Tarım Ekonomisi Dergisi
Turkish Journal of Agricultural Economics
ISSN 1303-0183
e-ISSN 3023-5596

Determination of sufficient income farm size for sustainable development in agricultural enterprises in Aydın province

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Makale Künyesi

Araştırma Makalesi / Research Article

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Geliş Tarihi / Received: 15.08.2024
Kabul Tarihi / Accepted: 01.10.2024

Tarım Ekonomisi Dergisi
Cilt:30 Sayı:2 Sayfa: 149-160

Turkish Journal of Agricultural Economic
Volume:30 Issue:2 Page: 149-160

DOI: 10.24181/tarekoder.1533809
JEL Classification: Q01, Q12, Q13

Abstract

Purpose: This study investigates the economic size, sufficient income farm size, and sustainability of agricultural farms in Aydın Province, known for its diverse and intensive agricultural production.

Design/Methodology/Approach: Data were collected via face-to-face surveys from 389 farms in 17 districts and 46 villages in 2022, using proportional sampling. Socio-economic characteristics were analyzed, and economic sizes were determined using ESU criteria. Income adequacy was assessed against the TURKSTAT relative poverty line. Statistical methods, including ANOVA, Kruskal-Wallis, and Chi-Square tests, were employed to compare farm groups.

Findings: Based on ESU, 30.85% of farms were large, 51.16% medium, and 18% small. Farms with agricultural incomes 15% below the poverty line were classified as insufficient. Sufficient income farms recorded a gross margin of 380 €/da/year and agricultural income of 299 €/da/year in 2022, while in 2024, these values were 13,300 TL/da/year and 10,465 TL/da/year, respectively. Farms with sufficient income exhibited greater economic size, income, and sustainability, while those below the threshold faced challenges in savings, investments, and self-sufficiency, limiting sustainable development.

Originality/Value: This research uniquely integrates economic size, income adequacy, and sustainability in a high-potential agricultural region, addressing a gap in the literature by offering a comprehensive analysis of these dimensions.

Keywords: Sufficient income, economic size, sustainable development, sustainable agriculture, Aydın

Aydın ili tarım işletmelerinde sürdürülebilir kalkınma için yeter gelirli işletme büyüklüğünün belirlenmesi

Özet

Amaç: Bu araştırma, tarımsal üretimin yoğun ve ürün çeşitliliği ile bilinen Aydın ilindeki tarımsal işletmelerin ekonomik özelliklerini, yeter gelirli işletme büyüklüğünü ve sürdürülebilir kalkınma durumlarını incelemeyi amaçlamaktadır.

Tasarım/Metodoloji /Yaklaşım: Veriler, 2022 yılında 17 ilçe ve 46 köydeki 389 çiftlikten orantılı örnekleme kullanılarak yüz yüze anket yoluyla toplanmıştır. Sosyo-ekonomik özellikler analiz edilmiş ve ekonomik büyüklükler ESU kriterleri kullanılarak belirlenmiştir. Gelir yeterliliği, TÜİK göreli yoksulluk sınırına göre değerlendirilmiştir. Çiftlik gruplarını karşılaştırmak için ANOVA, Kruskal-Wallis ve Ki-Kare testleri dahil olmak üzere istatistiksel yöntemler kullanılmıştır.

Bulgular: ESU kriterlerine göre, işletmelerin %30,85'i ekonomik olarak büyük, %51,16'sı orta ve %18'i küçüktür. 2022 gelir bazlı yoksulluk sınırı eşik olarak kullanılarak işletmeler gelir düzeylerine göre kategorize edilmiştir. Tarımsal gelirleri yoksulluk sınırının %15 altında olan işletmeler yeterli gelir sınırının altında kabul edilirken, yoksulluk sınırında olanlar yeterli gelire sahip kabul edilmiştir. Yeter gelirli işletmeler için 2022 yılında brüt marj 380 €/da/yıl, tarımsal gelir ise 299 €/da/yıl olmuştur. Bu değerler 2024 yılında sırasıyla 13.300 TL/da/yıl ve 10.465 TL/da/yıl olmuştur. Yeterli gelire sahip işletmelerin ekonomik büyüklük, tarımsal gelir, brüt kar marjı ve sürdürülebilirlik düzeyleri, yeterli gelir sınırının altındaki işletmelere göre daha yüksektir. Yeterli gelir seviyesinin altındaki işletmeler, yetersiz tasarruf, yatırım ve kendi kendine yeterlilik nedeniyle sürdürülebilir kalkınma fırsatlarından yoksundur.

Özgünlük/Değer: Bu araştırma, yüksek tarımsal potansiyele sahip bir bölgedeki işletmelerin ekonomik büyüklüğünü, yeterli gelirli işletme büyüklüğünü ve sürdürülebilir kalkınma durumunu benzersiz bir şekilde bütünleştirmekte ve bu boyutların kapsamlı bir analizini sunarak literatürdeki bir boşluğu doldurmaktadır.

