution of the examined variables were tested by using Kolmogorov-Smirnov test. Variables having non-normal distribution were transformed by using logarithmic transformation.

RESULTS AND DISCUSSION

Development of Licensed Warehousing in Turkey

In Turkey, 184 licensed warehouses are operated by 126 licensed warehousing companies in 35 different provinces. Based on the statistics of Ministry of Trade (MoT), the total capacity of these warehouses is approximately 7 million tons, and the average warehouse capacity is 38 thousand tons in 2020. While there is a total capacity of 69,750 tons for the storage of olive/olive oil, cotton, hazelnut, pistachio, raisin and dried apricot products, the total capacity for cereals is 6.93 million tons (Figure 1).

After initiating, government support for rent payment of depositor by 50%, capacity of warehouse was increased by 26 times during 2015-2020. The licensed warehousing capacity of grains reached 6.9 million tons in 2020. When glancing at the provincial distribution of the grain warehouse capacity, it is clear that Konya has the highest capacity. Top ten provinces and their capacity are shown in Table 1.

Table 1. Top ten provinces in grain warehousing and their capacity.

Province	LGW capacity (Ton)
Konya	1436870
Yozgat	546175
Adana	519680
Aksaray	318350
Gaziantep	305343
Karaman	283650
Şanlıurfa	278939
Diyarbakır	258300
Edirne	233900
Kırklareli	233100
Top ten provinces total	4414307
Turkey total	6906692

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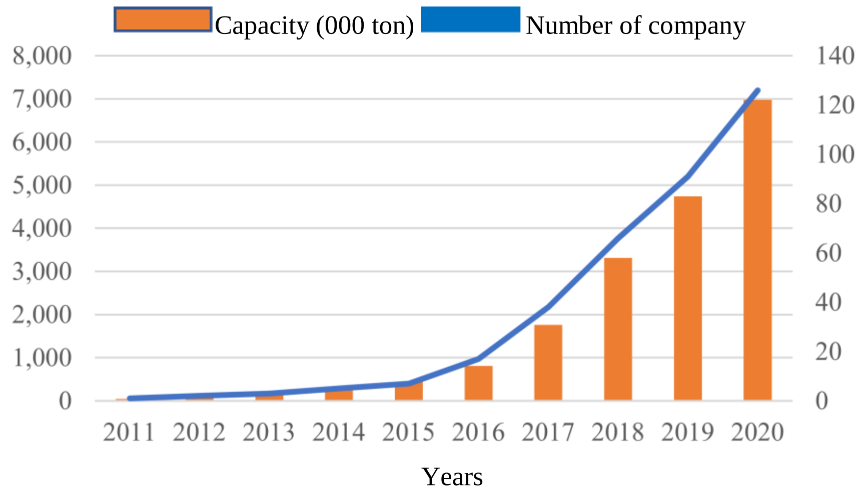

Figure 1. Capacity of the warehouse and the number of companies (MoT, 2020)

Characteristics of Examined Warehouses

The firm, having licensed warehouses under a standard business model, had a total storage capacity of 40 thousand tons in 12 different silos and conducted storage activities on 4.6 hectares of land. Eight out of 12 silos had the 2,500 tons' storage capacity, while that of the rest was 5,000 tons. The firm having licensed warehouses under standard business model had 3 white-collars workers and 7 blue-collar workers. Regarding the industrialist business model, its total storage capacity was 45 thousand tons in 12 different silos and conducted storage activities on 1.3 hectares of land. Half of the silos in the firm having licensed warehouses under industrialist business model had the 5,000 tons' storage capacity, while that of the rest was 2500 tons. The firm having licensed warehouses under the industrialist business model had 3 white-collars workers and 9 blue-collar workers (Table 2).

Economic performance of the alternative business model

Research results showed that the mean capacity value of steel silos was 3333 tons in the firm having licensed warehouses under a standard business model. The capacity use ratio varied from 31.17 to 75.66% associated with the silo and 57.93%, on average, in this firm. Regarding the industrialist business model, there were some small differences in terms of capacity use ratio. The mean capacity value of steel silos was 3,750 tons in the firm having licensed warehouses under the industrialist business model. The capacity use ratio varied from 49.78 to 73.19% associated with the silo and 61.15%, on average, under the industrialist business

Table 2. Structural characteristics of the examined firms.

