KSÜ Tarım ve Doğa Derg 28 (4), 1122-1130, 2025
KSU J. Agric Nat 28 (4), 1122-1130, 2025
DOI:10.18016/ksutarimdoga.vi.1627340

Investigating The Effect of Technological Features on Tractor Preference: Case of Konya Province

Zeki BAYRAMOĞLU[1], Hasan Gökhan DOĞAN[2]✉, Kemalettin AĞIZAN[3], Serhan CANDEMİR[4]
[1]Selcuk University, Agricultural Faculty, Department of Agricultural Economics, Konya-Türkiye,[2]Kirsehir Ahi Evran University, Agricultural Faculty, Department of Agricultural Economics, Kirsehir-Türkiye, [3]Aydın Adnan Menderes University, Çine Vocational School, Aydin- Türkiye, [4]Malatya Turgut Ozal University, Agricultural Faculty, Department of Agricultural Economics, Malatya-Türkiye.
[1]https://orcid.org/0000-0003-3258-3848,[2]https://orcid.org/0000-0002-5303-1770, [3]https://orcid.org/0000-0002-2340-2614
[4]https://orcid.org/0000-0003-4248-7024
✉: hg.dogan@ahievran.edu.tr

ABSTRACT
Tractors are the most important vehicle of the variety of mechanization used in the agricultural sector. Different fractions can be preferred by the manufacturer because of the many advantages it provide. Preferences that differ according to land type, land size, quality of production, and soil characteristics have necessitated a close examination of tractor markets. When researching tractor markets, it is very important to determine the expectations of the market in question. In this study, the preferences of manufacturers in Konya province in terms of technological features in choosing tractors were examined. The results of the survey conducted with 340 producers through proportional sampling were evaluated using conjoint analysis. According to the analysis results, the technological features of the tractors most preferred by the manufacturers are those with a power range of 71-100 HP, a traction feature of 4WD, price range 1-2 million TL (32,000-62,000$), automation, hydraulic system, air conditioning, heating, and sound insulation. It was determined that they were tractors with a large cabin volume and GPS and mapping systems. Planning the organization of the Turkish tractor market in line with producer expectations and regional/local market segmentation according to producer expectations is considered important for tractor manufacturers and efficiency in agricultural production.

Agricultural Economics

Research Article

Article History
Received : 26.01. 2025
Accepted : 14.03. 2025

Keywords
Tractor preference
Tractor technology
Conjoint analysis
Türkiye

Traktör Tercihine Teknolojik Özelliklerin Etkisinin Araştırılması: Konya İli Örneği

ÖZET
Traktörler, tarım sektöründe kullanılan mekanizasyon çeşitliliğinin en önemli bileşenidir. Sağladığı birçok avantaj nedeniyle üretici tarafından farklı fraksiyonlar tercih edilebilmektedir. Arazi türü, arazi büyüklüğü, üretim kalitesi ve toprak özelliklerine göre farklılık gösteren tercihler, traktör piyasalarının yakından incelenmesini gerekli kılmıştır. Traktör piyasaları araştırılırken söz konusu piyasanın beklentilerinin belirlenmesi oldukça önemlidir. Bu çalışmada, Konya ilindeki üreticilerin traktör seçiminde teknolojik özellik açısından tercihleri incelenmiştir. Oransal örnekleme yoluyla 340 üretici ile yapılan anket sonuçları, konjoint analizi kullanılarak değerlendirilmiştir. Analiz sonuçlarına göre, üreticiler tarafından en çok tercih edilen traktörlerin teknolojik özellikleri; güç aralığı 71-100 BG, çekiş özelliği 4WD, fiyat aralığı 1-2 Milyon TL (32.000-62.000$), otomasyon, hidrolik sistem, klima, ısıtma ve ses yalıtımıdır. Bu traktörler, kabin hacmi büyük, GPS ve haritalama sistemlerine sahip traktörler olduğu belirlenmiştir. Türkiye traktör pazarının organizasyonunun üretici beklentileri doğrultusunda planlanması ve bölgesel/yerel pazar segmentasyonunun üretici beklentileri doğrultusunda yapılması, traktör üreticileri ve tarımsal üretimde verimlilik açısından önemli görülmektedir.