Anahtar kelimeler: Yeter gelir, ekonomik büyüklük, sürdürülebilir kalkınma, sürdürülebilir tarım, Aydın

INTRODUCTION

The agricultural sector and farms is a critical socio-economic activity for meeting the food needs of present and future generations and plays an important role in achieving sustainable development goals. Agriculture has important functions related to food production and well-being. Therefore, sustainable development and growth of the agricultural sector is essential for the environment, society and the economy. To meet the needs of present and future generations, the importance of sustainable development of agricultural production and farms is increasingly recognised (FAO, 2012; Mellor, 1995; Nowak et al. 2019; Pretty, 2008; Tilman et al. 2002; Wiskerke, 2009).

Agricultural production and farms play an important role in the welfare of populations by influencing economic and rural development (Hurduzeu et al. 2022; Mellor, 1995). The World Bank's World Development Report highlights the importance of sustainable agriculture and rural development in achieving the Millennium Development Goals. In recent years, in addition to increasing the yield and quality of agricultural production, the need to determine the size of farms that can generate sufficient income for the sustainability of agricultural farms has come to the fore. Determining this size is of great importance in terms of a balanced distribution of growth in the agricultural sector and preventing farms from falling below the size of sufficient income (Gündoğmuş et al., 2017; Tımbıl, 2003). Many studies have analysed 'sufficiency and income sufficiency' strategies from a theoretical and macro perspective (Alcott, 2008; Figge et al. 2014; Princen, 2005). However there are gaps in determining the size of the farm with sufficient income. For sustainable agriculture it is important to determine the size of the farm with sufficient income in an objective and scientific way. Income from agriculture supports the sustainability of farming families and rural areas, and food from agriculture supports a sustainable society (Agovino et al., 2023).

In his 1968 speech at the University of Kansas, Senator Robert F. Kennedy stated that economic variables that make life worth living should be measured. Increasing the level of adequate income aims to increase the well-being, happiness, life satisfaction and overall sustainable development of individuals (Smith and Wesselbaum, 2023; UNDP, 1990). In agriculture, rural areas, and agricultural farms, sufficient income or the possession of sufficient income is crucial for sustainable development and its impact on agriculture. In agricultural sciences, studies aimed at determining the level of sufficient income in rural areas and agricultural farms are inadequate. Sufficient income is a critical issue that bridges the gap between sustainable development, sustainable agriculture, and agricultural farms, and it needs to be empirically measured (Smith and Wesselbaum, 2023). When income and sufficient income are considered as measurable variables, the necessity to consider their effects on farmer welfare, farmer economic development, and sustainable development becomes evident (Castro and Bleys, 2023; Aslan and Armağan, 2020; Katipoğlu and Armağan, 2020).

Income is a significant issue for economists who argue that high income and sufficient income contribute to individuals' life satisfaction and development. Sufficient income can ensure the sustainable development and well-being of individuals and agricultural farm owners. As an economic and measurable variable, the direct and objective measurement of sufficient income for individuals and agricultural farms is of critical importance for sustainable development. Increasing sufficient income per capita in agriculture and rural areas can enhance individuals' welfare, life satisfaction, and the sustainable development of agricultural farms, thereby securing future generations' food needs. To meet the needs of future generations without compromising the needs of the current generation, it is essential to increase the level of sufficient income and ensure sustainability in rural areas and agriculture. The limited research on sustainable development, sustainable agriculture, and sufficient income farm size, along with the inadequacy of studies that holistically examine these topics, further underscores the importance of this research (Deaton, 2008; Easterlin, 1974; Hurduzeu et al., 2022; Liao, 2021; Sen, 1999).

This study, focusing on agricultural farms in Aydın Province, is of vital importance due to the significant role of agricultural production and its economic impact. A detailed examination of the economic sizes of agricultural farms engaged in agricultural activities, the sufficient income farm sizes, and the state of sustainable development is a critical step in ensuring the sustainable development of agricultural farms. The existing studies on determining the economic size of farms and sufficient income farm sizes are inadequate and limited (Özkan & Armağan, 2019), making this research particularly significant. Additional empirical research is needed to better understand the effects of farms economic size and sufficient income level on sustainable development. This study aims to fill the knowledge gap in the field by examining the economic size of farms, sufficient income farm sizes, and their sustainable development status. The relationship between agricultural farm economic size, sufficient income farm size, and sustainable development is analyzed comprehensively in this study. The importance of this research is further emphasized by the fact that there has been insufficient study on sufficient income farm size in Aydın Province, especially at the regional

and national levels, over the past thirty years. Objectively and scientifically determining the economic size of farms and sufficient income farm sizes is critical for sustainability and development in agriculture. This research aims to determine the sufficient income farm size necessary for the sustainable development and continuity of agricultural production activities in agricultural farms in Aydın Province.

MATERIAL and METHODS

Material

The study was conducted in the regions where agricultural production is intensive and the number of farmers is the highest in the province of Aydın, according to the data obtained from the Aydın Directorate of Agriculture and Forestry. In 2020, there will be 50.825 farmers registered in the Farmer Registration System in Aydın. A total of 46 lowland villages from 17 districts of Aydın province, where the number of farmers is highest and production is intensive, were surveyed. Primary data were collected from the farmers engaged in agricultural production activities using farmer questionnaires. The ethical approval for these forms was obtained from the Research Ethics Committee of Aydın Adnan Menderes Social and Human Sciences University on 31.01.2002.

