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THE PROFITABILITY OF LENTIL CULTIVATED AS MIXTURES WITH BARLEY OR OAT

Key words: profitability, direct surplus, costs, yield, lentil, cereals, mixtures

ABSTRACT. The aim of the study was to evaluate the economic efficiency of lentil at different mixtures in ecological system. The study was based on the results of a two-year field study in 2022-2023, conducted at the Agricultural Experimental Station in Grabów, belonging to the Institute of Soil Science and Plant Cultivation in Puławy. This study evaluated effect of growing the lentil (*Lens culinaris* Medic.) with barley (*Hordeum vulgare* L.) or oats (*Avena sativa* L.) as a supporting plant impacts the yield of lentil. The one-factor experiment was set up as a randomized blocks design with four replicates in ecological conditions. The study showed that higher seeds/grain yield was obtained under the mixtures method, where a supporting crop was used than in sole cropping. The gross margin, as the difference between the value of seeds/grain yield and direct and indirect costs prepared for each cultivation system of lentil, showed definite differences. Analysis found that the highest gross margin was obtained under cultivation of lentil with oat (3,653.3 PLN/ha), while the lowest under cultivation lentil in pure sowing (695.3 PLN/ha), which determined by level of yielding. The level of the gross margin was more impacted by the level of the obtained yield and the cost of agrotechnical treatments than by the level of other direct costs. The highest rate of direct profitability without subsidies (profitability) determined as the relation of production value of lentil seeds/grain to direct costs determined based relation production value of seeds/grain to direct cost was obtained under cultivation legume with oat (1.50).

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INTRODUCTION

Lentils (*Lens culinaris* Medic.) belong to legumes, tribe Vetch. It is a very popular species in Western European countries (Spain), the United States and the Middle East (Syria, Iran, Pakistan, Lebanon). In Poland, before World War II, lentils were cultivated on an area of about 1,400 ha. Unreliable yields of this species, competition from more prolific species, and the lack of valuable domestic cultivars meant that with the intensification of our agriculture, lentils were almost completely pushed out of field cultivation, and on small areas they were grown only for personal use. In recent years, interest in lentil cultivation has increased. Unofficial data indicate that it is grown on an area of about 38 thousand ha [Panek 2024]. Globally, lentil production has increased fivefold since 1980 [FAOSTAT 2023]. Approximately five million tons of lentils are produced annually but with relatively large annual variations. In Poland, the area of cultivation of edible lentils is small among leguminous species due to low yields, significantly dependent on the course of weather conditions during the growing season. Lentils have the advantage of relatively low soil requirements, as they grow well on weaker, moderately compacted soils of the very good and good rye complex.

Lentils are, along with peas, one of the oldest and most valuable high-protein crop species [Szwejkowska and Bielski 2012]. The species is also valued for the high nutritive value of its seeds, as they are rich in protein (24-32%), carbohydrates, as well as significant amounts of some vitamins, mainly of the B group, and macronutrients, including phosphorus, potassium, magnesium, iron and sodium B2. The seeds content a high proportion of essential amino acids especially lysine, leucine, arginine, histidine and valine [Costa et al. 2006, Kowalczyk et al. 2007, Kahraman 2016].

Despite the many beneficial properties of lentils, the area under cultivation of this species is relatively small. This is mainly due to the limp stems showing a high tendency to lodge and low competitiveness against weeds. One method to reduce lodging in lentils may be to grow them in intercropping with other crop species [Zawieja 2006, Żabiński 2008. Duchene et al. 2017].

MATERIAL AND METHODS OF THE STUDY

A field trial was conducted in 2022-2023 at the Agricultural Experimental Station in Grabów, (Masovian Voivodeship, Poland) [51°21'18"N 21°40'09"E] belonging to the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy, Poland.

This study evaluated effect of growing the lentil (*Lens culinaris* Medic.) with barley (*Hordeum vulgare* L.) or oats (*Avena sativa* L.) as a supporting plant impacts the yield

of lentil. The one-factor experiment was set up as a randomized blocks design with four replicates in ecological conditions.

The experiment was established on a Luvisol soil with sandy loam texture classes, belonging to a very good rye complex.

The number of inputs of production means was determined based on actual consumption in the experience of natural fertilizer, seeds/grain material and cost of agrotechnical treatments. The costs of production means were determined based on purchase prices, and the value of lentil production was determined according to the average grain purchase price in 2022. Value direct payment (basic income support, redistributive payment, supplemental basic payment) was used according to the purchase in 2023. The quote of direct payment equaled 761.3 PLN.