Tarım Ekonomisi

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 26.01.2025
Kabul Tarihi : 14.03.2025

Anahtar Kelimeler
Traktör tercihi
Teknoloji
Konjoint analiz
Türkiye

Atıf İçin : Bayramoğlu, Z., Doğan, H.G., Ağızan K., Candemir, S. (2025). Traktör Tercihine Teknolojik Özelliklerin Etkisinin Araştırılması. *KSÜ Tarım ve Doğa Derg 28* (4), 1122-1130. DOI: 10.18016/ksutarimdoga.vi.1627340.

To Cite: Bayramoğlu, Z., Doğan, H.G., Ağızan K., Candemir, S. (2025). Investigating The Effect of Technological Features on Tractor Preference: Case of Konya Province. *KSU J. Agric Nat 28* (4), 1122-1130. DOI: 10.18016/ksutarimdoga.vi.1627340.

INTRODUCTION

Agricultural machinery markets are shaped by economic and political movements on a national, regional, and global scale. The products in the market in question have some differences from other markets and products according to their features and qualities specific to the field (Gazzarin, 2019). These differences are harsh working conditions, minimum working hours despite its potential, seasonal use, high need for security, long economic life, and operation in rugged terrains. On the other hand, many handicaps arising from the nature of agricultural production (energy costs, input-intensive production techniques, high risk, low return, etc.) can lead to the problem of narrowing access to capital for the acquisition of agricultural machinery (Okonkwo et al., 2023). However, policymakers and other stakeholders are struggling with factors that directly affect economic phenomena, such as the shrinkage of arable agricultural lands, deterioration of land quality, and the effects of global climate change. However, because this process is dynamic, the agricultural machinery industry continues to develop in a certain motion (Daum and Birner, 2020; Srivastava, 1993). Modern agricultural machinery has begun to become widespread in the agricultural production systems of developing countries worldwide, and this has caused an increase in the demand for agricultural machinery and tractors (Mottaleb, 2018). In every agricultural land, several tillage operations are carried out after harvest to prepare the desired soil conditions for planting the next crop (Singh et al., 2019a; Singh et al., 2019b). They do this with the help of tractors. From this perspective, tractors can be seen as the backbone of the agricultural sector. Meeting the increasing demand can only be achieved with increased productivity and correct production techniques and achieving this is almost impossible without tractors (Singh et al., 2021; Singh et al., 2022a; Singh et al., 2022b; Singh et al., 2022c). However, although tractors and related machines play an important role in increasing agricultural production, they may cause some problems that will cause discomfort and health problems to their drivers due to the lack of comfort and technological opportunities. At this point, it is considered very important to investigate the existence of technological opportunities that are effective in increasing agricultural production and to determine the preferences of the users (Servadio et. al., 2007). Another important element is the cost of agricultural production. Soil tillage in agricultural production is a high-cost input because of both the energy used and its low portfolio (<0.4 ha/day). If a rough calculation is made, considering that field agriculture is carried out on an area of 15.5 million hectares in Türkiye, the average annual fuel consumption is 620 million liters, depending on the soil processing methods. This amount constitutes 2.5% of the total diesel used in Türkiye (24 million tons). 1% savings in fuel consumption can contribute approximately 6.2 million dollars to the country's economy (Marakoglu and Çarman, 2010). In order to increase the fuel efficiency, traction performance, and stability of tractors, systems have been designed and implemented that will provide simultaneous easy and precise measurement of slip and traction resistance by providing visual and auditory warnings to the operators (Raheman and Jha, 2007, Kumar et al., 2016, Kumar et al., 2017). These systems can provide information to operators. In addition, the systems are designed to ensure continuous control of the traction force depending on the highest traction force produced by the tractors. It is known that traditionally operators had to constantly adjust the depth to obtain the required traction power, and it would be correct to state that this situation has negative effects on productivity (Dwyer et al., 1974, Cowell and Milne, 1977). In the calculations, it was determined that the operating frequency of a hydraulic control level is 3.13 times/min, and only 40% of these operations prevent excessive shifts (Ismail et al., 1981, Ismail et al., 1983).