Method

Data collection

In the research, the lowland villages of Aydın Province where crop and livestock production is most intensive and the number of farmers is highest were selected; this selection aims to represent the entire Aydın Province. The sample of farms and farmers was determined as the maximum sampling volume in finite main populations (Newbold, 1995).

The sampling formula is as follows

$$n = \frac{Np(1-p)}{(N-1)\sigma_{px}^2+p(1-p)} \quad (1)$$

Thus, n is the sample size, N is the population size (50.825), p is the estimation rate (p=0.50 is taken for the maximum sample size, since the proportion of farms with sufficient income is unknown. The proportion of farms with sufficient income is 0.50), σ_{px} is the confidence interval of the probability level (σ_{px} 0.02551 from the equation σ_{px}*1.96= 0.05 for 95% confidence interval, 0.05 level of error). As a result of the calculation, the sample size was found to be 383.88. The total sample size was distributed proportionally across the districts, and face-to-face interviews were conducted with a total of 389 farmers in 2022.

Data analysis method

Descriptive statistics (mean, percentage and standard deviation) were used in the analysis of some socio-demographic, physical asset and economic characteristics of the farms considered in this study. The annual agricultural income values of each farm were determined in order to define the farm size and economic size groups with sufficient income according to ESU. The analysed farms were grouped according to the agricultural income indicators. Parametric and non-parametric tests were used to compare groups of farms and to determine the relationship between some socio-economic variables. The Anova test was used for continuous variables with normal distribution and the Kruskal-Wallis-H test for continuous variables without normal distribution. When comparing the observed and expected frequencies of two multi-categorised variables, the Chi-square test was used to determine the relationship between the variables. In addition, some continuous variables were categorised and the Khi-square test was also applied to determine whether these variables affected the income level of agricultural farms.

Agricultural income has been used to group farms according to ESU (European Size Unit) values. According to ESU, the economic size of agricultural farms is divided into six main groups. For the year 2022, the total annual agricultural income of each agricultural farm was divided by the euro value of 2022 in TL (average euro exchange rate of 17.41 TL/€). The result obtained was divided by 1.200 € to determine the number and amount of ESUs of each farm's agricultural income in euro. The value of agricultural income in euro and the number of ESUs represent the economic size of the farms (EUROSTAT, 2014). In the EU Commission Implementing Regulation of 3 February 2015/220 and Council Regulation No 1217/2009, farms are divided into 14 classes in Euro and these classes can be grouped into six groups (EU Commission Implementing Regulation, 2015). In the study, the agricultural income indicator was used to divide farms into six groups according to the number of economic size units (ESUs): Farms with

less than 4 ESUs are classified as very small; farms with 4-8 ESUs are classified as small; farms with 8-16 ESUs are classified as below average; farms with 16-40 ESUs are classified as above average; farms with 40-100 ESUs are classified as large; and farms with 100 ESUs and more are classified as very large.

In order to calculate the Sufficient Income values of the farms, the indicator of the 'income-based relative poverty line calculated for Turkey using Purchasing Power Parity (PPP)' (20.663 TL/month) was used in the TURKSTAT 2022 Income and Living Conditions Survey (TURKSTAT, 2022). In determining the size groups of agricultural farms with sufficient income, 60 per cent of the median income calculated by TURKSTAT for Turkey, i.e. the income-based relative poverty line, was accepted as the threshold and/or limit. In this way, it was determined whether the total value of agricultural income received by each farm in a year could in principle ensure the subsistence of the household and whether it was below the income-based relative poverty line. In determining this situation for all agricultural farms, firstly, the TURKSTAT income-based relative poverty line (threshold value=20.663 TL*12=247.956 TL) was multiplied by 12 months and the annual relative poverty line was accepted as a fixed threshold and/or limit for all agricultural farms. If the annual agricultural income of the farms is 15% below this threshold, they are divided into three groups as farms below the adequate income, if it is above 15%, they are divided into three groups as farms above the adequate income and if it is in the range of the threshold, they are divided into three groups as farms with adequate income. The income-based relative poverty rate of agricultural farms in Aydın province is 21.3%. According to TurkStat, the income-based relative poverty rate in Turkey is 21.6% (TurkStat, 2022).

FINDINGS and DISCUSSION

Some socio-economic characteristics of farms according to ESU

In this study, the average age of farmers was 48.43 years. Çukur and Işın (2008) reported an average age of 47.44 years, while found it to be 52.22 years. The average agricultural work experience was 30.11 years, compared to 30.14 years reported by Çınar and Armağan (2009). Regarding education levels, 48.6% of the farmers were primary school graduates and 5.4% were university graduates. Kınıklı (2022) reported 47% of primary school graduates and 9.5% of university graduates. Membership rates varied, with Yılmaz (2021) reporting 89% membership in the Chamber of Agriculture, 16% in Agricultural Credit Cooperatives, and 33.6% in TARİŞ. In contrast, Kınıklı (2022) found 19.5% membership in agricultural credit cooperatives and 70% in agricultural development cooperatives. In this study, 64.8% were members of agricultural credit cooperatives and 29.6% were members of agricultural development cooperatives (Table 1).

