Socioeconomic assessment of no-till in wheat cropping system: a case study in Algeria

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Abstract

This paper aimed at the socioeconomic appraisal of two cropping systems namely no-till and tilled wheat in Sétif region (Algeria). The study based on a sample of 28 adherent farms in an international project of Conservation Agriculture adoption for smallholders in North Africa. Economic diagnosis showed that no-till system performed best with a gross margin difference of $ 84/ha in comparison with conventional tilled wheat. Moreover, no-till recorded less work time and fuel consumption, with 241minutes/ha and 42 liters/ha against 624 minutes/ha and 99 liters/ha for conventional tillage. Though, no-till still faced some local social and technical constraints that are relatively easy to overcome. If Algeria put forward its best efforts through increasing no-till in the suitable zones, many objectives could be achieved in the context of preserving natural resources and building up farming sustainability. It could be also a key solution for "Intended Nationally Determined Contribution" (INDCs) schemes to meet Algerian commitments regarding "Paris Agreement" on climate change.

Keywords: *No-till, Farm, Wheat, Conservation agriculture, Algeria.*

1. Introduction

Nowadays, one of the crucial challenges is to feed a growing and more demanding world population with reduced external inputs and minimal environmental impacts. Conservation agriculture (CA) is a production system aims at reducing the effort and cost of farming with the intention of protecting agricultural resources such as soil, water and biodiversity. Motivated by agronomic, economic and environmental considerations, this technique meets the criteria of sustainable agriculture and has gradually been imposed worldwide. This trend is closely associated with an increased awareness about the environmental externalities of the conventional farming practices in the public and policy arena (Krishna *et al*., 2012). The first key step in CA is to minimize the disturbance of the soil by using no-till (NT) cropping, also known as direct drilling or zero tillage, where the seed is planted directly into undisturbed soil along with fertilizer, by creating a narrow furrow just large enough for

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the crop's seeds to be injected. Globally, farmers are adopting CA at a dramatic rate, from 45 million hectares in 2001 (Derpsch *et al*., 2010) to about 157 million hectares in 2015 (FAO, 2018). NT has the potential to address the economic and environmental challenges of sustainable intensification such as reducing costs of labor, fuel and machinery, greenhouse gases emission and therefore increasing carbon sequestration, all of that could be tools of fighting climate change. The initiation of scientific NT attention can be traced back to the 1970s in Brazil, where the first NT field trials were conducted (Derpsch, 2008). NT practice by minimizing the soil disturbance and providing residue soil cover, is found to increase the soil fertility and water use efficiency, thus helping cereal farmers to sustain the crop yield over a longer term (Benites, 2008; Dhehibi *et al*., 2018), better control soil erosion, lower the overall cost of crop production, and increase farm income (Séguy *et al*., 1998). These opportunities could help countries meeting their commitments to the United Nations SDGs by 2030. In Algeria, cereals are mainly grown under rainfed conditions. Annually, about 3.5 million hectares are harvested in the northern strip; where two-thirds of the agricultural sole are suffering from the hardness of the semi-arid climate conditions. Moreover, the northern part of Algeria is highly subjected to soil erosion estimated annually at 2.000 to 4.000 tons/km² due to erratic rainfall and its high intensity during the rainy season (Demmak, 1982). Many research projects were conducted in northern Algeria for developing NT technologies (Zaghouane *et al*., 2006) where wheat yields are between 1 and 1.5 t/ha (Mahdi, 2004). For the first time in Algeria, the adoption of NT started in 2002 at the high plains of Sétif province with cereals and legumes crops. Since then, several government subsidy programs have been implemented to faster it. While, adoption process faced continually socioeconomic and technical constraints (Rouabhi *et al*., 2016). Over time, technology adoption needs to be monitored by extension services and scientists to draw attention to pros and cons and how to improve adoption process.

Through a sample of 28 adherent farms in an international subsidy program for NT adoption, the present paper tries to assess the agro-economic efficiency of CA technology by comparing two wheat cropping systems: namely NT and Conventional Tillage (CT) and aims also at diagnosing the adoption process of NT under the semi-arid conditions in Sétif province.