The economic assessment was carried out in a simplified way. The average seeds/grain yield were used as the main criteria for assessing production efficiency. All analysis were made in terms of 1 ha.

The analysis considered the effect of differentiated mixtures on the productive and economic efficiency of mixtures by calculating fuel consumption costs according to the formula proposed by Adam Harasim [2006]. Fuel costs were calculated as the product of tractor power expressed in kW, the coefficient defining fuel consumption per unit of power (0.110 g/kW), and the fuel price expressed in PLN/liter.

Taken as a measure of economic efficiency, the gross margin was calculated as the difference between the harvested value of grains and direct costs.

The effectiveness of cultivation of lentil was evaluated from the perspective of utilizing one of the basic production factors: land (the gross margin in PLN/ha). The gross profitability index for particular variants of the experiment was also calculated as the relation of the production value (W) to direct costs (K) (including the value of consumed fuel).

In addition, the unit direct cost was calculated, as the ratio of total direct costs to the yield of the plant in question, the cost competitiveness of the crop, recognized as the ratio of total direct costs to the gross margin, the economic efficiency of the crop (profitability of cultivation), calculated as a percentage of the ratio of the value of production to the direct costs.

The results of the study are presented in tabular term. The paper was mainly based on vertical comparative analysis of research results.

RESEARCH RESULTS AND DISCUSSION

The different cropping method mixtures affected the yielding of lentil and economic indexes. The highest yield of lentil seeds was obtained under cultivation legume with oat (5.1 t/ha), while the lowest one under cultivation in pure sowing of lentil (2.4 t/ha) (Table 1). The value of seeds/grain (include direct payments) was highest in cultivation of lentil under mixture with oat (5,631.3 PLN), while the lowest in cultivation of legume in pure sowing (2,641.3 PLN). The difference between the cultivation of lentil in pure sowing and cultivation with oat was more than twice.

Table 1. The yield seeds/grain, value seeds/grain, direct and indirect cost of lentil production under different mixtures

Specification	Mixtures		
	lentil – pure sowing	lentil + barley	lentil + oat
Seeds/grain yield [t/ha]	2.4	4.9	5.1
The value of seeds/grain with direct payments [PLN]	2,641.3	5,425.7	5,631.3
Direct costs [PLN], including:	1,946.0	1,988.0	1,978.0
– seeds/grain material	126.0	168.0	158.0
– nitrogen fertilization	1,820.0	1,820.0	1,820.0
– plant protection cost	0	0	0
Indirect cost [PLN], including:			
– work of machines	904.0	1,028.0	1,028.0
– service of harvest	420.0	560.0	560.0
– taxes and insurances	180.0	180.0	180.0
Share in direct costs [%]:			
– seeds/grain material	6.5	8.5	8.0
– nitrogen fertilization	93.5	91.5	92.0
– plant protection cost	0	0	0
Direct costs of production unit [PLN/t]	8.3	3.9	4.1
Total costs [PLN]	3,450.0	3,756.0	3,746.0
Unit total cost [PLN/t]	14.7	7.4	7.7

Source: own analysis

Direct costs are an important element of the economic analysis of all agricultural crop cultivation, because they largely determine the size and value of the production [Abramczuk et al. 2018]. The previous study of Jolanta Bojarszczuk and Jerzy Księżak [2023] showed that the seeds material costs stand the largest percentage in the direct cost structure of legume cultivation, followed by seeds material and mineral fertilizers. Irena Augustyńska and Arkadiusz Bębenista [2019], Józef Śliwa et al. [2015] and Hanna Adamska et al. [2016], also confirmed that the seeds material cost were the highest ration in total direct cost.

In Beata Szwejkowska and Stanisław Bielski [2012] study the cultivation of lentils is the highest cost turned out to be sowing and seed (37-40% of direct costs) as well as fertilization and mineral fertilizers (23-30%). The less unit direct costs was generated under cultivation of lentil with supporting crop, while the twice higher was noted under cultivation of legume in pure sowing.

The gross margin, as the difference between the value of seeds/grain yield and direct and indirect costs prepared for each cultivation system of lentil, showed definite differences (Table 2). The gross margin was determined as an indicator of economic efficiency. The economic effectiveness of cultivation of lentil cultivation system was evaluated from the perspective of utilizing the basic factors of production – land. Analysis found that the highest level of gross margin was obtained in cultivation of lentil with oat (3,653.3 PLN/ha), while the lowest under cultivation lentil in pure sowing (695.3 PLN/dt), which determined less level of yielding.