Table 1. *Some socio-demographic and physical characteristics of agricultural farms*

	1. Group (n=35)	2. Group (n=35)	3. Group (n=58)	4. Group (n=141)	5. Group (n=86)	6. Group (n=34)	General (n=389)
Farmer age	47.06	51.71	52.31	46.99	50.51	40.56	48.43
Agricultural experience (year)	27.51	32.26	32.72	28.47	33.42	24.65	30.11
Primary education (%)	60.0	54.3	51.7	45.4	52.3	29.4	48.6
Secondary education (%)	11.4	28.6	22.4	16.3	18.6	20.6	18.8
High school (%)	20.0	17.1	19.0	24.8	18.6	35.3	22.4
Associate's Degree(%)	5.7	0.0	1.7	6.4	5.8	5.9	4.9
University graduate (%)	2.9	0.0	5.2	7.1	4.7	8.8	5.4
Members in agricultural credit cooperative (%)	45.7	45.7	63.7	61.0	79.1	84.3	64.8
Members in Tariş (%)	20,0	22,9	29,3	36,9	52,3	53,0	37,8
Membership to chambers of agriculture (%)	94.3	37.2	99.1	99.3	97.7	100.0	98,4
Members in the irrigation union (%)	82,8	85,0	89,7	92,2	93,3	97,1	91,5
Membership to dairy unions (%)	22,9	14,3	15,5	19,8	17,4	11,8	17,7
Population per farm	4.11	3.80	3.90	4.33	4.88	5.85	4.45
Owned land area (da)	41.75	30.08	43.24	57.85	130.78	268.45	86.25
Rented-Out land area (da)	0.43	0.49	0.22	0.64	0.00	0.00	0.34
Land shared with a partner (da)	0.00	0.71	0.12	1.47	1.72	8.34	1.72
Rented-In land area (da)	5.66	5.51	11.52	25.47	41.78	99.67	29.90
Land shared with a partner (da)	1.00	0.29	3.11	4.75	9.04	12.68	5.41
Irrigated land area (da)	38.87	27.41	46.37	75.57	158.99	330.66	104.31
Non-irrigated land (da)	10.06	9.67	11.86	14.61	24.33	58.47	19.32
Average land area (da)	48.92	37.08	58.22	90.18	183.32	389.13	123.64
Livestock farmers (%)	65.70	60.00	70.70	72.30	70.90	52.90	68.40
Large ruminants (head)	43.11	26.93	26.62	35.23	60.13	81.00	43.49
Small ruminants (head)	21.04	77.34	82.05	39.28	58.90	97.10	60.84
Tractor ownership (units)	1.14	1.11	1.36	1.65	2.33	3.29	1.80

Çukur and Işın (2008) found the average population per farm to be 3.61, Şekerdil and Engindeniz (2020) found this ratio to be 4.49. In all farm groups, the proportion of the active population aged 16-64 (51.34%) is higher than in the other age groups. In the study, the average land size of agricultural farms was found to be 123.64 decares, Çukur and Işın (2008) and Aydın and Unakıtan (2016) found 116.31 and 117.49 decares, respectively. The average size of irrigated land is 104.31 decares, while the average size of non-irrigated land is 19.32 decares. Kınıklı (2022) found that the average irrigated area was 47.05 decares and the average non-irrigated area was 4.37 decares (Table 1).

Table 2. *Some economic characteristics of agricultural farms (1,000)*

	1. Group (n=35)	**2. Group (n=35)**	**3. Group (n=58)**	**4. Group (n=141)**	**5. Group (n=86)**	**6. Group (n=34)**	**General (n=389)**
Crop gross production value (TL/year)	339.6	239.5	448.6	748.3	1.646,1	4.252,7	1.125,8
Livestock gross production value (TL/year)	533.1	316.2	381.7	664.2	1.268,2	1.627,7	789.6
Crop production variable costs (TL/year)	105.0	49.3	109.4	189.7	427.7	1.152.7	294.3
Livestock production variable costs (TL/year)	487.9	206.4	364.7	387.2	707.6	626.4	453.7
Gross production value of the farm (TL/year)	689.9	429.3	705.3	1.219.3	2.545,7	5.114,5	1.657,6
Variable costs of the farm (TL/year)	592.9	255.7	375.8	576.9	1.135,4	1.779,1	748.0
Fixed costs (TL/year)	55.1	44.6	76.2	99.4	192.3	350.4	129.5
Gross margin value (TL/year)	97.0	173.5	329.5	642.3	1.410,2	3.335,3	909.6
Agricultural income value (TL/year)	41.8	128.8	253.2	542.9	1.217,9	2.984,8	780.0
Crop production value per decare (TL/da/year)	6.8	7.1	8.5	9.2	10.0	11.6	9.1
Crop production variable costs per decare (TL/da/year)	1.8	1.4	1.9	2.2	2.3	3.1	2.1
Fixed costs per decare (TL/da/year)	1.4	1.3	1.3	1.1	1.1	1.0	1.2
Gross margin value per decare (TL/da/year)	3.1	6.5	7.2	9.0	10.2	9.5	8.3
Agricultural income per decare (TL/da/year)	1.7	5.2	5.8	7.8	9.0	8.6	7.0

Variability in farm income levels was observed in this survey. The agricultural income of 18% of the farms was found to be less than 8 ESU and these farms were in the small and very small group. Bojnec and Latruffe (2007) found that the economic size of more than 40% of the farms was in the small and very small group and their agricultural income was less than eight ESU. Similar to this study, Wicki (2019) classified farms into six different economic size classes. In addition, Koç (2022) found that agricultural income accounted for 85.16% of farms livelihoods, while Fabusoro et al. (2010) found that only 35% of agricultural income contributed to farm income. In this study, the overall average share of annual farm income is 77.96% (Table 2). Up to Table 1, agricultural farms were classified according to the EU economic size unit and analysed using descriptive statistics. On the basis of these data on agricultural income, an economic analysis of the agricultural sector and agricultural farms can be carried out.