The existence of support systems that determine demand-side decisions in the acquisition of agricultural tools and machinery should be multifaceted. Because it is stated that approximately 150 different tools, machines, and devices are used in a modernized farm. Therefore, market expectations need to be analyzed well when marketing agricultural machinery. Thus far, various studies on agricultural machinery and tractors have been revealed in research on agricultural machinery. Although the research was aimed at filling the gap in the literature, it allowed for ranking the studies in a general framework (Durczak, 2011).

The main purpose of this research is based on the following motivation: evaluation of agricultural machinery is important from every aspect. The need to evaluate the quality/qualities/features of agricultural machinery and tractors is especially noticed by farmers who use these machines. In this research, we examined how the differences in tractor technologies, which are considered essential in terms of both comfort and work efficiency, are included in manufacturer preference decisions. The results determined according to the multi-dimensional preference criteria will shed light on policymakers both in terms of the tractor market and sectoral efficiency projections.

MATERIAL and METHOD

Method Used in Obtaining Data

The research was carried out in the Konya province. In Konya, there are 107 thousand agricultural enterprises (TOB, 2023) and 74,628 tractors in the Farmer Registration System (TUIK, 2024). Konya has characteristics representing Turkish agriculture, considering its diversity in production, sociodemographic structure, and five agroecological production regions. Within the scope of this study, the preference for technological features of tractors with 35 horsepower was investigated. The number of tractors with 35 horsepower and above in Konya is 69,121 (TUIK, 2024). The presence of tractors by district in Konya is given in Table 1.

Table 1. Tractor presence by district
Çizelge 1 İlçelere göre traktör varlığı

Districts	Number of tractors	Tractor Ratio	Number of Surveys
Çumra	7500	12.08	41
Karatay	6561	10.57	36
Altınekin	5129	8.26	28
Cihanbeyli	4650	7.49	25
Ereğli	4332	6.98	24
Ilgın	4323	6.96	24
Akşehir	3804	6.13	21
Beyşehir	3730	6.01	20
Seydişehir	3250	5.23	18
Kadınhanı	3200	5.15	18
Karapınar	2972	4.79	16
Meram	2887	4.65	16
Yunak	2631	4.24	14
Selçuklu	2618	4.22	14
Kulu	2549	4.11	14
Sarayönü	1952	3.14	11
Total	**62,088**	**100.00**	**340**

In Konya, 16 districts with tractors of 35 horsepower and above were purposely determined, and the main mass was created. The presence of tractors in these 16 districts constitutes 89.83% of the total tractor existence of 35 horsepower and above. The Proportional Sampling Method was used to determine the number of businesses to be surveyed (Newbold et al., 1995).

$$n = \frac{N\,(pq)}{(N-1)D^2 + (pq)}$$

In the formula, n= sample size, N = number of businesses in the population (62,088), $D^2 = (d/t)^2$, d = the amount of error allowed in the population average, and t = the value of the allowed confidence limit (t) in the distribution table.

p = Ratio of tractor presence that maximizes the sample volume. In a study conducted in Konya Çumra district (Keleş & Hacıseferoğulları, 2016), the presence of tractors per enterprise was determined to be 1.04 and in the Kadınhanı district to be 0.81 (Yalmancı, 2008). In this study, $p = 0.5$ was used to reach the maximum number of samples. Since q = 1-p, q = 0.5 is taken.

Using the formula given above, the number of businesses to be surveyed was determined to be 338 with a 99% confidence interval and a 7% margin of error. But it was made 340. In the distribution of the enterprises to be surveyed by districts, the ratio of the districts' tractor assets to the total tractor assets was considered (Table 1).