Business model	Silo type	Silo number		Capacity (Thousand tons)	Area (m^2)	Number of workers	
		2500 tons	5000 tons			White-collar	Blue-collar
Standard	Steel	8	4	40	4.60	3	7
Industrialist	Steel	6	6	45	1.30	3	9

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model. Based on the results of the t-test, the difference between standard and industrialist business models was not statistically significant in terms of capacity use ratio (P> 0.10). Similarly, the difference between the standard and industrialist business models was not statistically significant (P> 0.10). Annual grain loss under standard and industrialist business model were 14,93 tons and 8,85 tons, respectively, while that of the percentages of grain loss was 0.92 and 0.47% per year in steel silo (Table 2). Research finding on product loss in both business model was lower than that of the results of previous research conducted by Jayas (2012), who suggested that, in a developed country, the average loss of grain in steel silos was 1-2%, while that of developing countries was 20-50%. Similarly, Manandhar *et al*. (2018) stated that losses in the stages of production, processing, and storage of grain value chain were 15, 13-20, and 15-25%, respectively. It was emphasized that 10-20% of the total losses during grain storage were sourced from insects (Phillips and Throne, 2010). Previous studies conducted by Kumar and Kalita (2017) and Chomchalow (2003) reported that the physical and ingredient losses in the stored grain sourced from insects would reach 40%. It was found that grain losses sourced from toxins were around 10% (Kumar and Kalita, 2017; Mesterházy *et al*., 2020).

When glancing at the turnover ratio, it was between 0.60 and 1.05, and 0.86, on average, indicating that mobility of the stored crop was low level. The turnover ratio of the industrial business model was higher than that of the standard business model (P< 0.01). The turnover ratio under the industrialist business model was between 0.95 and 2.08, and 1.29, on average (Table 3).

Grain loss varied associated with capacity use ratio, turnover ratio, and silo under a standard business model. Based on the results of regression analysis, annual grain loss decreased by 4.05 tons, and variation in grain loss was122% during the period of 2017-2019, while capacity use ratio decreased by 3.4% annually in the same period. Regarding the turnover ratio, the annual decrease in turnover ratio was 0.04 and variation in turnover ratio was 31.7% during the period of 2017-2020. Negative trends in capacity use ratio and turnover ratio affected the firm income negatively. The trend was almost the same in the industrialist business model in terms of turnover ratio. However, the case was the reverse in terms of grain loss and capacity use ratio. Both indicators increased during the examined period. The variation in grain loss was 108% and grain loss increased by 1.2 tons annually in this business model. The

Table 3. Benchmarking of standard and industrialist business model.

Variables	Standard business model	Industrialist business model
Capacity use ratio	0.58±0.07	0.61±0.05
Turnover ratio*	0.86±0.15	1.29±0.27
Loss per silo	14.93±0.00	8.85±5.41
Revenue per silo (thousand US$)	26.61±4.62	25.33±5.01
Fixed cost per silo (thousand US$)**	30.52±6.64	11.87±3.09
Variable cost per silo (thousand US$)	11.87±0.92	12.88±3.55
Total cost per silo (thousand US$)	42.39±7.46	26.35±6.24
Gross income per silo (thousand US$)	14.74±4.11	12.45±2.60
Net income per silo (thousand US$)***	-15.71±5.25	1.09±3.99

*, ** and ***: Reflect that the difference between standard and industrialist business models was statistically significant at the probability level of 10, 5, and 1%, respectively.

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capacity use ratio increased by 0.82% each year (Table 3).

In licensed warehouses under a standard business model, the main depositors were merchant, and they constituted 51.7% of the total stored grain, followed by farmers (35.41%) and industrialist (12.87%). Wheat for flour (*Triticum aestivum* L.) was the most stored grain by 65.5%. Barley (*Hordeum vulgare* L.) (20.3%) and triticale (*X Triticosecale Wittm.)* (14.2%). Farmers tended to put wheat for flour. Indeed, 82% of the total farmers' grain stored in the warehouse was *Triticum aestivum* L., while the rest was barley and triticale. The case was the same for merchants and industrialists: 53% of the total merchants' grain stored in the warehouse was *Triticum aestivum* L., while the rest was barley and triticale. The percentage of the stored *Triticum aestivum* L. by industrialists was 68%. Naturally, the main depositor was an industrialist in the firm under the industrialist business model (61.53%). The percentages of farmers and merchants were 23.64 and 14.83, respectively. Like a firm under a standard business model, industrialists and farmers tended to store *Triticum aestivum* L. The percentages of *Triticum aestivum* L., *X Triticosecale Wittm*, and *Triticum durum Desf.* were 94, 4, and 2%, respectively (Table 5).