Some socio-economic characteristics of the sufficient income groups of farms

Sufficiently profitable area and sufficiently profitable farm size should be assessed independently of each other and should not be used interchangeably. In the literature, these concepts can sometimes be confused and cause confusion, but they are different concepts. According to the Ministry of Agriculture and Forestry, adequate income addresses the philosophy of sustainability by maintaining the agricultural structure and the minimum subsistence of the farm population. Adequate income per hectare refers to unlimited income, but the use of the concept of adequate income per farm is more accurate, as the income from crop and livestock production on farms is consumed by the farm population.

For farms, individuals, countries, societies and farmers, there is no definitive conclusion and approach as to what level of income is sufficient or not, and how much income per month increases welfare (Castro and Bleys, 2023). However, based on some approaches, adequate income can be calculated and measured for agricultural farms. In this study, the level of adequate income for farms was determined by taking into account the relative poverty line and the farm income values.

Agricultural farms with adequate income can help families make a living, contribute to the economy and support food security by providing socio-economic sustainability. Table 3 presents some descriptive statistics of the groups of farms with sufficient income. The value of agricultural income may have been high in the farms with sufficient income. However, in these groups of farms, only 20 per cent of the farms have an agricultural income value of more than one million.

Table 3. *Some descriptive statistics of the farm size groups with sufficient income*

	Farms below the sufficient income level (1. Group)	Sufficient income farms (2. Group)	Farms above the sufficient income level (3. Group)	General Farms
n number	83	25	281	389
Minimum value (TL)	2.779	211.932	285.595	2.779
Maximum value (TL)	207.963	281.309	10.459.286	10.459.286
Mean Value (TL)	101.850	242.608	1.028.231	780.082
Standart Deviation	60.163	24.134	958.195	908.287

The average age of farmers engaged in agricultural production is 48.43 years and the average work experience is 30.11 years. Özden and Armağan (2005) found the average age of farmers to be 54.57 years and the average working experience to be 31.79 years, Çınar and Armağan (2009) found the average age to be 52.22 years and the average working experience to be 30.34 years, Keleşoğlu (2019) found the average age to be 45.64 years and Bozkıran (2023) found the average age to be 56.33 years and the average working experience to be 35.24 years. The educational level of the farmers is 48.6% primary school, 18.8% secondary school, 22.4% high school, 4.9% associate degree and 5.4% bachelor degree. Koç (2022) found that 29.6% of the business owners were primary school graduates and 12.17% were undergraduate graduates, Keleşoğlu (2019) found that 61.11% were primary school graduates and 1.11% were undergraduate graduates and Ken (2023) found that 60.98% were primary school graduates. This study found that the membership rates of farmers in cooperatives and trade unions were not the same as the membership rates of farmers in Çukur and Işın (2008) and Kınıklı (2022). The average population per farm is 4.45, which differs from the findings of Çukur and Işın (2008), Çınar and Armağan (2009), Keleşoğlu (2019) and Gökçe (2022). According to TurkStat, the average household size in Turkey is 3.2 persons. In this study, 68.4% of the farmers were engaged in animal husbandry, while Ken (2023) found that 50% of the farms were engaged in animal husbandry. Furthermore, in this study there are 15.60 dairy cows and 26.72 sheep per farm. Keleşoğlu (2019) found that there were 10.96 milking cows and 79.33 sheep per farm while Kınıklı (2022) found 27.89 cows per farm (Table 4).

Table 4. *Some socio-demographic and physical asset characteristics of sufficient income farm groups*

	1. Group (n=83)	2. Group (n=25)	3. Group (n=281)	General (n=389)
Farmer age	50.21	52.64	47.53	48.43
Agricultural experience (year)	30.97	33.12	29.59	30.11
Primary education (%)	59.1	48.0	45.6	48.6
Secondary education (%)	18.1	28.0	18.1	18.8
High school (%)	18.1	16.0	24.2	22.4
Associate's Degree(%)	2.4	4.0	5.7	4.9
University graduate (%)	2.4	4.0	6.4	5.4
Members in agricultural credit cooperative (%)	49.4	60.0	69.8	64.8
Members in Tariş (%)	24.1	32.0	42.3	37.8
Membership to chambers of agriculture (%)	96.4	100.0	98.9	98.5
Members in the irrigation union (%)	84.3	92.0	93.6	91,5
Membership to dairy unions (%)	18.1	8.0	18.5	17.7
Population per farm	3.86	4.24	4.64	4.45
Owned land area (da)	33.95	41.04	105.72	86.25
Rented-Out land area (da)	0.38	0.00	0.36	0.34
Land shared with a partner (da)	0.30	0.00	2.29	1.72
Rented-In land area (da)	5.60	13.58	38.53	29.90
Land shared with a partner (da)	0.94	4.37	6.83	5.41
Irrigated land area (da)	32.09	49.00	130.57	104.31
Non-irrigated land (da)	9.09	9.99	23.18	19.32
Average land area (da)	41.19	58.99	153.75	123.64
Livestock farmers (%)	61.40	72.00	70.10	68.40
Large ruminants (head)	37.2	24.2	46.9	43.4
Small ruminants (head)	55.1	105.6	54.6	60.8
Tractor ownership (units)	1.16	1.40	2.03	1.80