2. Material and methods

2.1. *Conceptual framework*

Cereals are the predominant crops in Sétif province, annually they occupy about 1073880 ha, most area is allocated to durum wheat (44%) where the majority is conducted in CT. Rainfall and temperatures are subject to large intra and inter-annual variations, which impact the annual yields that fluctuate from 0.8 to 1.5 t/ha (MARD 2017). The low productivity levels of wheat in the semi-arid zone is not due solely to environmental factors, it is also the result of both crop management and adaptation to local conditions. Local farmers became interested in NT wheat cropping in 2002 (Bouzerzour *et al*., 2006). Much of this interest was a result of the availability of NT seeders, the technical and financial support provided by extension services of agriculture. This study was conducted in 2016 crop year in Sétif province (Algeria) at the end of "CANA Project" http://cana-project.org/. This project aimed at adapting CA for rapid adoption by smallholder farmers in North Africa. The geographic spread of the project included three North Africans platforms (Sétif-Algeria), (Chaouia-Ouardigha-Morocco) and (Fernana-Tunisia), with a scientific cooperation of the Australian Center for International Agricultural Research (ACIAR) and ICARDA. The study focused on a sample of 28 tracked farmers involved in NT adoption process for three years (2013-2014-2015) in CANA project. Indeed, farms were financially subsidized and technically supported during the project period. But, in 2016, farms no longer received incentives. Given this new situation, it would be appropriate to assess the artificial effects of the CANA project and hence the actual choices of NT adoption by farms. If NT practice has positive impacts, thereafter the adoption rate of NT will be reliable afterwards. Against, if NT has not enough advantages, farms will abandon it and return back to the old system (CT).

2.2. *Characteristics of the area study*

Situated in the northern part of Algeria, Sétif province is characterized by a semi-arid climate with an annual rainfall of 458 mm, where the majority area of cereals located in central and southern, has less than 25% occurrence of exceeding 400mm/annum (Rouabhi, 2017). The study area includes 10 municipalities spread over an area of 1500 km², known by cereals as staple crops particularly durum, soft wheat and barley. In Algeria, the average farm size of smallholders represent 79.2% of all farms, varying from 2.7 to 9 hectares (Shaw, 2015). The small scale farming is the most dominant in the region because of the land tenure law and the recursive division of land by families.

2.3. *Source of data and treatment methods*

Through a targeted sampling method, gathered data turned around financial and technical aspects of 28 selected farms, combining NT and CT for durum wheat cropping. Supplemental information was gathered via interviews with officials of agricultural services and cooperatives. The collected data were got verified from experts and the socioeconomic team of CANA project. Every possible care was taken to ensure the accuracy and reliability of the information especially for financial data.

At first, the study focused on the farms characterization and then went through a financial assessment; the accounting model used in this study was based on the gross margin. Indeed, the average annual costs and returns for one hectare of NT and tilled durum wheat were calculated under rainfed conditions. Variable costs referred to the overheads which varied directly according to the level of production of grown crop. They included seed, hired labor, fertilizers, pesticides, and hired machinery. However, fixed costs are defined as costs that do not change with the level of production, they include depreciation, interest, repair maintenance and insurance (Sofijanova *et al*., 2012). Indeed, fixed costs depend on the quality and the costs of investment. The profitability levels of durum wheat farming in both cropping systems were examined in a gross margin comparative analysis; the gross margin is the difference between the gross income and total variable costs.

Break even yield refers to the yield (q/ha) to be obtained to cover variable costs only; this parameter will give some indication of the riskiness or exposure of the particular farm. Break even yield is a ratio of total variable costs and the gross income of one quintal of product (grain and straw). The results, calculated in the national currency unit, were converted to US Dollar at the actual rate of exchange during 2016 crop year.

