The Role of Zero Tillage in Economic Return of Rain-fed Lentils in Al-Qamishli (and Al-Malikiyah (Al-Hasakah Governorate

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Abstract

This study aims to define the role of zero tillage (ZT) in economic return for the lentils in the regions of Al-Qamishli and Al-Malikiyah (Al-Hasakah governorate). All farmers who followed ZT system in these regions has been selected. Sample size amounted to 200 randomly selected farmers, of which 100 follow ZT system, and the other 100 follow traditional cultivation. The economic analysis depended on estimating the average production costs, and economic returns for growing seasons 2013/2014 and 2014/2015. The results showed that the production cost in ZT is less than the TC by 12%, estimated to 56024, 63982 SYP/ha respectively. The net profit of ZT was about 391986 SYP/ha on average, with 7958 SYP/ha greater than TC. Moreover the average cost ZT compared to ZT has been reduced by 19.8%, estimated to 30 and 37 SYP/kg, respectively. The analysis showed that the ZT reduce the amount of fuel consumption, working hours, seeding rate and total cost by 67%, 56 %, 44%, 32%, respectively. While the yield has increased by 9%. This study revealed that ZT achieved an economic return higher than TC by 12.%

Keywords: Zero tillage (ZT), Traditional cultivation (TC), Production costs, Economic return, Rain-fed lentils.

Introduction:

Lentil *(Lens culinaris* M.) is an important food legume crop with various uses as food and fodder due to its protein-rich grains (25-28)% (Wang and Daun, 2006). Globally, it is cultivated on 4.52 million hectares with 5.03 million tones production (FAO, 2014), locally in Syria it is cultivated on 0.11 million hectares with 0.12 million tones production, and in Al-Hasakaha 0.03 million hectares with 0.03 million tones production (Ministry of Agriculture and Agrarian Reform, 2013). The major geographical regions of lentil production are Canada (39.44%), India (21.83%), Australia (6.9%), Turkey (6.8%), and Nepal (4.5%) (FAO, 2014). Lentils cultivation is characterized in Syria as high costs crop but low rate of adoption of agricultural innovations. Farmers suffered increased production costs, which reduces the gross margin of profits. The cost of agricultural operations in Syria during 2003-2013 seasons was 15176 SYP/ha, the cost of requirements was 8261 SYP/ha, and the other expenses 5424 SYP/ha. The average of total cost was 28862 SYP/ha, which is offset by the average yields of 917 Kg/ha, but the average official price is 61.6 SYP/kg, which means that the gross margin is about 27625 SYP/ha (NAPC, 2013). ZT is an approach to managing agro-ecosystems for improved and sustained productivity, increase profits and food security and to preserve and enhance the resource base and the environment. ZT is characterized by three linked principles, namely: 1.Continuous minimum mechanical soil disturbance. 3. Permanent organic soil cover. 3. Diversification of crop species grown in rotations, sequences or associations (Kassam *et al*., 2014). ZT saves time in preparing seed bed (Hernanz *et al*., 1995). According to Tebrügge and Böhrnsen, (1997) the following economic advantages have been found when comparing TC with the plow to ZT in long-term soil tillage field experiments in Germany:

- Saving in machines, labor, working hours, and fuel consumption, were lower in ZT by 39%, 75%, 80%, 84%, respectively, as compared to TC.
- Variable costs were lower in CA, wages by 84%, fuel 85% and repair costs were 65% when compare to TC.
- Fixed costs also were lower in CA, tractor by 86%, stubble cultivation 100%, soil tillage and sowing 27% as compared to TC.