Rent revenue of standard and industrialist business model was very close, and the difference between the business model and industrial model in terms of rent revenue was not statistically significant (P> 0.10). The firm having grain warehouses under standard business model gained revenue of US $ 26,630 per silo and US $ 319,527 totally, while that of industrialist business model were US $ 25296 per silo and US $ 303,254 totally. The fixed costs of the standard business model were higher compared to the industrial business model (P< 0.01), while the reverse was the case for the variable cost (P> 0.10). The annual total cost of the firm under the standard business model per silo was US $ 42,390, and 90% of it was fixed cost, while the rest was variable. Unlike standard business model, the annual total cost of the firm under the industrialist business model per silo was low, which was US $ 24,704, and 48% of it was fixed cost

Table 4. Amount of grain stored in warehouses under different business models by grain type and depositor.

Grain species	Farmers		Merchant		Industrialist		Turkish Grain Board		Total	
	000 ton	%	000 ton	%	000 ton	%	000 ton		000 ton	%
Standard business model										
Triticum aestivum L.	65.99	44.50	62.32	42.00	19.92	13.4	0.07	0.10	148.30	65.5
Triticum durum Desf.	-	-	-		-	-	-		-	-
X Triticosecale Wittm.	1.18	3.70	24.10	74.90	6.89	21.4	-		32.17	14.2
Hordeum vulgare L	13.01	28.30	30.65	66.60	2.33	5.1	-		45.99	20.3
Total	80.18	35.40	117.07	51.70	29.14	12.9	0.07	0.10	226.47	100.0
Industrialist business model										
Triticum aestivum L.	38.84	24.30	24.66	15.42	96.36	60.28	-	-	159.86	96.13
Triticum durum Desf.	-	-	-	-	2.17	100.00	-	-	2.17	1.31
X Triticosecale Wittm.	-	-	-	-	3.79	100.00	-	-	3.79	2.28
Hordeum vulgare L	0.47	100.00	-	-	-	-	-	-	0.47	0.28
Total	39.31	23.64	24.66	14.83	102.32	61.53	-	-	166.29	100.00

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Table 5. Economic performance of business model associated with species and turnover ratio ($\$ t^{-1}$).

Grain species	Standard business model		Industrialist business model	
	Gross income ($\$ t^{-1}$)	Net income ($\$ t^{-1}$)	Gross income ($\$ t^{-1}$)	Net income ($\$ t^{-1}$)
Triticum aestivum L.				
Low turnover ratio (< 0.60)	5.10	0.49	3.14	2.91
Moderate Turnover Ratio (0.61< TR< 0.95)	12.51	-4.53	11.69	9.79
High Turnover Ratio (0.96< TR< 2.08)	16.51	-7.03	16.74	12.31
Triticum durum Desf.				
Low Turnover Ratio (< 0.60)	3.81	-3.62	4.95	0.47
Moderate Turnover Ratio (0.61< TR< 0.95)	15.02	-6.04	6.81	2.04
High Turnover Ratio (0.96< TR< 2.08)	16.40	-5.32	12.35	3.45
X Triticosecale Wittm.				
Low turnover ratio (< 0.60)	3.46	0.47	3.01	-1.97
Moderate Turnover Ratio (0.6< TR <0.95)	8.08	1.35	5.71	-1.62
High Turnover Ratio (0.96< TR < 2.08)	9.75	-3.34	8.13	-0.89
Hordeum vulgare L.				
Low Turnover Ratio (< 0.60)	5.19	0.71	2.33	-2.77
Moderate Turnover Ratio (0.61< TR< 0.95)	11.56	2.01	3.65	-2.38
High Turnover Ratio (0.96< TR< 2.08)	2.01	7.45	5.17	-2.29

while the rest was variable cost.