3. Results and discussion

3.1. *Social characterization*

The characterization of farms was based on some socioeconomic components, taking into account the criteria of the farm and the personal skills of the farm holder such as the age, the educational level and the technical level of agricultural training. Indeed, these criteria allow a fine understanding of the decision making process regarding NT adoption in farms. The observed age spanned between a minimum of 32 years and a maximum of 66 years. The average age was 51 years; where almost of 54% of farmers were older than 50 years. This finding corroborates the results of the general census of agriculture in 2001, stating that the age of Algerian farmers is high. Indeed, the higher age may give an idea on the skills and the accumulated experience within farm.

However, the low level of farmer's instruction is the major impediment that faces agricultural development in Algeria (Zoghbi, 1992). The results showed that the level of education of farmers is relatively high, where 39% and 25% represented the secondary and the university level respectively. This result is contrary to the figures put forward by Rouabhi *et al*. (2014) saying that the level of education of local farmers is largely low. This contrast could be due to the targeted sampling method used in this study. Accordingly to the educational level, the observed level of agricultural technical training was relatively high as well. Where 39% had a very good technical level, however, 36% had a medium level and 25% had a low level of training. In Algeria, the role of agricultural training centers in developing skills and training farmers is very limited. Berranen (2007) highlighted that only 1% of the total number of farmers has been concerned by training between 2000 and 2006. Locally, the low level of education and the lack of agricultural training were the most important obstacles to the development and extension of agricultural technology.

3.2. *Economics of NT and CT cropping*

Keeping regular records on-farm of all technical and financial activities is an important component of farm management and decision-making for long term planning. Farm Gross margin is one of the simple financial means that helps to improve farm potentials. In the following parts, a comparison is implemented between the profitability of NT and CT of one hectare of durum wheat.

3.2.1. *Gross income*

The gross incomes per hectare for NT and CT systems were $ 990.38 and $ 941.50 respectively (Table 1), indicating a relative association between the gross incomes and cropping system. Generally, the grain yield is the backbone of the economic income of farms practicing cereal crops. Within the sample the average grain yield of durum wheat were 26.41 q/ha in NT system and 21.52 q/ha in CT system. Locally, grain yields were usually variable from one year to another; they are strongly associated with the amount and the distribution of the annual rainfall. It should be noted that CA technology could improve resilience of farms to climatic hazards, if it is well combined with crop rotation and right crops residue management. Moreover, NT could significantly increase rainfed crop productivity in dry climates, suggesting that it may become an important climate change adaptation strategy for ever-drier regions of the world (Pittelkow *et al*., 2015).

In Algeria, cereal farms are supported and sheltered from international price fluctuations, their grain productions are sold to the governmental cereal collection units at incentive prices of $ 28.12/q. Indeed, sales of straw represent an additional financial resource for farms, because in the semi-arid region the production system is based on the combination of livestock farming and cereals (Rouabhi *et al*., 2016), as a result, secondary products such as straw and grazing areas become coveted. Sales of straw in the CT system exceeded straw sales in the NT system, where straw sales were about 107 straw bales/ha and 79 straw bales/ha respectively, it should be noted that straw bale weights between 15 and 20 kg. According to the principle rules of NT, farms have to keep more straw on field, in order to guarantee more organic cover, able to preserve soil moisture and minimize erosion, which could have a positive impact on farm sustainability over time.

3.2.2. *Variable costs*

According to the accounting model, variable costs are broken down into input costs, hired machinery and miscellaneous. The NT system is known to minimize operating expenses and hence reducing total variable costs, in this study variable costs in NT system recorded $ 244.17/ha against $ 279.02/ha in CT.