Method Used to Analyze Data

In this study, conjoint analysis was used to determine the factors affecting tractor preference. Conjoint analysis follows the decomposition approach. It assumes that the overall preference for a product (or service) is determined by preferences for specific features of the product, that these preferences come together, and that the participant maximizes his/her own utility when deciding on the features of the product (Heck et al., 2024). When applying conjoint analysis, participants are asked questions indirectly, assuming that they cannot express their preferences reliably. Participants are presented with various sets of features with different characteristics and are asked to rate them. Based on the participants' overall ratings, their relative preferences (partial value utilities) for different levels are inferred. The determined partial value utilities can be used in simulations to investigate which feature

combinations are most preferred in the relevant product choice (Orme, 2010). Conjoint models are constructed according to the additive part-value rule, which is generally preferred (Ness, 1997; Hair et al., 1990). In the additive part-value model, it is assumed that the part-value of each attribute level is independent and that the total utility of any product profile is the sum of the part-values of the attribute levels of that product profile. Assuming that S_{ij} represents the consumer's level of preference for any alternative product profile (for one of the sixteen choices presented to him), W_{iat} represents the utility or part-value corresponding to level t of attribute a for person i, and Y_{jat} represents a variable expressing the existence of level t of attribute a in product profile j, the additive part-value can be formulated as follows:

$$S_{ij} = \sum_{\alpha=1}^{n} W_{iat} Y_{iat}$$

The aim of conjoint analysis is to calculate W_{iat} values for each feature level.

In addition to traditional conjoint analysis, the most widely used conjoint analysis today is choice-based conjoint analysis (Sawtooth Software, 2017). In choice-based conjoint analysis, participants are presented with different concepts and asked to choose one of them; In traditional conjoint analysis, participants rate the alternatives. Selecting attributes and attribute levels is a critical step in choice-based conjoint analysis. Additionally, manufacturers' preferences are categorized by the size of their business based on the average scores they give to their conjoint cards.

RESULTS

The average age of the producers participating in the research was determined as 42.32 years, 37.05% of the education level had a high school, the average irrigated land size was 338.66 da, and the average dry land size was 128.42 da. In a study conducted in Erzurum province, the average age of producers was calculated as 41.39, and the amount of irrigated land was 98.89 da (Aksoy et al., 2019). In a similar study conducted in the region, the average dry land size was calculated as 128.42 da (Baybas & Aksoy, 2021). When the production pattern in the region is examined, sugar beet, calf corn, silage corn, alfalfa, potatoes, tomatoes, watermelons, melons, and onions are produced in irrigated areas. It can be stated that in dry areas, wheat, barley, sunflower, chickpeas, and lentils are produced. Within the scope of the research, the average number of tractors per enterprise was determined to be 1.77 units, and the average horsepower was determined to be 100.96 hp. The results of the conjoint analysis applied to determine the technological features effective in the tractor preference of the participating producers are given in Table 2. The results obtained reflect the benefit scores and average importance levels of the technological features. Pearson's R and Kendall's tau values, which reflect the suitability of the model, were found to be statistically significant ($p<0.01$). When the features are examined in terms of tractor technology, the most important feature is the presence of a cabin (20.79%). GPS (13.80%), Security (12.89%), Control (12.17%), Hydraulics (11.26%), Horsepower (10.18%), Price (9.46%), Emission (9.11%), and Propulsion (0.30%). When the lower levels are examined in terms of benefits, it can be stated that tractors with 1-2 million TL in terms of price, tractors with 101-150 hp in terms of horsepower, and tractors with 2WD in terms of propulsion come to the fore.

Preferences in different criteria and total benefit scores obtained because of the combinations created from the preference cards presented to the producers in determining the technological features that affect tractor preference are given in Table 3.

Table 3 shows the tractor features preferred by manufacturers and their related benefit scores. When the 16 profiles created were ranked in terms of benefit scores, the most preferred profile was profile 16, and the least preferred profile was profile 1. Accordingly, the most preferred tractor type by producers in Konya province in terms of technological features has a power range of 71-100 hp, 4 WD in terms of Propulsion, a price of 1-2 million TL, an automated hydraulic system, air conditioning, heating, sound insulation, and cabin volume. It was determined that they were large tractors equipped with GPS and mapping systems. The least preferred tractor type in terms of technological features is the tractors that have 40-70 hp engine power, 2WD in terms of drive, a price between 1 and 2 million TL, and do not have any other technological features. When Table 4 is examined, according to the average scores of 16 preference cards on the 5-point Likert scale, the card in the 16th row is compatible with Table 3.

