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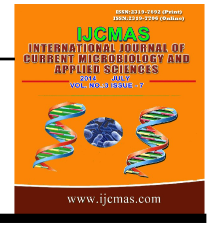

Original Research Article

Impact of tillage on soil conservation and the crop yield of durum wheat in semi arid region

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A B S T R A C T

The cultivation of winter cereals is still difficult to control because it faces several constraints such as weather conditions, as well as the poor grasp of the technical route. This leads to a low production equivalent to 20 million quintals (ONS, 2011), covering 30 % of national needs. It is, therefore, urgent to fill an estimated deficit of more than 60 % of the national consumption of this strategic product. For this purpose, one of the strategies to advocate is to increase yields per hectare and extend the area sown to winter cereals for fallow resumption while maintaining soil under a sustainable agriculture policy. In this context, this study is the identification and evaluation of one of the limiting factors in cereal production, the tillage. To do this, a wheat crop has been implemented in three technical routes (complete chain, reduced labour and no-tillage or direct seeding). At the end of our experiment, the results, in general, show that the wheat yield is dependent on tillage because a conventional tillage or a complete work of soil brings about the best production and best profit margin for the individual farmer if the cost of farm equipment used is already amortized! Otherwise, it is the technique of direct seeding that takes advantage and provides significant performance and better profit margin for the farmer. In addition, this study shows that a reduction of tillage does not increase the crop yield, but reduces costs and protects the soil. In this semi-arid area, the yields for the three treatments (conventional tillage, reduced tillage and direct seeding) are respectively: 32.9 quintals / ha, 27.33 quintals / ha and 26.1 quintals / ha. In conclusion, the results we have obtained experimentally in the conduct of wheat with the use of crop-tillage prove that it is possible to guarantee a satisfactory productivity while respecting the principle of sustainable agriculture (conservation agriculture).

Keywords

Semis direct,
Blé,
Préservation du sol,
Agriculture durable.

Introduction

Since the development of our civilization, less than 10 000 years ago B.C, the main function of soil wasthe agricultural production to be able to satisfy human needs (Robert 2005). This demand does not stop increasing forasmuch the world population stops increasing. Farmlands are then subjected to an intense regime of exploitation. This has led to a deterioration of the quality of soil.

Certainly, the impoverishment of soil is partly natural (progressive acidification drivingly of the ions in waters of percolation) and almost inevitable. However, the agriculture remains the main factor of exhaustion of soil (Tessier on 2009).

If soil formation is a slow process, degradation of farmland, is however a quick process. This soil degradation due to plowing undermines the hope of securing an efficient and sustainable profitable farming. Therefore, a new way of managing farmland for restoration or preservation of soil should be initiated.

In order to address simultaneously the degradation of soil quality and declining production, the direct seeding techniques, which aim to reduce tillage, are applied in most countries of the five continents (Steiner, 1998; Derpsch, 2001).

This action is not only a way of managing different soil, but also a sustainable operating philosophy of the soil resource, in complete harmony with nature.Besides the economic benefits, working time, energy, the direct seeding techniques are a new agricultural approach that aims to develop or restore the land to a natural fertility.This improvement in soil fertility is based on organic and biological soil revitalization and restructuring of its superficial party which instead of being susceptible to degradation will become a support for sustainable agriculture.

In this context, a wheat crop was installed to evaluate one of the parameters limiting cereal production namely tillage. Thus, three technical routes have been adopted (a complete work or complete chain, reduced tillage and no-tillage or direct seeding) to study their effect on the parameters of wheat yield and soil microbial activity.

Materials and Methods

Location of the test

The test took place during the partner 2011-2012, in the research station of the Technical Institute of Field Crops (CETO), located in the Province de Tiaret at an altitude of 980m and whose coordinates are 35°24 ' 8.1 " N and 1°34 ' 29.4 " E.

The soil used, with silty clay is rich in calcium and nitrogen (previous crop «lens»). The study area is located in the semi-arid bioclimatic.

The plant material and the implementation of the test

Soil preparation has been using basal application (nitrogen fertilizer) as urea (46%) of a total herbicide (GLYFOSINATE Basta) at 2.5 l / ha and a fungal treatment with TILT at 0.5 l / ha.