Crop yield largely depends on weed control, residue management and cultural practices as well as, environmental factors, such as soil and climate conditions (Shipitalo *et al*., 2000). Kosutic *et al*., (2005) reported that zero tillage system requires 85.1% less energy with respect to TC. Yalcin and Cakır, (2006) confirmed that TC had the highest fuel consumption, while ZT had the lowest. Marakoglu and Carman,(2010) stated that ZT had the lowest labor and machinery energy input, it was detected that lower seed rates were drilled on ZT fields using drill seeders, which saved in Iraq 0.8 $ million, while the saving was in Syria 1.2 $ million (ICARDA, 2012). Kumar *et al.,* (2013) pointed out that the energy use efficiency increased by 13 % in ZT when compared with TC. Similarly, there are many studies showed that energy consumption of TC system is more than ZT (Salem *et al*., 2013). Crop yields in zero tillage was either equal or higher than TC (Imran *et al*., 2013). The application of ZT system increases yield productivity of lentils by about 8%, and reduces fuel consumption rate of about 19.26%, and number of working hours by about 28.93%, besides lowering production costs, which achieved about 18.11%, also increases yield by about 5% compared with the traditional cultivation (ACSAD, 2014). At the same time, it was suggested seed rates of 100-120 kg/ha for lentil, depending upon mean seed weight, and viability (Loss *et al*., 2015).

Research Methodology:

Problem:

The increment in fuel (diesel) and agricultural requirements prices, leads to an increase in production costs, thereby a reduction in gross margin, which negatively affects the farmer income and his standard of living. With reference the unavailability of economic studies and researches about ZT, and its impact on increasing the productivity of rain-fed crops, and reducing production costs, besides the possibility of substitution ZT instead of TC. This research is based on the assumption that ZT may contribute to mitigating the impact of these issues.

Objectives:

The objectives of this research are:
1-To identify the role of ZT in the economic return of rain-fed lentils.
2- To analyze the total costs and their relative importance under ZT and TC conditions.
3-To calculate some economic indicators under ZT and TC such as working hours, fuel consumption, seeding rate, production total costs, and profit.

Data Source:

1. **Primary data:**

It includes some economic characteristics of farmers who applied ZT and TC in the study area and through a personal interview under a questionnaire prepared for this purpose, which included data on production costs, revenues, and profitability of lentils, which collected from a sample of farmers.

2. **Secondary data:**

This data was collected from official sources such as, Ministry of Agriculture and Agrarian Reform, General Commission for Scientific Agricultural Research (GCSAR), Arab Center for the Studies of Arid Zones and Dry lands (ACSAD), and the published results on this topic.

Sample:

Before starting the adoption of special research questionnaire, a quick scan through interviews with a number of farmers in the study area was done, and the farmers who were adopting ZT were selected. By returning to the name records of farmers in the Directorate of Agriculture in the two studied areas, who were about 100 farmers, also 100 farmers randomly selected who depend on TC, at the same area, to achieve the same ecology and climate conditions to make the comparison more identical, so the total sample size was 200 farmers. The data was entered into the computer, and the programs (SPSS- Excel) were used to obtain the economic indicators.

Methods:

1-Economic analysis:

We relied on the classification of the Ministry of Agriculture and Agrarian Reform in Syria, which classified the costs into the following:

1.1The cost of agricultural operations: Included, costs of plowing, planting, harvesting, sorting, packing and transportation.

1.2 The cost of production requirements: Included, costs of seeds, containers and herbicide.

1.3The cost of capital interest: 7.5 % from cost of production requirements.

1.4 The cost of incidental expenses: 5% from cost of (production requirements, agricultural operations).

1.5 The cost of land rent: 4% of production (Ministry of Agriculture and Agrarian Reform, 2015).

2-Revenues: $TR = Py \cdot Y$

Py = Price per output unit (SYP), Y = Total quantity of output (Kg)

3-Net income: NI = TR - TC

TR= Total revenue, TC= Total cost (Elmahy, 2003).

4-Fuel: The fuel level was measured in the tank before and after plowing (Natsis *et al.*, 1999).

5-Working hours: By calculating the number of hours needed to complete all agricultural operations (Bassam, 1991).

6-Yield: It was computed by averaging yield of hectares in the study area (Abbas *et al.*, 2009)

7- Region:

The research was performed in the villages of Al-Qamishli and Al-Malikiyah regions (Al-Hasakah governorate).

Results and Discussion:

1-Total cost:

Table (1) shows the production costs of a lentils in the study area, under ZT and TC conditions. The ratio of the agricultural operations in ZT higher than TC. Plowing cost was zero in ZT because there were no plowing, thereby, increased efficiency of agricultural operations.