Regarding the profitability, there was no statistically significant difference between standard and industrialist business models (P> 0.10). Gross incomes of standard and industrialist business models were US $ 14,740 and 12,426, respectively. At the same time, the net income of the industrialist business model was better than the standard business model (P< 0.05). Net incomes of standard and industrialist business models were US $ 14,740 and 592, respectively (Table 3). It was found that the revenue and cost of the firm under the standard business model had positive trends. Revenue and cost of standard business model annually increased by US $ 2,024 and 5,473, respectively. However, the revenue of the firm under the standard business model had positive trends. Revenue of industrialist business model annually increased by US $ 2,071, while total cost decreased by US $ 2,663.

The results of the economic analysis showed that the value of the empty day was larger in the industrialist business model compared to the standard business model. One empty day caused a gross income loss of US $ 55.33, and the annual sacrifice in gross income was US $ 2,851.63 in the standard business model. Whereas one empty day caused gross income loss of US $ 90.68, and annual sacrifice in gross income was US $ 3,158.88 in the industrialist business model.

Regarding the link between revenue and turnover ratio, it was found that an increase in turnover ratio led to an increase in revenue and gross income in both business models. Correlation coefficients between revenue and turnover ratio for standard and industrialist business model were 0.21 and 0.271, respectively, and they were statistically significant at the 5% probability level. When glancing at the relationship between turnover ratio and gross income,

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correlation coefficients between revenue and turnover ratio for standard and industrialist business models were 0.65 and 0.35, respectively, and they were statistically significant at the 5% probability level. These research findings corroborate with the results of previous studies conducted by Coulter and Sondhi (1996) and Coulter *et al*. (2000). However, opposite result was found in the study conducted by Khan *et al*. (2016), who suggested the negative relationship between inventory turnover and profit margin for foods. Turnover ratio also affected the grain loss during the storage. There was negative relationship between turnover ratio and grain loss in both business models. Correlation coefficients between turnover ratio and grain loss for standard and industrialist business model were -0.25 and -0.52, respectively ($P< 0.05$). Regarding the link between cost and turnover ratio, variable cost decreased when turnover ratio increased under standard business model, while the opposite situation was valid for industrialist business model. When turnover ratio increases, total and fixed cost also increases in the firm under standard business model, while there is positive relationship between fixed cost and turnover ratio in industrialist business model.

The highest gross income was gained from *Triticum aestivum L.* in high turnover ratio under standard business model. Gross incomes gained from *Triticum aestivum L* in low, moderate, and high turnover ratio were 5.03, 12.57 and 16.57, respectively. *Triticum durum Desf.* in moderate and high turnover ratio followed it. Similarly, the highest gross income was gained from *Triticum aestivum L.* in high turnover ratio under industrialist business model. Gross incomes gained from *Triticum aestivum L* in low, moderate, and high turnover ratio were 3.11, 11.69, and 16.72, respectively. *Triticum durum Desf.* in turnover ratio followed it (Table 5).

Capacity Management Optimization

The results of the MOTAD programming showed that turning from standard business model to industrialist one increased the profitability due to low level of grain loss and high level of inventory turnover. Based on the results of MOTAD programming, changing business plan from standard to industrialist and arranging storage organization would increase gross income by 177.27%. Similarly, increasing inventory turnover from current level to 1.35 led to increase in gross income (Table 6). This finding confirmed the result of Amiri *et al*. (2012) who suggested that inventory turnover ratio should be considered in optimization. After planning, the percentage of wheat for flour increased in licensed warehouse under standard business model. With the optimization plan, the percentage of wheat for flour increased from 80.82% to 90.68% and barley and wheat for fodder removed from storage portfolio. LGW had the opportunity to reduce their working capital by 21.69% (Table 5). This finding corroborated with the results of previous

Table 6. Benchmarking of variables before and after planning.