The durum variety used called "Simeto" or "Sersou" is introduced from Italy. The thorough manure is brought after the autumn plowings (nitrate fertilizer) in the form of urea (46 %) in the air then sowing the dose of 125 kg / ha. A total weed killer GLYFOSINATE Basta, at the rate of 2.5 l / ha is used followed by a fungal treatment (TILT in 0,5 l / ha).
The harvest is made with a harvester experimental threshing machine (width 1,5 m).

Measurement and Analysis

a) Measurement of yield components

- The number of spikes / m²: Between

the heading stage and early flowering;

• The number of grains / ear: after grain maturity;

• The weight of 1000 grains: after harvest (15% grain moisture).

The actual grain yield

Microbiological Analysis

The estimation of microbial mass (aerobic bacteria and fungi: azotobacters, germs ammonifiants, nitrifying bacteria and denitrifying) is essential to study the flow in the soil of certain elements such as carbon and nitrogen. (Pachepsky, et al. 2003).

By indirect enumeration whose principle is based on cultures in liquid or solid environment after inoculation with dilutions of soil suspensions. Soil samples were ground and sieved to 2 mm and then treated with different dilutions of suspensions incubations (petri dish and agar medium supplemented with Actidione for fungi and nutrient enriched agar for bacteria at 28 ° C and then read the results after seven days of incubation according to the method of the Most Probable Number from Mac Crady (1918).Preparation of soil suspension dilutions consist in placing a series of 9 tubes sterilized, numbered 1 to 9 Each tube contains 9ml of distilled water to which was added 1 g of the sieved soil and homogenized, followed by stirring. The suspension is 10^{-1}dilution, the transfer tube 2, it is the suspension dilution 10^{-2} stir and repeat the operation (Fig. 01).

Results and Discussion

The results obtained are treated with the STATISTICA 6.0 software / comparison with lesser means squares with the general linear model (GLM) factorial ANOVA to determine the degree of significance of the parameters studied and their impact on the performance of the studied culture.

The yields for the three treatments (conventional work, reduced work and direct seeding) are respectively: 32.9 qx/ha27, 33 quintals / ha and 26.1 quintals / ha (Figure 3b).

Reducing tillage affects the thousand kernel weight is in the treatment "direct seeding" lower than the reduced work and that of the complete work which are respectively 35.06g, 37.33g and 40g (Figure 3a). Indeed, this factor reduces crop production but preserves the soil.

Thus, a reduction of tillage, is accompanied by a reduction in the number of grains per ear and the thousand kernel weight. The value of the latter ($p = 0.35$) in direct seeding is lower than the reduced work and complete work.

According to the figure (4a), the highest rate of the aerobic bacteria is posted(shown) by treatment(processing) TC with $19{,}50\times10^6$ germ/ g of soil before seeding, $33{,}33\times10^6$ germ/ g of soil after seeding and $20{,}33\times10^6$ germ/ g of soil during the harvest. For the rate of fungi, (figure 4b), the variation is the same shape but it is more important: $98{,}33\times10^6$ germ/ g of soil before seeding (high rate) at TC and the lowest rate is noticed at SD with an average of $57{,}00\times10^6$ germ/ g of soil.

The picture 03 and the figure 5a release a rate of azotobacters of $175{,}33.10^6$ germ/ g of soil before seeding at TC. Most low rate is $91{,}66.10^6$ germ / g of soil registered in TM. After sowing, $242{,}66.10^6$ germ / g at TC and a minimal value of 148.106 germ / g of soil in TM. In the harvest, the highest rate is $128{,}66.10^6$ germ / g of soil registered in TC and the lowest rate registered in TM with an average of 96.10^6 germ/ g of soil.

Concerning the rate of ammonifiants, we note a clear increase for routes TC and SD. Indeed, before seeding $0{,}7.10^6$ germ/ g of soil (SD) and $0,6.10^6$ germ/ g of soil (TC). After seeding, a high rate of ammonifiants $1,1.10^6$ germ/ g of soil (SD) and (TC) which remains up to the stage of the harvest. It's the same for the rate of nitrifiants and dénitrifiants with a variation which presents the same evolution as that of the ammonifiants (picture 03)

It should be note that the soil contains a considerable mass of microorganisms which are the main agents of decomposition of the organic matter to substances easily assimilated by plants.