Table1. The production costs and relative importance under ZT and TC (mean of two seasons).

Unit: SYP/ha

Item	ZT		TC		Difference (1)-(2)	%
	Cost (1)	%	Cost (2)	%		
Plowing	0	0	3000	4.69	-3000	-100
Planting	1500	2.68	1500	2.34	0	0
Controlling	750	1.34	750	1.17	0	0
Harvesting	16977.2	30.3	15545	24.3	1432.24	8.43
Sorting and packing	1700	3.03	1500	2.34	200	11.76
Transportation	1886	3.37	1727	2.7	159	8.43
Total of agriculture operations	22813.24	40.7	24022	37.5	-1208.8	-5.03
Seeds	16000	28.6	22400	35	-6400	-28.6
Chemical control	7000	12.5	7000	10.9	0	0
Containers	4760	8.5	4200	6.56	560	11.76
Total of production requirements	27760	49.5	33600	52.5	-5840	-17.4
Capital interest 7.5%	2082	3.72	2520	3.94	-438	-17.4
Incidental expenses 5%	2528.622	4.51	2881.1	4.5	-352.48	-12.2
Land rent 15%	840.3734	1.5	959.671	1.5	-119.3	-12.4
Total costs	**56024.24**	**100**	**63982.8**	**100**	**-7958.5**	**-12.4**
Yield (Kg/ha)	1886.36		1727.27		159.09	8.4
Costs per Kg	**29.7**		**37.04**		**-7.34**	**-19.8**

Source: Survey data.

The costs of harvesting, sorting and packing, and transportation were increased in ZT as compared with TC, because of the increment in productivity. It is also evident that the production requirements in ZT less than TC, while the value of all production requirements reduced except the

containers and cord value in ZT compared with TC. The fertilization during the two growing seasons were not used, because of its high prices. The cost of a ton of fertilizer was about110 thousand SYP. The cost per kilogram of lentils in ZT less than TC. In general it can be concluded that the total production costs in ZT less than TC and the difference is less about 7958 SYP/ha (ACSAD, 2014; Tebrügge and Böhrnsen, 1997).

2-Yield and Revenue:

The results shows that ZT increases the productivity, revenue and income compared to TC.

Table 2.Yield and income for lentils under ZT and TC (means of two seasons).

Unit: kg/ha

Item	CA	TC	Difference	%
Grain yield	1886.36	1727.27	159.09	8.4
Price	225			
Revenue	424431	388635.75	35795.25	8.4
Straw yield	943.18	1295.45	352.27-	-27
Price	25			
Revenue	23579.5	32386.31	8806.81-	-27
Production return	**448010.5**	**421022.06**	**26988.43**	**6**

Source: Survey data.

The statistical analysis reveals a significant differences (Sig= 0.03) between ZT and TC for straw yields, actually at least half of the crop residues above the surface of the ground is left to achieve the desired benefits, whereas the grain yield was higher under ZT but non-significant (Sig=0.3) compared with TC (ACSAD, 2014; Imran et al., 2013).

It can be noticed from Table (2) that the yield average increased in ZT rain-fed lentil compared with TC, which was about 159 kg per hectare, keeping in mind that the average price of one kilo of grain of lentil is 225 SYP so, farmers will make an additional income estimated by 35775 SYP/ha. Taking into account the total area of rain-fed lentils in Syria in 2013 which was 113738 hectares, therefore, ZT can increase the production of about 18.08 million tons of lentils equivalent of about 4068 million SYP. So we can imagine the money that can be supplied besides the production increase, if the farm system of agriculture is shifted to ZT system.

3- Production Costs and Economic Returns:

It can be noticed from the Table (3) the reduction in the production costs under ZT, this is mainly because of saving in fuel and labor, i.e. costs of plowing, and lower seeding rate, by using a precision drill instead of broadcasting of seeds. There was an increase in the production return (outputs) on an average of 6%.