Table 2. Chosen economic indicators of cultivation of lentil under different mixtures

Specification	Mixtures		
	lentil – pure sowing	lentil + barley	lentil + oat
Gross margin [PLN/ha]	695.30	3,437.70	3,653.30
Gross margin [PLN/t]	2.96	7.06	7.21
Index of profitability (with direct payments)	0.77	1.44	1.50
Index of profitability (without direct payments)	0.54	1.24	1.30
Cost competitiveness of cultivation [PLN]	4.96	1.09	1.03
Grain yield offsetting direct costs [t/ha]	4.31	4.10	3.75

Source: own analysis

The rate of direct profitability without subsidies (profitability) [%] was also determined as the relation of production value of lentil seeds/grain to direct costs (Table 2). The level of the gross margin was more impacted by the level of the obtained yield and the cost of agrotechnical treatments than by the level of other direct costs.

Many studies show that subsidies have a dominant share in the income of organic farms [Komorowska 2013, Drygas et al. 2019, Nachtman 2021], therefore their higher level of activity for organic farms than conventional farms is mainly a factor encouraging this type of farming.

In order to deepen the analysis, same indicators were calculated to determine the economic efficiency of lentil. The analysis showed that the cultivation of lentil with cereals was economically justified – the economic efficiency index was above 100%. The highest profitability (without direct payment) of lentil cultivation determined based relation production value of seeds/grain to direct cost was cultivation of legume with barley (1.50). While the lowest index was obtained in cultivation of lentil in pure sowing. In direct cost structure the highest percentage had fertilization (manure) cost.

Grain yield allowed to offsetting direct costs was the less under cultivation of lentil with oat (3.75 t/ha), while the highest under cultivation of legume in pure sowing (4.31 t/ha).

SUMMARY

The analysis of production and economic indices (the yield, the gross margin, direct costs and the rate of profitability) the most favorable variant of lentil cultivation was the cultivation with supporting crop. The cultivation of lentil with oat or spring barley brought the highest value of harvested seeds/grain. In direct cost structure the highest percentage had fertilization cost. The less unit direct costs was generated under cultivation of lentil with supporting crop, while the twice higher was noted under cultivation of legume in pure sowing. The highest profitability of lentil cultivation determined based relation production value of seeds/grain to direct cost was obtained under cultivation legume with oat (1.50).

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OPLACALNOŚĆ PRODUKCJI SOCZEWICY W MIESZANKACH Z JĘCZMIENIEM LUB OWSEM

Słowa kluczowe: opłacalność, nadwyżka bezpośrednia, koszty, plon, soczewica, zboża, sposób uprawy

ABSTRAKT. Celem badań była ocena efektywności ekonomicznej produkcji soczewicy w zależności od sposobu uprawy w systemie rolnictwa ekologicznego. Analizę oparto na wynikach trzyletnich badań, przeprowadzonych w Rolniczym Zakładzie Doświadczalnym w Grabowie (Instytut Uprawy Nawożenia i Gleboznawstwa w Puławach). W badaniach oceniono wpływ uprawy soczewicy (*Lens culinaris* Medic) z jęczmieniem (*Hordeum vulgare*) lub owsem (*Avena sativa* L.) jako roślinami podporowymi, na plon soczewicy. Z badań wynika, że wyższy plon nasion uzyskano, gdy soczewicę uprawiano z rośliną podporową niż w czystym siewie. Osiągnięto wyraźne różnice w nadwyżce bezpośredniej, będącej różnicą między wartością plonu nasion a kosztami bezpośrednimi i pośrednimi. Najwyższą nadwyżkę bezpośrednią uzyskano w uprawie soczewicy z owsem (3653,3 PLN/ha), natomiast najniższą w uprawie soczewicy w czystym siewie (695,3 PLN/ha) i zależała ona od poziomu plonowania. Na wartość nadwyżki bezpośredniej większy wpływ miał poziom uzyskanego plonu i koszt zabiegów agrotechnicznych niż poziom pozostałych kosztów bezpośrednich. Najwyższy wskaźnik opłacalności bezpośredniej bez dopłat, wyznaczony jako relacja wartości produkcji nasion soczewicy do kosztów bezpośrednich, osiągnięto z uprawy soczewicy z owsem (1.50).

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