It is important to note that the biological activity of grounds rich in humus produces plants in biological balance (Sepanso, on 2008); In the soil, the biological activity is concentrated in the superficial coats and in the periphery of the galleries of the earthworms where the contribution of the organic matter and the water contribute to the best conditions of aeration (Mustin, on 1987 in Batra and al, on 1997). Besides, the studied microbial groups evolve differently according to the conditions to which they are related.

Thus, the aerobic bacteria present a density which is relatively lower that the other microbial germs (in period before sowing). Which is probably due to the wintry low temperatures which favor hardly the evolution of these germs. On the other hand, in spring period, their rate presents a remarkable growth because the temperatures are more clement.

The highest rate of the aerobic bacteria is registered at the sample TC for three periods of taking which is due to the present of quantity of nitrogen in the ground which is the most higher compared with the other treatments processing, because bacteria proliferate better in the circles rich in nitrogen (the cultural precedent = culture of the lens). Besides, bacteria are the most sensitive perceptible to the lack of water than the other microorganisms, the optimum of their activity is situated between 50 in 75 % of the capacity in the field (low rate of the aerobic bacteria in TM).

fungi are lesser in periods before seeding and harvest while they quickly evolve after seeding that is understandable by the conditions of temperature, humidity, aeration and availability of nourishing elements. The rate of mushrooms increases quickly essentially in the treatment TC which shows the highest rate. The low alkalinity also favors this development because fungi prosper better in the acid and airy environment (Duchauffour, on 2001).
The stability of the aggregates is correlated to the quantity of the organic carbon present in the ground. As this quantity increases appreciably in direct sowing, the aggregates are more stable in this cultural situation (Saber and Mrabet, on 2002; Pachepsky, and al. 2003; Sasal and al. 2006). If the stability of the aggregates is increased in direct sowing, the lack of working the ground exercises leads, on the other hand, to a decrease of the porosity of the horizon of surface compared with a ground worked formally; of numerous studies carried out in pédoclimatic conditions varied end in an increase of the visible density in direct sowing, in five to first ten centimeters of ground (BASIC and al, on 2004).

Nevertheless, the optimal temperatures of the growth rate and the biochemical activity vary according to the species (Taylor and Aidan, on 2004). The majority of bacteria are mésophilic with an ideal of temperature which is situated between 25 and 35°C (Frey and al ., on 1999; Prescot and al, on 2003). Besides, the development of bacteria is better when the pH varies from 6 to 8

(Soltner, on 2003).Yet, in three treatments processings, the pH is upper to 8 which explains the low rate of microorganisms.

Moreover, the microbial populations have a density ten times as big and even more around the rhizosphere in soil free roots, (Batra and al, on 1997). The climatic modifications in direct sowing such as the more low temperature differences and higher moisture contents are favorable to an increase of the microbial activity and the biomass (bacteria and fungi) in the first centimeters of the soil (Kladivko, on 2001; Prescot and al, on 2003). However, in direct seeding, fungi are dominant in the first five centimeters of ground while in ploughed situation, this zone is colonized by bacteria (Frey and al ., on 1999; Galvez and al ., on 2001).

The effects of the working ground exercises on the animal macrorganism were mainly studied on annelids or worms for their key roles in the agroecosystem (Kladivko, on 2001). The amount of earthworms strongly increases in unprocessed compared to a conventionally worked ground floor (Tebrügge and Düring, on 1999; Anken and al. 2004).

It now appears that the biological characteristics of grounds are dependent not only on physico-chemical and pedological properties but also on the anthropological activity. Indeed, certain cultural practices, as the liming or the drainage, may change indirectly the biological characteristics of the soil through a modification of the physico-chemical conditions.

Other more direct effects are related to the "organic status" through culture systems. Any organic input, resulting in an increase of microbial biomass. Conversely, the intensification of agriculture (notably through the work of highly energetic ground) generally leads to a decrease in stock organic by physical protection of organic matter, stimulation of the biological activities of mineralization and ultimately decrease the microbial biomass (Bernard et al. 2007).

Compared to a ploughed ground nitrogen and organic carbon increased in direct sowing in the first five to ten centimeters of soil (Pekrun and al. 2003). Al Balesdent and. (2000) show a reduction in the rate of mineralization of organic carbon in no-till compared to tilled soil. For Pekrunet al. (2003), decomposing microorganisms, dominated by fungi, promotes immobilization of nitrogen which increases soil but despite this, the high amount of organic matter helps retain significant mineralization in direct seeding. (PRESCOTT et al , 2003).