Table 3. Production costs and economic returns for lentils under ZT and TC (mean of two seasons).
Unit: SYP/ha

Item	Production costs		Production return		Net return	
Farming system	ZT	TC	ZT	TC	ZT	TC
	56024.24	63982.77	448010.5	421022.06	391986.26	357039.29
Difference	7958.53-		26988.437		7958.53-	
%	12.44-		6.02		12.44-	

Source: Survey data.

The reduction of production costs is the most attractive advantage of CA for farmers, and it is the major driving force for Syrian farmers to rapidly adopt CA system. Production costs are reduced especially costs of fuel, seeds and labor (ACSAD, 2014; Tebrügge and Böhrnsen, 1997).

4- Working hours:

The results showed that the CA reduced in working hours by 56.54 % under the compared with TC, Table (4).

Table 4. Impact of ZT and TC on working hours (mean of two seasons).

Unit: Hour/ha

Item	Month	ZT	TC
Ploughing	July	0	0.75
Prepare seed bed	October	0	0.5
Planting/Sowing	November	0.5	0.33
Harvesting	May	0.33	0.33
Total		**0.83**	**1.91**
Reduction percentage		**56.54 %**	

Source: Survey data.

The positive impact of ZT on the distribution of labor during the production cycle, and even more important, the reduction in labor requirement are the main reasons for farmers in Syria to rapidly adopt Zero tillage, especially for farmers who rely completely on family labor. The reduction in on-farm labor requirement allows farmers to:

- Extend the cultivated area.
- Hire themselves out in off-farm employment.
- Diversify their activities, including processing of agricultural products.
- Reduce the cultivated area, which due to increasing yield, thereby allow more marginal areas to recuperate (Hernanz *et al*., 1995; Tebrügge and Böhrnsen, 1997; Kosutic *et al*.,(2005); ACSAD, 2014).

5- Fuel consumption

The results show that CA reduces fuel consumption by 67% compared with TC, Table (5).

Table 5. Impact of ZT and TC on fuel consumption (mean of two seasons).

Item	Month	ZT	TC
Ploughing	July	0	12.5
Prepare seed bed	October	0	8.33
Planting/Sowing	November	8.33	4.72
Harvesting	May	0.33	0.33
Total		**8.66**	**25.88**
Reduction percentage		**% 67**	

Unit: L/ha **Source:**

Survey data.

This reduction in ZT is mainly caused by no ploughing (two to three times), thereby reducing the number of agricultural operations, where seeding and fertilizers placement can be done in one single operation by using the direct drill. Implementation of CA can reduce fuel consumption by 17 liter (Tebrügge and Böhrnsen, 1997; ACSAD, 2014; Kumar *et al.*,2013). This is of great importance in Syria, where the existing price of fuel reached up to 135 SYP. The average total quantity of fuel which can be saved under TC is 17 liters per hectare, which costs 2295 SYP/ha, so all farmers applied TC in Syria will be able to save money estimated by 261 million SYP, if lentils is cultivated over 113738 ha (Ministry of Agriculture and Agrarian Reform, 2015).

6-Seeding rate:

The results show that TC reduced seeding rate by 28.57% compared with ZT, Table (6).

Table 6. Seeding rate of lentils under ZT and TC (mean of two seasons).

Unit: Kg/ha

Item	ZT	TC
Seeding rate	100	140
Difference	**40**	
Reduction percentage %	**28.57**	

Source: Survey data.

It can be observed from Table (6) that application of TC caused a reduction in seeding rate by 40% over ZT. The reduction in the seeding rate under ZT system compared with conventional one is attributed to the utilization of a precision direct drill. (Loss *et al*., 2015; ACSAD, 2014). Keeping in mind that the average price of the one kilogram of lentil seeds suitable for seeding (Clean and treated) is 170 SYP for lentil, and the average difference in the seeding rate is 40 Kg for lentils, taking into account the total area of lentils which is non irrigated in Syria (113738 hectares) in 2013, therefore, the reduction in seeds of about 4.5 million tons of lentils equivalent of about 773 million SYP. So, we can imagine the amount of money that can be saved as a result of reducing seeding rate when ZT is adopted. (ICARDA, 2012).