DISCUSSION

Using farm equipment in agriculture and updating it according to developing technologies provides many advantages. These advantages include labor saving, resource efficiency, output efficiency, saving time in tillage and land management, and obtaining several crops per year in the case of suitable irrigation facilities and climatic factors. The most important of these farm tools is the tractor. The development of tractor technologies is extremely

important for agricultural production. While the presence of GPS systems enables automatic steering, air conditioning, and cabin systems enable labor efficiency because they are comfort oriented. While appropriate tractor power provides work efficiency, optimal capital and fuel consumption provide economic advantages. Therefore, manufacturers' preference criteria for tractor acquisition form the basis of national policy. For example, Ethiopia publicly announced its decision to encourage the acquisition of tractors to reduce postharvest losses and increase the mechanical strength index (ENPC, 2015). In addition, an agricultural mechanization strategy has been proposed to increase the level of advanced agricultural mechanization by supporting middle-income producers and to ensure national food production and security (ATA, 2017). Various methods have attracted attention in the literature for determining tractor preference. Mehta et al., (2011) developed a decision support system to determine tractors and suitable equipment working in different field conditions, and Zou et al., (2011) developed a hybrid system that allows selection using neural networks and a support vector machine. Grisso et al., (2014)'s selection method, developed with tractor test data, and Osman, (2011)'s methods for determining selection criteria with linear programming can be listed. In this research, tractor options with different technological features were presented to the manufacturer, and the manufacturer selected the most suitable ones among 16 different selection criteria. And then the data was analyzed with Conjoint Analysis. The research was conducted in the Konya province of Türkiye. One of the most important regions where intensive agriculture is practiced in Türkiye is Konya. Konya province, which consists of five agro-ecological zones and 31 districts, has an agricultural structure that can represent the whole of Türkiye in terms of both business scale size and production pattern.

Table 2. Utility Scores and Average Importance Values Resulting from the Conjoint Analysis
Çizelge 2. Konjoint Analizinden Elde Edilen Fayda Puanları ve Ortalama Önem Değerleri

Technological Features Affecting Tractor Preference		Utility Estimate	Std. Error	Average importance score (%)
Horsepower	40-70	-.184	.095	10.187
	71-100	-.019	.095	
	101-150	.151	.095	
	150-+	.052	.095	
Propulsion	2-WD	.005	.055	0.304
	4-WD	-.005	.055	
Price	between 1 Million and 2 Million	.156	.073	9.463
	between 2 Million and 4 Million	-.001	.085	
	more than 4 Million	-.155	.085	
Hydraulics	None	-.185	.055	11.262
	Automated Hydraulic System	.185	.055	
Cabin	None	-.342	.055	20.794
	Air conditioning, heating, sound insulation, and cabin volume	.342	.055	
GPS	None	-.227	.055	13.808
	GPS and Mapping Systems	.227	.055	
Control	None	-.200	.055	12.173
	Intelligent speed control, autopilot systems, and data collection features	.200	.055	
Security	None	-.212	.055	12.897
	Emergency Braking System, Collision Prevention System, Rear View Camera, Airbag	.212	.055	
Emission	None	-.150	.055	9.112
	A system designed to reduce pollutants released into the atmosphere from exhaust gasses	.150	.055	
(Constant)		2.850	.058	

Correlation of Observed and Expected Values	Value	Sig.(p)	
Pearson's R	.987	.000	(p<.05)
Kendall's tau	.917	.000	(p<.05)