All parameters of yield are positively correlated with grain yield (tab 4). This means that the increase in ear / m2, number of grains / spike and thousand kernel weight provide increased performance grain. For cons, the same table is a negative correlation between the number of plants/m2 and other performance parameters can be seen after

Adoption of Direct Seeding system is for economic, agronomic but also by climatic reasons. In semi-arid areas with very low and often poorly distributed rainfall, the SD technique to perform dry sowing and thus enjoy the first rains.

In the Western Europe, the agriculture (farming) of preservation occupies a different place(square) according to the geographical situation of the countries which have very heterogeneous pluviometries. At present, the countries of the Eastern Europe and the States of former(old) Soviet Union appropriate gradually the technique of the Direct Sowing to face a very short vegetative period due to the long and rigorous winters, (Dupraz, on 2006).

The purpose of our test is the establishment of a wheat crop in three technical routes (complete chain, reduced tillage, and no tillage or direct seeding) is a highlighted the possibility of using seedlings live in the conduct of wheat produces acceptable productivity while respecting the principle of sustainable agriculture (conservation agriculture).

In view of the results obtained, this work shows that a simplification of tillage does not increase the crop yield, but reduces costs and protects the soil.

In this semi-arid area, the yields for the three treatments work conventional, reduced tillage and direct seeding) are respectively 32.9qx/ha, 27.33qx/ha and 26.1qx/ha. These results, obtained experimentally show that it is possible to substantially improve the productivity of cereals in different agro-ecological regions by the method of direct seeding.

However, to improve the national cereal production and achieve food security, it is necessary to encourage and convince farmers to adopt new techniques and adequate production as direct seeding, which has many advantages and interests such as the fight against erosion, conservation of soil structure, optimization of working time and exploitation of mineral and water resources especially early in the crop cycle .

Our constant concern is to design cropping systems to low levels of inputs that are both productive, sustainable and environmentally friendly power to evoke or advocate Conservation Agriculture and Sustainable Agriculture. Resorption of fallow with tillage preserves soil and increase grain production.

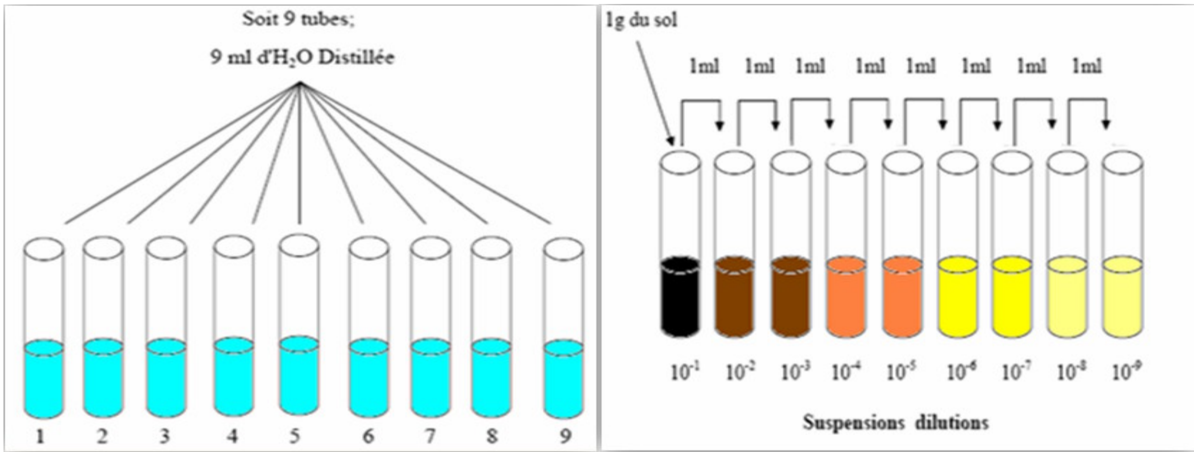
Table.1 Chains of tools used for working the soil

Travail du sol	Chaîne 1: (CC) Chaîne complète	Chaîne2: Travail réduit (TR)	Chaîne 3: Semis direct (SD)
Labour (retournement du sol)	charrue à socs;	Non	Non
Pseudo-labour (destruction des mottes)	Cover croop	Cultivateur à dents (Chisel)	Non
Façons superficielles (ameublissement)	Herse	Herse	Non
Semis	Semoir classique en ligne	Semoir classique en ligne	Semoir du semis direct