References:

Abbas .G.; M.A. Ali; G. Abbas; M. Azamand; and I. Hussain (2009). Impact of planting method on wheat grain yield and yield contributing parameters. The Journal of Animal & Plant Sciences. 19(1): 30-33

Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) (2014). Conservation Agriculture Field Experiments Report 2014, Damascus, Syria.

Bassam, S. (1991). Founded machinery management and measurement of operational hours and estimate the mechanical capacities and needs a mechanism. Altdrebh session in machinery and agricultural machinery management. The Arab Organization for Agricultural Development. Baghdad, 10-24 September 1988.

Erenstein, O. (2009). Leaving the plow behind: Zero-tillage rice-wheat cultivation in the Indo-Gangetic Plains. In D.J. Spielman; and R. Pandya-Lorch (eds.) (2009). Millions fed: Proven successes in agricultural development, IFPRI: Washington DC. Available from http://www.ifpri.cgiar.org/book-5826/millionsfed/cases/ricewheat.3/12/2015

Elmahy, M. (2003). An Economic study of the role and impact of EL- Bustan Agricultural Development Project (BADP)-in Improving Resources-Utilization Efficiency in the production of the most prominent summer crops of the project's Area Bustan Agricultural Development project (BADP), Ministry of Agriculture and land reclamation &commission of the European Union- December.

FAO .(2014). FAOSTAT – FAO's corporate database. Available from http://faostat3.fao.org/download/Q/QC/E. call: 10.2.2016

Hernanz, J.L., V.S. Girth and C. Cerisola, 1995. Long-term energy use and economic evaluation of three tillage systems for cereal and legume production in central Spain. Soil Till. Res., 35: 183-198

Imran, A.; J. Shafi; N. Akbar; W. Ahmad; M. Ali; and S. Tariq (2013). Response of wheat (*Triticum aestivum*) cultivars to different tillage practices grown under rice-wheat cropping system. Uni. J. Plant. Sci., 1: 125-131

International Center for Agricultural Research in the Dry Areas (ICARDA) (2012). Conservation agriculture: Opportunities for intensified farming and environmental conservation in dry areas. ICARDA Research to Action 2. Available from http://www.icarda.org/sites/default/files/conv-agree.pdf. Call 17.2.2015

Kassam, A.; T. Friedrich; R. Derpsch; and J. Kienzle (2014). Worldwide adoption of conservation agriculture. 6th World Congress on Conservation Agriculture, 22-25 June 2014, Winnipeg, Canada.

Kosutic, S.; D. Filipovic; Z. Gospodaric; S. Husnjak; I. Kovacev; and K. Copec (2005). Effects of different soil tillage systems on yields of maize, winter wheat and soybean on albicluvisol in north-west Slavonia. J. Cent. Eur. Agric., 6: 241-248

Kumar, V.; Y.S. Saharawat; M.K. Gathala; A.S. Jat; S.K. Singh; N. Chaudhary; and M.L. Jat (2013). Effect of different tillage and seeding methods on energy use efficiency and productivity of wheat in the Indo-Gangetic Plains. Field Crops Res., 142: 1-8

Loss, S.; A. Haddad; J. Desbiolles; H. Cicek; Y. Khalil; and C. Piggin (2015) .The Practical Implementation of Conservation Agriculture in the Middle East. Available from https://apps.icarda.org/wsInternet/wsInternet.asmx/DownloadFileToLocal?filePath=Tools_

and_guidelines/Practical_Implementation_conservation_agriculture.pdf&fileName=Practical_Implementation_conservation_agriculture.pdf. Call 12.2.2016

Marakoglu, T.; and K. Carman (2010). Energy balance of direct seeding applications used in wheat production in middle Anatolia. Afr. J. Agrıc. Res., 5: 988-992

Ministry of Agriculture and Agrarian Reform (2013 & 2015). Statistical Department, Planning and International Cooperation, Ministry of Agriculture and Agrarian Reform, Damascus, Syria.