3.2.2.1. Materials (Inputs)

In durum wheat cropping system, much money is spent to purchase inputs, according to the study, the cost of inputs were $ 131.59/ha in NT and $ 134.78/ha for CT system, representing 54% and 48% of the total variable costs respectively. NT practice is found to be helping the farmers to reduce seed rate by 25%, because of its positive effect on seedling emergence rate. Krishna *et al*. (2012) reported that farms can earn 8% to 11% of seeding rates in NT compared to CT. Locally, farmers used from 1.2 q to 1.4 q of seeding density in CT while in NT the density could drop to 0.9 q/ha. The seeding rate is generally related to several technical factors such as pedoclimatic conditions, specific weight of wheat varieties and seeder adjustment. Inputs of seeds were about $ 29.25/ha and $ 39/ha for

NT and CT respectively. However, for both systems, prices of fertilizers were similar with $ 68.94/ha. The most used mineral fertilizers were Mono-Ammonium Phosphate (MAP) and urea, used respectively at various doses of 1 q/ha and 0.8 q/ha in autumn and spring. However, costs of sprays in NT were greater than those of CT, because of the supplemental use of "Glyphosate" in NT system. Locally, "Glyphosate" is used as a pre-seed herbicide; it is applied at a dose of 3 liters per hectare, equivalent to a supplemental cost of $ 27.81/ha. Farms using "Glyphosate" may have early weed control, so they would use less anti monocotyledon and anti-dicotyledon herbicides during the remaining cropping cycle. Recently, some farms were taking health concerns about the use of "Glyphosate", therefore, they reverted to mechanical weeding in order to avoid its prolonged use. Indeed, the level of education of farms holders reflected their awareness about the "Glyphosate" use, which is considered as «probably carcinogenic to humans» (WHO, 2015). In many countries, "Glyphosate" has been banned for public health considerations but in Algeria it is still allowed.

3.2.2.2. Hire machinery

Machinery costs amounted to $ 79.02/ha for NT system and $ 111.67/ha for CT. According to the dry farming techniques applied locally, farms usually adopt a biennial rotation, cereal on uncultivated fallow, where, the soil is plowed in spring and left to rest until autumn and then re-worked and seeded. This technique aimed at weeding, scheduling fallow works and conserving soil moisture by taking advantage of spring rainfall for the following year (Bernard, 1911). This procedure seemed to have supplemental costs in comparison with NT. The advantage here is in favor of NT because of the total absence of land preparations. Godwin (2014) showed that the NT system could potentially have a work rate of 2.5 less than CT, both matched to the appropriate sizes of tillage tools. In NT, farm saved $ 21.88/ha in plowing, $ 17.58/ha in the bed seeding preparation and $ 1.76/ha in rolling. Seeding operation was more expensive in NT; it was 3 times more expensive. To be managed, the NT seeder required a powerful tractor, higher than 100 horsepower (hp). Also, the seeder unavailability in the region implied more expensive rental services. Spraying operation encompasses the application of herbicides; the treatment cost was $ 5.52/ha in NT and $ 2.76/ha in CT. Generally, the number of interventions is higher in NT, where farms are forced to perform a pre-seeding treatment to completely eradicate all plants through Glyphosate use.

For cropping systems, all costs of grain harvest, straw baling, swathing and freight were similar; with $ 56.05/ha. Some others charges (miscellaneous) were assessed on the basis of 2% of the gross income per hectare. Miscellaneous included insurance, levies and taxes, their costs were quite similar for both cropping systems; with $ 33.56/ha in NT and $ 32.58/ha in CT.

3.2.3. *Gross margin*

Economically, the NT system was more efficient than the CT system, the gross margin was $ 746.21/ha in NT and $ 662.48/ha in CT. this variation was mainly due to the decrease of the total variable costs under the NT system. Erenstein *et al*. (2008) estimated a cost-saving of 7-10% in some regions of India and Pakistan. However, Krishna *et al*. (2012) reported that NT adopters are found to save about 34% over their CT counterparts in the subsistence wheat farming systems. It should be noted that grain yields under the NT system may drop during the first years of adoption. Morris *et al*. (2014) indicated that the crop yields immediately after NT adoption are lower than in CT, but that they improve with time. Also, a targeted review of NT studies in sub-Saharan Africa and South Asia reported at high risk of short-term yield declines for major annual crops (Brouder and Gomez-Macpherson, 2014). In 2013, over the CANA project platforms in the Maghreb, the gross margin in Morocco and Tunisia were in favor of NT system, in Morocco, under low annual rainfall zone, gross margin was $ 367/ha under NT against $ 356/ha under CT. In Tunisian high annual rainfall zone, gross margin was $ 775/ha for NT and $ 625/ha. Break-even yield analysis computed the yield necessary at a given level of prices to cover all variable costs. In Algeria, selling price