Table.2 Analysis of variance of components of efficiency

paramètres	SC	DDL	MC	F	P
Nbr grains/ épi	88,22	2	44,11	2,529	0,16
PMG (g)	36.59	2	18.29	1.257	0.35
Rdt (qx/ha)	79.63	2	39.81	0.421	0.67

Figure.1 Preparation of dilutions of soil suspensions



\+ Growth - No Growth

Figure.2 Results of the number of spikes / m2 treatment (a) and number of grains / spike (b)

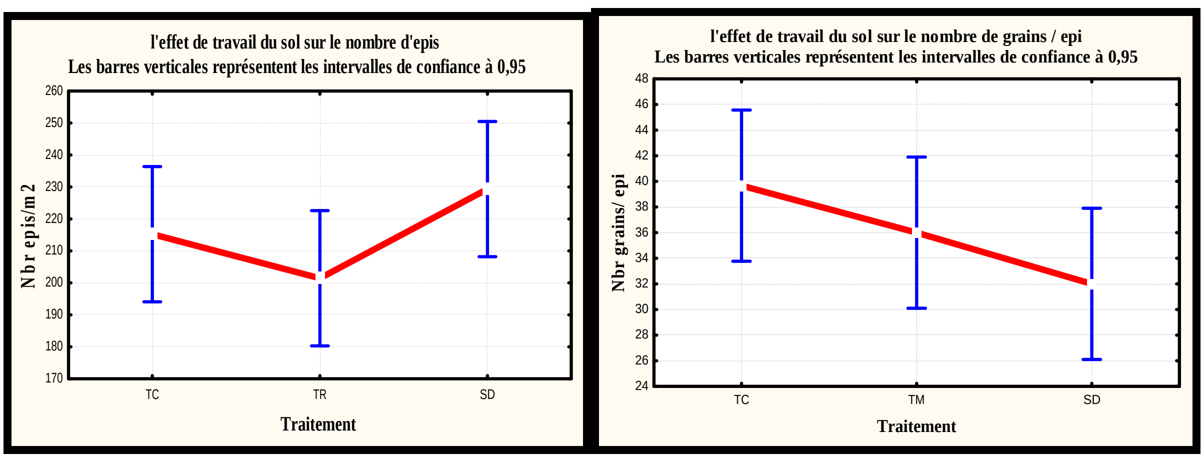


Figure.3 Results of the PMG treatments (a) and the actual grain yield (quintals / ha) (b)

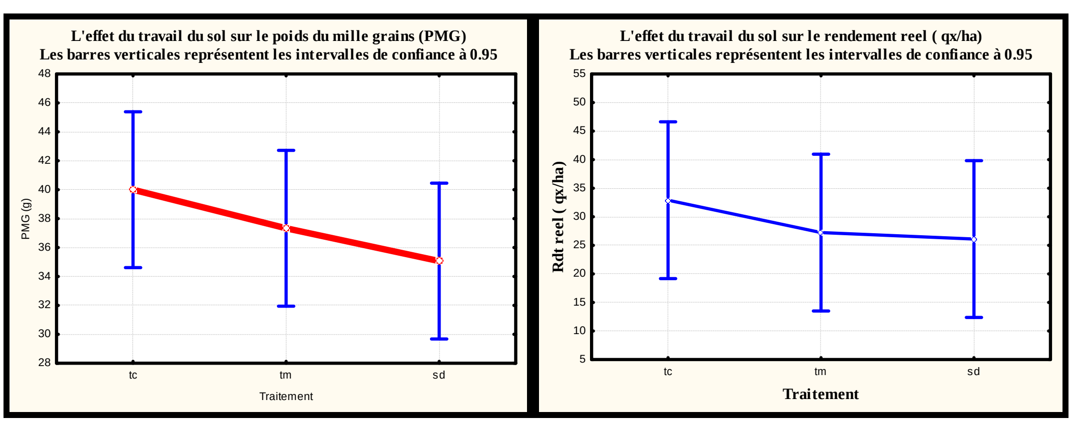


Table.3 Results of the density of soil microorganisms (x 10^6)