Natsis, A.; G. Papadakis; and J. Pitsilis (1999): The Influence of soil type, soil water and share sharpness of a Mouldboard plough on energy consumption, rate of work and tillage quality. J. Agric. Ing. Res., 72: 171-176.

National Agricultural Policy Centre (2013). The reality of food and agriculture in Syria, Damascus, Syria.

Salem, A.A.; T. Luigi; and D.M. Giuseppe (2013). A comparison of the energy consumption of rainfed durum wheat under different management scenarios in southern Italy. Energy. 61: 308-318.

Samaan, A. (2010). The analysis and evaluation of agricultural projects (theoretical part). Damascus University publications. Pp239.

Shipitalo, M.J.; W.A. Dick; and W.M. Edwards (2000). Conservation tillage and macropore factors that affect water movement and the fate of chemicals. Soil Till. Res., 53: 167-183

Tebrügge, F.; and A. Böhrnsen (1997). Crop yields and economic aspects of no-tillage compared to plough tillage: Results of long-term soil tillage field experiments in Germany. In: Tebrügge and Böhrnsen 50 (Eds.): Experiences with the application of no-tillage crop production in the West-European countries. Proceedings of the EC-workshop IV, Boingneville, 12-14 May 1997: 25-43, 1997. Wiss. Fachverlag Dr. Fleck, ISBN 3-960600-95-1.

Yalcin, H.; and E. Cakir (2006). Tillage effects and energy efficiencies of subsoiling and direct seeding in light soil on yield of second crop corn for silage in Western Turkey. Soil Till. Res., 90: 250-255

Wang, N. and J. K. Daun (2006). Effects of variety and crude protein content on nutrients and anti-nutrients in lentils (Lens culinaris). Food Chemistry, 95: 493–502

دور الزراعة الحافظة في العائد الاقتصادي لمحصول العدس البعل في منطقتي القامشلي والمالكية (محافظة الحسكة)

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الملخص:

هدف البحث الى دراسة دور نظام الزراعة الحافظة في العائد الاقتصادي لمحصول العدس البعل في منطقتي القامشلي والمالكية (محافظة الحسكة). تم أخذ كافة المزارعين الذين يعتمدون نظام الزراعة الحافظة في هاتين المنطقتين والبالغ عدده نحو 100 مزارعاً، بالإضافة لاختيار 100 مزارعاً يعتمدون نظام الزراعة التقليدية وذلك بالاعتماد على طريقة العينة العشوائية. اعتمد التحليل الاقتصادي لتقدير التكاليف الإنتاجية، والعائد الاقتصادي لمحصول العدس البعل لمتوسط الموسمين الزراعيين 2014/2013 و2015/2014. بينت نتائج التحليل بأن تكاليف إنتاج العدس البعل في الزراعة الحافظة أقل من تكاليف الانتاج في الزراعة التقليدية بنسبة 12.44 %، حيث بلغت وسطياً 56024، و63982 ل.س/هكتار لكل من الزراعة الحافظة والزراعة التقليدية على التوالي، كما حققت الزراعة الحافظة ربحاً صافياً بلغ وسطياً نحو 391986 ل.س/هكتار، أي بزيادة بلغت 7958 ل.س/هكتار مقارنةً بالزراعة التقليدية. بالإضافة إلى انخفاض تكلفة الكيلوغرام الواحد من محصول العدس البعل في الزراعة الحافظة مقارنة بالزراعة التقليدية بنسبة 20 % حيث بلغت وسطياً 30 و37 ل.س على التوالي. وأظهرت نتائج التحليل انخفاض كمية الوقود المستهلكة، وعدد ساعات العمل، ومعدل البذار، واجمالي التكاليف بنسب 67%، 56، 44%، 32% على التوالي. بينما ازداد الإنتاج بنسبة 9%. ويبين البحث بأن الزراعة الحافظة تحقق عائد اقتصادي أعلى من الزراعة التقليدية بنسبة 12%.

الكلمات المفتاحية: الزراعة الحافظة، الزراعة التقليدية، العدس البعل، العائد الاقتصادي، تكاليف الانتاج.