Table 5 shows the value of crop and animal production, gross margin and agricultural income of the groups of farms with sufficient income. In group 1, the value of animal production of the farms with insufficient income is higher than the value of crop production. In the other two groups, the value of crop production is higher than that of animal production. In group 3, the farms above sufficient income have higher values of crop production per decare,

gross margin and agricultural income than the other groups. In this study, the average gross margin per decare per farm was determined to be 8 thousand TL and the value of agricultural income was determined to be 7 thousand TL. Aslan and Armağan (2020), Katipoğlu and Armağan (2020) found the average gross margin per farm to be below about 3 thousand TL.

Table 5. *Some economic characteristics of sufficient income groups (1,000)*

	1. Grup (n=35)	**2. Grup (n=35)**	**3. Grup (n=58)**	**Genel (n=389)**
Crop gross production value (TL/year)	287.2	472.8	1.431,6	1.125,8
Livestock gross production value (TL/year)	417.6	315.8	926.8	789.6
Crop production variable costs (TL/year)	74.6	122.9	374.4	294.3
Livestock production variable costs (TL/year)	308.5	252.2	514.5	453.7
Gross production value of the farm (TL/year)	533.8	700.2	2.074,8	1.657,6
Variable costs of the farm (TL/year)	383.1	375.2	889.0	748.0
Fixed costs (TL/year)	48.8	82.4	157.5	129.5
Gross margin value (TL/year)	150.6	325.0	1.185,0	909.6
Agricultural ıncome value (TL/year)	101.8	242.6	1.028,2	780.0
Crop production value per decare (TL/da/year)	7.4	8.1	9.6	9.1
Crop production variable costs per decare (TL/da/year)	1.7	1.9	2.3	2.1
Fixed costs per decare (TL/da/year)	1.4	1.3	1.1	1.2
Gross margin value per decare (TL/da/year)	5.5	6.6	9.3	8.3
Agricultural income per decare (TL/da/year)	4.0	5.2	8.1	7.0

Some socio-economic variables thought to influence the level of sufficient income

According to the results of the ANOVA test, age, work experience and average population per farm show statistically significant differences between the groups of farms with sufficient income. According to the results of the Tukey test, significant differences were found between the age averages ($p<0.02$) in the 2nd and 3rd groups of farms and between the population averages ($p<0.001$) between the 1st and 3rd groups of farms (Table 6).

Table 6. *Some general characteristics of the farmers*

	1. Group (n=83)	**2. Group (n=25)**	**3. Group (n=281)**	**General (n=389)**	**F-value**	**Sig-value**
Farmer age	50.21	52.64	47.53	48.43	3.14	0.04*
Experience in agriculture (years)	30.97	33.12	29.59	30.11	1.09	0.30
Population per farm	3.86	4.24	4.64	4.45	6.30	0.002***

Significance level: ***p< 0.01; **p < 0.05

The Kruskal-Wallis H test was used to determine the significant difference between the means of the economic variables of the groups of farms with sufficient income. The results showed that there were statistically significant differences between the means of the economic variables. The Dunn-Bonferroni test was used to compare between groups and to determine statistically significant differences. This test showed that farms in the third group had higher adequate income levels and economic benefits. In addition, farms in groups 2 and 3 are more advantaged than those in group 1 (Table 7). Smith and Wesselbaum (2023) state that the level of development, economic size and income of countries, regions and individuals can affect the level of adequate income, welfare and living standards.

***Table** 7. Relationship between income levels and some farm economic variables*

	1. Group (n= 83)	2. Group (n= 25)	3. Group (n= 281)	General (n= 389)	H	p	Post-Hoc
Variable costs in crop production (1,000 TL)	74.6*	122.9*	374.4*	294.3	135.89	0.000	2>1, 3>1,2
Variable costs in livestock production (1,000 TL)	308.5*	252.2	514.5*	453.7	17.10	0.000	3>2
Fixed costs of the farm (1,000 TL)	48.8*	82.4*	157.5*	129.5	90.29	0.000	3>2, 2>1, 3>1
Crop gross production value (1,000 TL)	287.2	472.8	1.431.6	1.125.8	168.01	0.000	1<2, 3>1, 2
Livestock gross production value (1,000 TL)	417.6*	315.8*	926.8*	789.6	39.85	0.000	1>2, 3>2, 3>1
Gross production value of the farm (1,000 TL)	533.8	700.2	2.074.8*	1.657.6	165.78	0.000	3>1, 3>2
Gross margin value of the farm (1,000 TL)	150.6*	325.0*	1.185.8*	909.6	229.67	0.000	3>2, 2>1, 3>1
Crop gross production value per decare (1,000 TL)	7.4	8.1	9.6*	9.1	32.17	0.000	3>2, 3>1
Variable costs in crop production per decare (1,000 TL)	1.7*	1.9	2.3*	2.1	26.65	0.000	3>1
Gross margin value of the farm per decare (1,000 TL)	5.5	6.6	9.3*	8.3	65.28	0.000	3>1, 3>2
Agricultural income per decare (1,000 TL)	4.0	5.2	8.1*	7.0	76.61	0.000	3>2, 3>1