	Current	Plan
Capacity use ratio (%)	59.54	60.00
Wheat for flour (*Triticum aestivum L.)* (%)	80.82	90.68
Wheat for macaroni (*Triticum durum Desf.*) (%)	0.66	9.32
Wheat for fodder *(X Triticosecale Wittm.)* (%)	8.24	-
Barley *(Hordeum vulgare L.)* (%)	10.29	-
Working capital need (Thousand US $)	470.41	368.34
Working capital reduction (%)	21.69	
Gross income (Thousand US $)	292.90	812.13
Gross income increase potential (%)	177.27	

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studies conducted by Wouda *et al.* (2002), Liu *et al.* (2009), Orzechowska and Bazı (2010), Devangan (2016). Wouda *et al*. (2002) stated that decreasing production cost via optimization led to decrease in working capital need in milk value chain. Similarly, Devangan (2016) suggested that storage cost and labor requirement would decrease if capacity optimization was achieved in licensed warehouse. Orzechowska and Al-Bazi (2010) emphasized that rental revenue of warehouse would increase via process arrangement by using mathematical programming. Lei *et al*. (2006) proved that economic performance would be increased by mathematical model that simultaneously balance activities warehouse and manufacturing.

MOTAD programming results also showed that gross income of warehousing firm would be US $ 1.35 million under current capacity use ratio. If capacity use ratio were 95, 90, 85, 80, and 70%, gross income of warehousing firm would be US $ 1.29, 1.21, 1.15, 1.08 and 0.95 M, respectively. Shadow prices of grain warehouse per ton varied between US $ 13.42 and 13.72. Research results also showed that additional risk by US $ 1 led to increase gross income by US $ 0.27.

Sufficiency Level of Government Support and Incentives

Since the development of licensed warehouse is vital for Turkish economy in many respects, government has supported the licensed grain warehouse by using different tools. Tools used by government for supporting licensed warehouse can be summarized in 7 groups including tax-exempt, rent subsidy, transportation support, support for laboratory tests, interest subsidy, credit support for initial investment and working capital, and investment incentives (VAT exempt, tax reduction, insurance premium subsidy, withholding tax subsidy and interest subsidy).

Crops stored in licensed warehouse are exempted withholding tax (2%), income tax (20%) and Value Added Tax (VAT) (1%). Government also pays rent support for crops stored in licensed warehouses. Amount of rent subsidy differs depending on depositor type. Farmers who stored their crops in licensed warehouse take US $ 0.68 per ton each month for wheat, rye, maize, barley, paddy and oat, US $0.90 for lentil, chickpea, bean and soybean and US $1.13 for sunflower. For other depositors such as merchants, industrialists etc., the amount of rent support was 0.34 per ton for one month for all crops. Government gives support for transportation and laboratory test by $ 3.33 for all depositors. Depositors have the opportunity to benefit credit interest subsidy by 100% in exchange for an electronic Certificate of Title (CT) stored crop covered maximum of 75% of the total bill for 9 months. In the other dimension, investors benefit from interest subsidy by 50%, a maximum US $ 6.67 M, when using credit for establishing the licensed warehouse.

Regarding benefits of farmers from government support for LGW, it was clear that government support constituted 14.9% of grain farmers' income. Typical farmers purchased US $ 195.81 and gained US $ 247 per ton. They generated a net income by US $ 51.19 per ton. Government provided the support by US $ 7.63 per ton to farmers per year. About 54% of the government support was rent subsidy, while the percentage of transportation and laboratory test support were 44 and 2%, respectively (Table 7). Research results also showed that storing grain in licensed warehouse was unprofitable without government support. The findings confirmed the results of previous research conducted by Ceyhan *et al*. (2018) who suggested that wheat farmers would get 7.22% extra income compared to the harvest season under the presence of government support, if they sold the wheat in March. Barley farmers would get 8.28% extra income compared to harvest season, if they sold the barley in January. However, storing in licensed warehouse without

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Table7. Government support for licensed grain warehouse per ton depending on depositor and crop.

	Rent revenue per month ($ t^{-1})	Rent subsidy[a]		Transportation subsidy[b] ($ t^{-1})	Laboratory test subsidy ($ t^{-1})
		Other depositor	Farmers		
Wheat, rye	1.20	0.34	0.68	3.33	0.22
Maize	1.26				
Barley, paddy, oat	1.33				
Lentil, Chickpea, bean, soybean	1.66		0.90		
Sunflower	2.06		1.13		

[a] Rent subsidy is lasting for a period of 6 months, [b] Maximum limit was 30 tons.

government support was not profitable for farmers.