	No-tillage		*Conventional Tillage*	
Income	*Yield*	*Income*	*Yield*	*Income*
Grain (q/ha)	26,41	742,78	21,52	605,25
Straw (bale/ha)	79,23	247,59	107,6	336,25
Gross income	**$990,38**		**$941,50**	
Materials (input)				
Seed	29,25		39,00	
Fertilizer	68,94		68,94	
Sprays	33,40		26,84	
Total Input	**131,59 (54%)**		**134,78 (48%)**	
Hire machinery				
Plought	0,00		21,88	
Soil preparation	0,00		17,58	
Seeding	13,99		4,73	
Rolling	0,00		1,76	
Fertilising	3,46		6,91	
Spraying	5,52		2,76	
Grain Harvest	27,54		27,54	
Straw Baling and swathing	17,97		17,97	
Freigth	10,55		10,55	
Total Hire machinery	**79,02 (32%)**		**111,67 (40%)**	
Miscellaneous				
Insurance	13,75		13,75	
Levies & Other (2% of income)	19,81		18,83	
Total Miscellaneous	**33,56 (14%)**		**32,58 (12%)**	
Total Variable Costs	**$244,17**		**$279,02**	
Gross Margin	**$746,21**		**$662,48**	
Break Even Yield (to cover variable costs only)	**8,68 q/ha**		**9,92 q/ha**	

Table 1 - Per hectare gross margin of durum wheat cultivated under NT and CT.

of durum wheat is incentive ($ 28.12/q), hence farmers who are practicing NT are more able to cover variable costs, with less Breakeven yield (8.68 q/ha). However, Breakeven yield in CT is 9.92 q/ha. Generally, the economic profitability is certain in both cropping systems, but in NT system it could provide more advantages in economic, agronomic and environmental terms.

3.3. *Time saving and fuel consumption*

The substitution of CT by NT allowed more even distribution of labor over the year, because of the elimination of soil preparations operations. Amount of time used up for each operation in minutes are shown in Table 2. For CT system, land is usually prepared since spring, where deep plough and weeding are carried out, as a result the labor time duration was consistently higher (710 min/ha/year) with 12 field tasks, However, in NT the number of field tasks was only 7 with a labor time duration of 297 minutes. The major part of work time was allocated to soil preparation in CT with 405 minutes corresponding to 57.04% of all labor time. However, the great part of work time in NT was taken by harvesting, baling and freight operations with 225 minutes (75.76%). Fuel consumption was higher in CT system with 90 liters

	Time of labor (minute)		Fuel consumption (liter)	
	NT	CT	NT	CT
Subtotal Soil preparation	**0 (0%)**	**405 (57,04%)**	**0 (0%)**	**49 (54.38%)**
Ploughing	-	240	-	28
First Cover crop pass	-	60	-	8
Second Cover crop pass	-	60	-	8
Seedbed preparation	-	30	-	3
Rolling	-	15	-	2
Subtotal Seeding &Fertilizing	**32 (10.77%)**	**60 (8.45%)**	**10 (20.41%)**	**7 (7.77%)**
Seeding	17	30	8	3
Fertilizing (MAP)	-	15	-	2
Fertilizing (Urea)	15	15	2	2
Subtotal Spraying	**40 (13,47%)**	**20 (2.82%)**	**5 (10.20%)**	**5 (0.12%)**
Spray (Glyphosate)	20	-	2.5	-
Sprays (anti mono and anti-dicotyledon)	20	20	2.5	2.5
Subtotal Harvesting, baling & freight	**225 (75.76%)**	**225 (31.69%)**	**34 (69.39%)**	**34 (37.73%)**
Harvest	90	90	24	24
Baling & bales freight	45	45	7	7
Grain freigh	90	90	3	3
Total	**297**	**710**	**44**	**90**