* Differences Between Groups Dunn-Bonferroni Test P<0.05

Farms with high agricultural income, large economic size and high sufficient income level are more advantageous by meeting household needs and production costs. Kizilaslan and Adiguzel (2009) found that the unsuccessful and medium farms, which they divided into three groups according to their agricultural income, could not generate income to cover family labour costs. Wicki (2019) found that small and very small farms do not provide sufficient income and do not have sustainable development opportunities. Anderzén et al. (2020) found that about 70 per cent of farms do not provide sufficient income to meet family needs. Castro and Bleys (2023), taking into account the standard of living, set the adequate income level at between 1,400 and 2,100 euros per month, which is higher than the adequate income level in the study. The results of the studies conducted in different regions of Turkey and the world differ from the results of this study.

Chi-square analysis was used to examine the difference between the level of adequate income of agricultural farms and some variables. It was found that variables such as level of education, membership in agricultural institutions/organisations, land size, number of dairy cows and cattle have a positive effect on the level of adequate income at $p < 0.05$ level. This indicates that there is a significant difference between the level of adequate income and these variables and the H0 hypothesis (socio-economic variables do not differentiate the level of adequate income) is rejected and the H1 hypothesis (socio-economic variables significantly differentiate the level of adequate income) is accepted (Table 8). Gómez-Limón and Sanchez-Fernandez (2010) found significant differences between agricultural income and farm sustainability and socio-economic characteristics. Koç (2022) and Bozkıran (2023) also found significant relationships between farm groups and socio-economic characteristics.

In the agricultural sector, for the sustainable development of agricultural farms and rural areas, these farms should provide sufficient income through annual agricultural activities. It is important that the farm population can make a living from agricultural production, even at a minimum level, otherwise the sustainability and development of agricultural farms may be jeopardised. Farm farms that achieve a sufficient income level can help households to make a living without falling below the poverty line, contribute to the local economy, improve the social status of the farm population, support food supply and food security.

Table 8. *Difference between income levels and some variables*

	1. Group (n= 83)		2. Group (n= 25)		3. Grup (n=281)		General (389)		Pearson Chi-kare X^2
	Person	%	Person	%	Person	%	Person	%	
Education									
Primary	64	77.1	19	76.0	170	63.7	262	67.4	
Other educational levels	19	22.9	6	24.0	102	36.3	127	32.6	6.14*
Membership status in agricultural credit cooperative									
Member	41	49.4	15	60.0	196	69.8	196	69.8	
Not a member	42	50.4	10	40.0	85	30.2	85	30.2	11.90*
Membership in agricultural development cooperative									
Member	18	21.7	8	32.0	89	31.7	115	29.6	
Not a member	65	78.3	17	68.0	192	68.3	274	70.4	3.14
Membership status in tariş									
Member	20	24.1	8	32.0	119	42.3	147	37.8	
Not a member	63	75.9	17	68.0	162	57.7	242	62.2	9.46*
Membership status to breeding cattle breeding association									
Member	21	25.3	9	36.0	112	39.9	142	36.5	
Not member	62	74.7	16	64.0	169	60.1	247	63.5	5.86*
Irrigated land area									
50 da and below	73	88.0	16	64.0	64	22.9	153	39.4	
51 da and above	10	12.0	9	36.0	216	77.1	235	60.6	120.33*
Width of the farm land									
50 da and below	69	83.1	11	44.0	40	14.2	120	30.8	
51da and above	14	16.9	14	56.0	241	85.8	269	69.2	144.74*
Livestock farming situation									
Yes	51	61.4	18	72.0	197	70.1	266	68.4	
No	32	38.6	7	28.0	84	29.9	123	31.6	2.38
Number of dairy cows									
10 head and below	29	74.4	11	78.6	77	43.3	117	50.6	
11 head and above	10	25.6	3	21.4	101	56.7	114	49.4	17.02*
Total number of cattle									
30 head and below	32	76.2	14	87.5	93	50.0	139	57.0	
31 head and above	10	23.8	2	12.5	93	50.0	105	43.0	16.09*

*: P<0.05

CONCLUSIONS AND RECOMMENDATIONS

It can be said that Aydın province, located on the Aegean coast of Turkey, is an intensive and rich agricultural production centre both regionally and nationally. Due to the high intensity and diversity of plant and animal production in Aydın Province, it is important to examine agricultural farms on the axis of socio-economic characteristics, adequate income farm size, sustainability and sustainable development. Based on this view, the aim of this study is to determine the adequate income farm size for sustainable development in agricultural farms.