CONCLUSIONS

Under the light of the research results, it was clear that industrialist business model was economically more efficient than standard business model. Both standard and industrialist business models were economically feasible under the condition of the existing government support. According to the research findings, the integration of a licensed warehouse and firm is very effective in the industrialist business model. This integration had a positive effect on productivity. In the absence of government support and incentives, it is clearly understood from the research results that the industrialist business model is more resistant to unexpected market conditions than standard business models. Therefore, the study suggests conversion from standard business model to industrialist one. The study also suggests storing much more wheat for bread rather than other crops. However, this is highly dependent on the value chain. Differentiation associated with the value chain should be considered when deciding on stored crops. Determining the storage portfolio associated with the value chain, such as feed value chain etc., may positively contribute to the economic sustainability of the warehouse. Since the working capital load of grain warehouses was increasing due to rent paid by depositors at the end of the storage, revising the related legislations by the government to arrange quarterly arrangement of monthly rent payments may improve the economic sustainability of grain warehouses via reducing the working capital load. On the other hand, the study recommends controlling and monitoring inventory turnover to optimize the capacity of LGW. Developing a decision support system and selecting the most appropriate inventory turnover using the data obtained from decision support system may increase the profitability of the grain warehouse.

Awareness and information level of farmers was one of the important determinants of developing the warehousing system. Farmers' awareness about the licensed warehousing system and credibility of the warehouse receipt was not at satisfactory level in Turkey. Farmers' extension education programs may positively contribute to the rising of the warehousing system. In addition, strengthening the credibility of warehouse receipts among financial institutions may accelerate participation of the farmers in the warehousing system.

Further research on capacity optimization focusing on different crops, such as pulse etc., and benchmarking the alternative

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business models in different value chains are needed.

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مقایسه مدل های کسب و کار جایگزین در انبارهای غلات دارای مجوز و بهینه سازی ظرفیت

و. سیهان، و ا. گلهان اولوسوی

چکیده

در انبارهای غلات دارای مجوز (LGW) در ترکیه مشکلات جدی در بهینه سازی مدیریت ظرفیت به دلیل نبودن تحلیل دقیق از مدل تجاری کنونی وجود دارد. بنابراین، هدف این پژوهش، تحلیل اقتصادی مدل‌های تجاری استاندارد و صنعتی و بررسی بهینه‌سازی مدیریت ظرفیت در LGW در ترکیه بود. داده های پژوهش با استفاده از مصاحبه نیمه‌ساختاریافته از مدیران انبارها و مشاهدات جمع آوری شد. برای آگاهی از داده هایی در سطح انبار، از سوابق مدیریت شرکت های مورد بررسی نیزاستفاده شد. از مدل MOTAD هم برای تولید طرح بهینه‌سازی ظرفیت تحت شرایط خطردار استفاده شد. نتایج تحقیقات نشان داد که نسبت استفاده از ظرفیت دو مدل کسب‌وکار متفاوت تقریباً یکسان است و هر دو نسبت استفاده از ظرفیت کمتری نسبت به مدل بهینه داشتند. نیز، گردش موجودی مدل کسب و کار صنعتی بالاتر از مدل استاندارد بود ($p<۰/۰۱$). مقدار تلفات در هر دو مدل کسب و کار کمتر از ۱% بود. درآمد ناخالص مدل کسب و کار صنعتی در مقایسه با مدل کسب و کار استاندارد بیشتر بود. نتایج برنامه‌ریزی MOTAD نشان داد که با مشوق‌ها و حمایت‌های دولتی، بهینه‌سازی سازمان ذخیره‌سازی در مدل کسب‌وکار صنعتی، درآمد ناخالص انبارهای دارای مجوز را ۱۷۷/۲۷% افزایش داد. اطمینان از مدیریت بهینه ظرفیت، نیاز به سرمایه در گردش را تا ۲۱.۶۹ درصد کاهش می دهد. این مطالعه تبدیل یک مدل کسب‌وکار استاندارد به مدل صنعتی و نیز کنترل و نظارت بر گردش موجودی برای بهینه‌سازی ظرفیت انبارهای غلات دارای مجوز را پیشنهاد می‌کند.

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