Table 3. Total and Ranking of the Utility Values of All Profiles

Çizelge 3. Tüm Profillerin Fayda Değerlerinin Toplamı ve Sıralaması

Row	Horsepower	Propulsion mechanism	Price	Automated Hydraulic System	Cabin Design and Comfort (Air Conditioning, Heating, Sound Insulation and Cabin Volume)	GPS and Mapping Systems	Control Systems (Smart speed control, automatic pilot systems and data collection features)	Security Technology (Emergency Brake System, Collision Prevention System, Rear View Camera, Airbag)	Emission Control Systems (Systems designed to reduce pollutants released into the atmosphere from exhaust gasses)	Total Score
1	between 40 and 70 hp	(2-WD)	between 1 million and 2 million	None	None	None	None	None	None	-1.341
2	between 101 and 150 hp	(4-WD)	between 2 million and 4 million	None	None	Yes	None	None	None	-0.718
3	between 71 and 100 hp	(4-WD)	More than 4 million	Yes	None	None	None	None	Yes	-0.514
4	between 40 and 70 hp	(4-WD)	More than 4 million	None	None	None	Yes	Yes	None	-0.466
5	between 71 and 100 hp	(2-WD)	between 2 million and 4 million	None	Yes	Yes	None	Yes	None	-0.207
6	More than 150 hp	(4-WD)	between 1 million and 2 million	None	Yes	None	None	Yes	None	-0.005
7	between 101 and 150 hp	(2-WD)	between 1 million and 2 million	Yes	Yes	None	None	Yes	Yes	0.05
8	between 101 and 150 hp	(4-WD)	More than 4 million	None	Yes	None	Yes	None	Yes	0.059
9	between 71 and 100 hp	(2-WD)	between 2 million and 4 million	None	None	None	Yes	Yes	Yes	0.077
10	More than 150 hp	(2-WD)	between 2 million and 4 million	Yes	Yes	None	Yes	None	None	0.194
11	More than 150 hp	(2-WD)	More than 4 million	Yes	None	Yes	None	None	Yes	0.394
12	More than 150 hp	(4-WD)	between 1 million and 2 million	None	None	Yes	Yes	Yes	Yes	0.466
13	between 40 and 70 hp	(2-WD)	between 1 million and 2 million	None	Yes	Yes	Yes	None	Yes	0.499
14	between 101 and 150 hp	(2-WD)	between 1 million and 2 million	Yes	Yes	Yes	None	Yes	None	0.646
15	between 40 and 70 hp	(4-WD)	between 2 million and 4 million	Yes	Yes	Yes	None	Yes	Yes	0.726
16	between 71 and 100 hp	(4-WD)	between 1 million and 2 million	Yes	Yes	Yes	Yes	None	None	0.726

Table 4. Average Score of the Preference Criteria by Business Size Groups
Çizelge 4. İşletme Büyüklük Gruplarına Göre Tercih Kriterlerinin Ortalama Puanı

	Agribusiness Size Groups (da)			
	0-100	101-300	301-+	Total
1	3.584	3.694	3.589	3.621
2	2.232	1.963	2.084	2.100
3	2.424	2.056	2.290	2.265
4	2.384	2.176	2.458	2.341
5	2.912	3.037	2.822	2.924
6	2.808	2.815	2.757	2.794
7	3.584	3.694	3.589	3.621
8	3.152	2.981	2.879	3.012
9	2.800	2.630	2.636	2.694
10	3.112	2.991	2.991	3.035
11	2.704	2.602	2.523	2.615
12	3.544	3.398	3.196	3.388
13	3.112	3.194	3.215	3.171
14	3.392	3.565	3.495	3.479
15	3.472	**3.778**	**3.729**	3.650
16	**3.664**	3.685	3.692	**3.679**

CONCLUSION

When the research results obtained are examined, it can be stated that there is a holistic demand for tractor preference in terms of technological features, apart from safety and emission criteria. It has been concluded that tractor power, which is sized according to the average business size, is sufficient if it is double-wheel drive and in the range of 71-100 hp. Considering the agricultural structure of Konya, which is the study area, it can be stated that tractors are mostly used in soil cultivation and in transportation operations. Therefore, it can be said that safety and emission preferences are not considered among the primary criteria by the manufacturer. These results are important in terms of taking regional dynamics into consideration when making simulations for the tractor market, diversifying financing opportunities/financing range, and creating marketing systems. However, it is important to detail the findings obtained on a national and regional basis. Although Konya province has a profile that can represent Turkey in terms of agriculture, it can be stated that the business structures in Turkey vary from region to region and even in different provinces in the same region. Therefore, it is recommended to expand this study in order to ensure the correct selection of tractors, which are the most important tools of agricultural production suitable for the conditions of the age, and to increase agricultural productivity accordingly.

Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

Conflict of Interest

The authors of the articles declare that they have no conflict of interest.

REFERENCES

Agricultural Transformation Agency (ATA) (2017). Mechanization. *http://www.ata.gov.et/programs/mechanization* Access: 20.05.2024

Aksoy, A., Demir, N., & Demir, O. (2019). An analysis on determinants of farmers' tractor purchasing behavior in Erzurum Province. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi*, *50*(1), 75-83.

Baybas, S., & Aksoy, A. (2021). Erzurum İli Çiftçilerinin Traktör Marka Tercihini Etkileyen Faktörlerin Belirlenmesi. *Turkish Journal of Agricultural Engineering Research*, *2*(2), 376-389.

Cowell, P. A., & Milne, M. J. (1977). An implement control system using pure draught force sensing and modified linkage geometry. *Journal of Agricultural Engineering Research*, *22*(4), 353-371.

Daum, T., & Birner, R. (2020). Agricultural mechanization in Africa: Myths, realities and an emerging research agenda. *Global food security*, *26*, 100393.

Durczak, K. (2011). System oceny jakości maszyn rolniczych. Rozprawy Naukowe. *Uniwersytet Przyrodniczy w Poznaniu, 418*, 1-161..

Dwyer, M. J., Crolla, D. A., & Pearson, G. (1974). An investigation of the potential for improvement of tractor draught controls. *Journal of Agricultural Engineering Research*, *19*(2), 147-165.

Ethiopia National Planning Commission (ENPC). *Growth and Transformation Plan-II* (2015/16–2019/20). Vol. I: The main text. Addis Ababa, Ethiopia. 2015.

Gazzarin, C. (2019). Ökonomie. Maschinenkosten 2019. *Agroscope Transfer*, *291*, 1-27.

Grisso, R.B., Perumpral, J.V., Roberson, G.T. & Pitman, R. (2014). Using tractor test data for selecting farm tractors. *Virginia Cooperative Extension*, https://pubs.ext.vt.edu/442/442-072/442-072_pdf.pdf

Hair J., Anderson R., Tatham R., (1990), Multivariate Data Analysis With Readings, 2 nd Edition, New York, Macmillan.

Heck, J., Jahnke, L., Leker, J. (2024). Early evidence of a transition towards sustainability-oriented decision-making in the chemical industry in Germany, Austria, and Switzerland: A choice-based conjoint analysis. *Energy Policy*. *184*, 114028.

Ismail, S. M., Singh, G., & Gee-Clough, D. (1981). A preliminary investigation of a combined slip and draught control for tractors. *Journal of Agricultural Engineering Research*, *26*(4), 293-306.

Ismail, S. M., Singh, G., & Gee-Clough, D. (1983). Comparison of the field performance of three implement control systems for a tractor. *Journal of Agricultural Engineering Research*, *28*(6), 521-536.

Keleş, İ., & Hacıseferoğulları, H. (2016). Konya ili çumra ilçesi tarım işletmelerinin tarımsal yapı ve mekanizasyon özelliklerinin belirlenmesi. *Selçuk Tarım Bilimleri Dergisi*, *3*(1), 48-58.

Kumar, A. A., Tewari, V. K., & Nare, B. (2016). Embedded digital draft force and wheel slip indicator for tillage research. *Computers and Electronics in Agriculture*, *127*, 38-49.

Kumar, A. A., Tewari, V. K., Gupta, C., & Pareek, C. M. (2017). A device to measure wheel slip to improve the fuel efficiency of off road vehicles. *Journal of Terramechanics*, *70*, 1-11.

Marakoglu, T., & Carman, K. (2010). Energy balance of direct seeding applications used in wheat production in middle Anatolia. *African Journal of Agricultural Research*, *5*(10), 988-992.

Mehta, C. R., Singh, K., & Selvan, M. M. (2011). A decision support system for selection of tractor–implement system used on Indian farms. *Journal of terramechanics*, *48*(1), 65-73.