There are several indicators that reflect the economic success, economic size and adequate income farm size of agricultural farms. These are land area, number of livestock, gross income, gross margin and agricultural income indicator. Considering indicators such as minimum wage, hunger line, poverty line and per capita income to determine the adequate income farm size of farms can provide better evaluations for the sustainable development of agricultural farms. In determining the adequate income level and economic size of farms, gross margin and agricultural income indicators better reflect the success and sustainability status of the farms. In this research, while analysing the adequate income level and the sustainable development status of the farms, the agricultural income indicator and the poverty line were taken as the basis. According to the results of this research, it was found that 21.3% of the surveyed agricultural farms were below the poverty line with the income level obtained from agricultural activities, 22% were in the unsustainable farm category, and 45% of the farm owners were not happy and satisfied with their lives. Based on the agricultural income values of the farms in 2022, these farms were divided into three groups according to the sufficient income threshold. If the agricultural income of the analysed farms is 15% below the TURKSTAT relative poverty line (247,956 TL/year or 14,250 €/year in Euro basis) for the year 2022, these farms are considered to be

below the sufficient income line. Farms whose agricultural income values are 15% above the income-based relative poverty line are above the sufficient income line. If we look at today's year 2024, farms with agricultural income values between 424 thousand TL/year or 12,114 €/year (the average of the Euro value of the first six months of 2024 is 35 TL/€) and 16,387 €/year or 573,562 TL/year are sufficient income farms. It can be said that the agricultural income values of adequate income farms are equivalent to two monthly minimum wages in 2024.

In this research, the average land size of the agricultural farms in the adequate income limit of the farms considered in 2022 was 59 decares, the crop production value was 466 €/da/year, the crop production variable cost was 109 €/da/year, the fixed cost value was 78 €/da/year, the gross margin value of the farms was 380 €/da/year, the agricultural income value was 299 €/da/year, the livestock unit per head was 26.5 heads, the livestock production variable cost was 547 €/head/year and the livestock gross production value was 685 €/head/year. The average size of the farms above the sufficient income threshold was 154 decares, the crop production value was 552 €/da/year, the crop production variable cost was 132 €/da/year, the fixed cost value was 66 €/da/year, the gross margin value was 534 €/da/year, the farm income value was 465 €/da/year, the livestock unit was 43.85 heads, the livestock production variable cost was 674 €/head/year and the livestock gross production value was 1.215 €/head/year. In this study, a new approach was introduced to determine the size of farms with an sufficent income, based on the farm income values and the 2022 poverty line.

It can be emphasised that agricultural farms with annual agricultural income values below the adequate income threshold do not have sustainable development opportunities, as they cannot provide income, savings and investments for the farm, cannot cover the costs of family labour and cannot provide a self-sufficient income level. It can be seen that these farms are forced to continue agricultural activities because they have no other alternative. However, if this negative situation continues, it can be said that farms that cannot achieve a sufficient level of income may give up farming. The economic, social and environmental protection and support of agricultural farms, rural areas and the population living from agriculture, without endangering the lives of present and future generations, can guarantee sustainable development and food security.

Financial, economic and incentive programmes should be strengthened within the framework of agricultural policy in order to enable farms to achieve sufficient income and economic size. In order to increase the sufficient income level of agricultural farms and their economic, social and environmental sustainable development, it can be recommended to expand the use of digital agricultural methods and modern agricultural technologies. In order to inform, raise awareness and sensitise farmers to sustainable development and sustainable agriculture, it may be recommended to implement training programmes through universities and other institutions and organisations. In addition, more R&D projects and socio-economic policies should be developed to develop methods to support economic welfare, social welfare, sufficient income level and sustainable development model in agriculture, rural areas and agricultural farms. It is emphasised that the EU Farm Sustainability Data Network (FSDN), which covers the economic, social and environmental aspects of the data of these farms, should be established in all farmers in order to identify and measure sustainable development issues in agricultural farms (ESO, 2023). The establishment of FSDN in agricultural farms in the world and in Turkey and the determination of the size of the farm with sufficient income can further facilitate the measurement of sustainable development in agriculture and farms. This network can help farmers to make more effective decisions for the sustainable development of agricultural farms. In future studies, it is necessary to carry out studies on FSDN and adequate farm size. In addition, it is believed that the study can be improved by conducting it in different cities other than Aydın province and with different sample groups. In this context, it can be suggested that new studies should be carried out by both the researchers responsible for the study and other researchers in the field in order to expand the scope and fill the gap with FSDN and the size of the farm with sufficient income.

Researchers' Contribution Statement Summary

The authors declare that they have contributed equally to the article and have not plagiarised.

Conflict of Interest Statement

The authors declare that there is no conflict of interest between them.

Ethic Declaration

This research was approved by the Social and Human Sciences Research Ethics Committee of the Rectorate of T.C. Aydın Adnan Menderes University with the document number 31906847/050.04.04.04-08-26 dated 31/01/2022.

Additional Information

This study is based on the first author's PhD thesis.

Acknowledgement

The author Fırat Aslan is a 100/2000 Higher Education Board scholar in the field of Sustainable Agriculture priority areas doctoral fellow.

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