Table 2 - Assessment of NT and CT systems in the context of time labor and fuel consumption.

of gasoil per hectare against 44 l/ha in NT. As the same pattern of labor duration allocation, soil preparation operations consumed more fuel in CT with 49 l/ha (54.38%) while harvesting, baling and freight operations were the most consumers of fuel in NT, with 34 liters (69.39%). Çarman *et al*. (2013) suggested that the CT required 5.6 times more fuel compared to NT. These findings were also in agreement with the research results of Köller (2003). Fuel consumption under NT was invariably less than under CT, though the difference will depend strongly on the soil type, the depth of ploughing and adequacy of the input energy to be used and the machinery. In this context, the NT system was less emitting CO_2; hence this cropping system could be an alternative to fight against green house gas emission.

3.4. *Logics and dynamics of the NT adoption*

The abovementioned results indicated that economic and environmental benefits of NT are confirmed and unequivocal; in spite of some constraints facing its adoption by local farmers. During the CANA project, the total area of NT cultivated by all farms was 175.5 ha. In 2016, after the CANA project, the area reached 257 ha with only 8 remaining farms, implying 20 abandoner farms. Controversially, the number of farms adopting NT has dropped while the area of NT has increased, meaning that the eight farms increased NT areas and found NT more fitting, whereas the average area of NT by farm grew up from 6.26 ha to 32.12 ha in 2016. Due to the completion of the CANA project that provided subsidies to farms, some of them were unable to pursue NT practice either for financial or technical reasons. As the success of NT adoption may be influenced by artificial supports, this may reclassify virtuous and potential farms from opportunists ones. In this regard, Nyanga (2012) pointed out that once a subsidy project is completed farms will stop practicing direct seeding because they no longer receive artificial incentives.

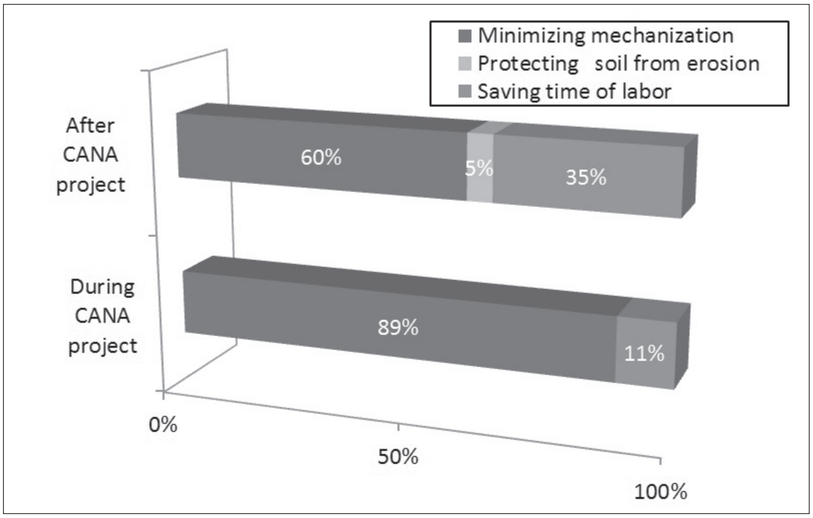

Figure 1 - Evolution of the main reasons for adopting NT during and after CANA project.

3.4.1. *Reasons for adopting NT*

Through CANA project, adherent farms aimed at improving their economic skills via adopting NT, by minimizing production costs and saving time of labor. During CANA project, there were 89% of farmers who considered that NT adoption may decrease mechanization cost, against 60% after CANA project (Fig. 1). In 2016, 35% of farms realized that NT could reduce significantly time of labor, however, during CANA project only 11% of farms considered that. This rising rate of time consideration is due to the positive effects of NT practices experienced by adoptive farmers. According to Raunet *et al*. (1999) the suppression of plowing can facilitate cultural operations by saving time and allowing flexibility to farmers. Else, in 2016, a little proportion of farms (5%) began to feel the role of adopting NT in protecting soil against erosion.