treatment	périod	Rate of aerobic bactéria	Rate of Fungi	Rate of azotobacters	Rate of ammonifiants	Rate of nitrifiants	Rate of dénitrifiants
TC	bfs	19,50	98,33	175,00	0,6	0,6	0,7
	afs	33,33	115,33	242,00	1,1	1,1	1,1
	har	20,33	92,33	128,00	1,1	1,1	1,1
TM	bfs	7,65	67,00	91,00	0,3	0,6	0,3
	Afs	21,50	98,66	148,00	1,1	1,1	1,1
	har	16,00	92,33	96,00	0,6	1,1	1,1
SD	bfs	11,66	57,00	111,00	0,7	0,7	0,7
	Afs	24,00	101,00	204,00	1,1	1,1	1,1
	har	14,00	62,33	116,00	1,1	1,1	1,1

bfs = before sowing ; *afs* = after sowing ; *har* = harvest

Figure.4 Rate of aerobic bacteria (a) and fungi (b) in the three treatment before and after seeding and harvesting

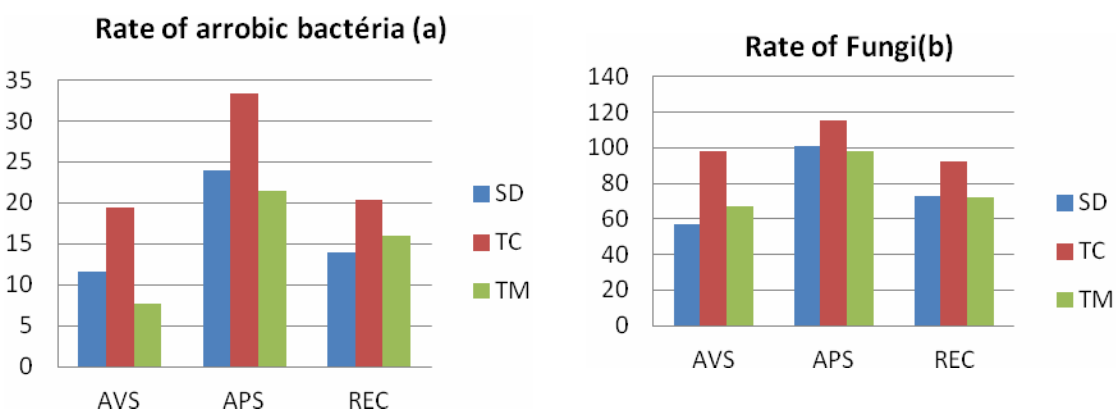
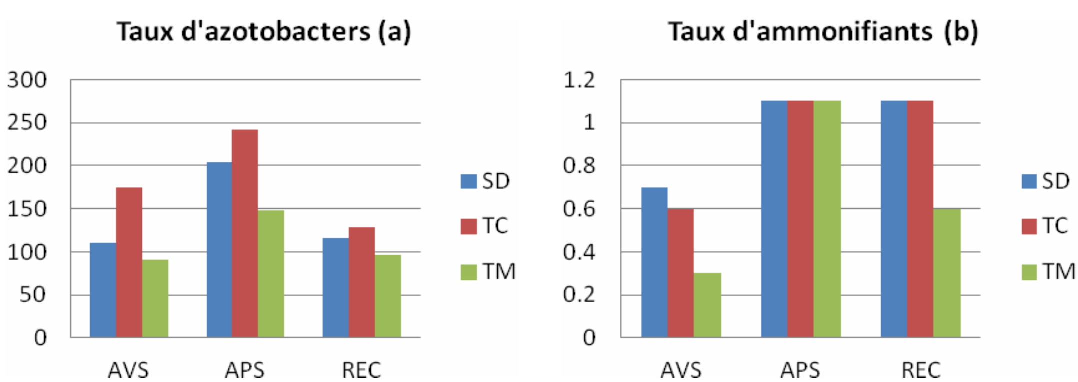


Figure.5 Rate of azotobacters (a) and the ammonifiants (b) in the three treatments before and after sowing and harvesting



In addition, the Direct Seeding experiencing tremendous success globally with more than 100 million hectares spread over the entire planet: the United States, Canada, Australia, Europe, China and not forgetting the countries of the Mediterranean Basin and among them Morocco and Algeria. Meet the growing demand for food, it is necessary to find solutions: Direct Seeding can probably be one.

However, Tillage system designs in a global agricultural exploitation and around a synergy of skills and experience between researchers, institutions, economic operators, especially farmers. The Direct Seeding is a win-win alternative to both increase farm income while improving water conservation and soil, and reducing production variations.

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