Mottaleb, K. A. (2018). Perception and adoption of a new agricultural technology: Evidence from a developing country. *Technology in society*, *55*, 126-135.

Ness, M.R., (1997), Multivariate Analysis in Marketing Research, in: Padberg D. Ritson C. and Albisu L.M., eds: Agro Food Marketing, Chapter 12, Wallingford*, Oxfordshire*, CAB International., p: 253-278.

Newbold, P., Carlson, W., & Thorne, B. (1995). Statistic For Business and Economics, *by Prentice-Hall*. Inc., NJ.

Okonkwo, C. E., Isaac, M. O., Alhassan, E. A., Ogbevire, M., Alake, A. S., Ajao, F. O., & Olayanju, A. T. (2023). Design and fabrication of a fish feed mixing cum pelleting machine for small-medium scale aquaculture industry. *Open Agriculture*, *8*(1), 20220124.

Orme, B.(2010). Getting started with conjoint analysis: strategies for product design and pricing research. In: Getting Started with Conjoint Analysis: *Strategies for Product Design and Pricing Research*, fourth ed. Research Publishers LLC.

Osman, N. O. A. (2011). A Model for Farm Machinery Selection. *Master Thesis*, University of Khartoum, Faculty of Agriculture.

Raheman, H., & Jha, S. K. (2007). Wheel slip measurement in 2WD tractor. *Journal of terramechanics*, *44*(1), 89-94.

Sawtooth Software. (2017). Sawtooth software: the CBC system for choice-based conjoint analysis. *Sawtooth Software Technical Paper Series 9*, 1–27.

Servadio, P., Marsili, A., & Belfiore, N. P. (2007). Analysis of driving seat vibrations in high forward speed tractors. *Biosystems engineering*, *97*(2), 171-180.

Singh, A., Singh, L. P., Singh, S., & Singh, H. (2019a). Optimization of Occupational Whole Body Vibration Exposure for Rotavation Operation. In Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) Volume VI: Transport Ergonomics and Human Factors (TEHF), *Aerospace Human Factors and Ergonomics 20* (pp. 467-473). Springer International Publishing.

Singh, A., Singh, L. P., Singh, S., Singh, H., Chhuneja, N. K., & Singh, M. (2019b). Evaluation and analysis of occupational ride comfort in rotary soil tillage operation. *Measurement*, *131*, 19-27.

Singh, A., Samuel, S., Singh, H., Kumar, Y., & Prakash, C. (2021). Evaluation and analysis of whole-body vibration exposure during soil tillage operation. *Safety*, *7*(3), 61.

Singh, A., Nawayseh, N., Singh, H., Samuel, S., Prakash, C., Singh, R., ... & Chhuneja, N. K. (2022a). Modelling and optimization of tractor ride conditions under water tanker operation. *Theoretical Issues in Ergonomics Science*, *23*(4), 453-474.

Singh, A., Singh, L. P., Singh, S., & Singh, H. (2022b). Occupational Whole Body Vibration Exposure Among Tractor Drivers During Harrowing. *In Ergonomics for Improved Productivity: Proceedings* of HWWE 2017

Volume *2* (pp. 127-135). Springer Singapore.

Singh, A., Samuel, S., Singh, H., Singh, J., Prakash, C., & Dhabi, Y. K. (2022c). Whole body vibration exposure among the tractor operator during soil tillage operation: An evaluation using ISO 2631-5 standard. *Shock and Vibration*, *2022*, 1-8.

Srivastava, A. K., Goering, C. E., Rohrbach, R. P., & Buckmaster, D. R. (1993). Engineering principles of agricultural machines. ASABE Press. ISBN: 1-892769-50-6. doi: https://doi.org/10.13031/epam.2013

TOB. (2023). Çiftçi Kayıt Sistemi Verileri. Tarım ve Orman Bakanlığı.

TUIK. (2024). Tarımsal İstatistikler. Retrieved 09.04.2024 from https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1

Yalmancı, B. (2008). Konya ili kadınhanı ilçesinde tarım işletmelerinin tarımsal mekanizasyon düzeyinin belirlenmesi. https://agris.fao.org/search/en/providers/122624/records/64736594e17b74d222545703