3.4.2. *Constraints of NT adoption*

According to the sample, NT adoption faced some resistance regarding the socioeconomic and technical context; the evolution of these constraints varied over time and is linked to the comprehension and the ability of farms to be accustomed with. According to Figure 2, the feeling of farms towards the major constraints facing NT adoption during and after the CANA project has changed completely.

3.4.2.1. Economic constraints

The NT seeder is a specific seeder, it is very heavy, weighing between 2300 and 2500 kg and it needs a powerful tractor to be managed. Locally, the majority of tractors are medium power and they are unable to lift NT seeder, therefore acquiring a powerful tractor becomes a necessity for NT adoption.

During the early years of NT experience, yield may drop because of the lack of mastery of both machinery and weed control; as a result yield performance could be affected. Pittelkow *et al*. (2015) indicated that yields in the first years following NT implementation declined for all crops. NT farming systems require an increased amount of herbicides, as mechanical weed control and tillage is not a valid option for these systems (Friedrich, 2005). During CANA project 42% of farms considered that herbicides cost weighted negatively on NT adoption, while in 2016 only 10% evoked this constraint. This could be explained by the shift of some farms to other weed control alternatives such as using crop rotation. It should be noted that the ownership of NT seeder is paramount to continue the adoption of NT, the majority of farms that abandoned NT did not possess their own NT seeder.

3.4.2.2. Social constraints

According to the surveyed farms, the conflict with neighboring farms that practice sheep

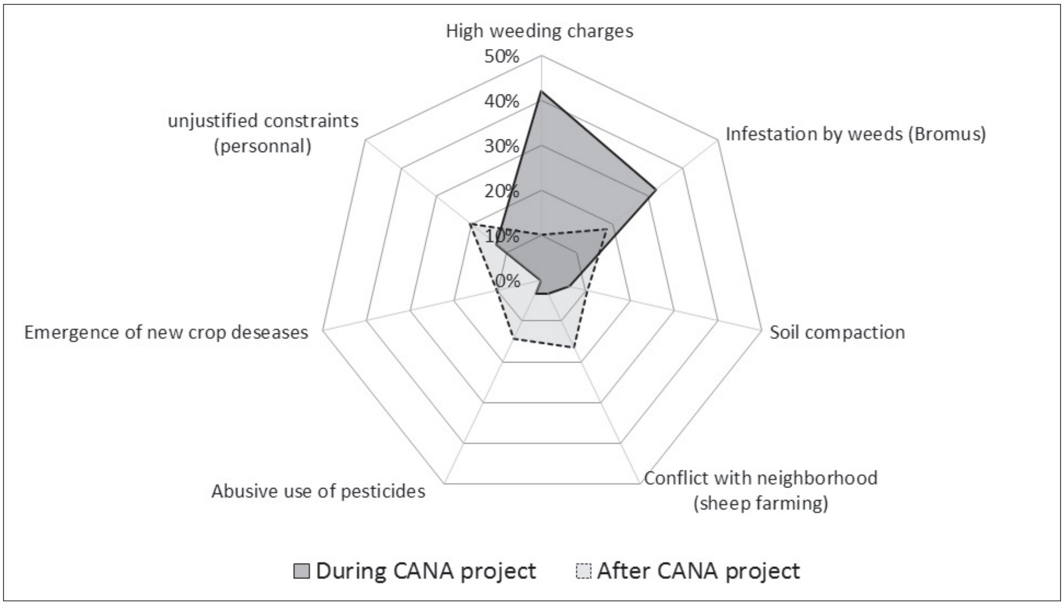

Figure 2 - Major constraints affecting NT adoption during and after CANA project.

farming became more noticeable in 2016; it increased from 3% during CANA project to 16% afterwards. Said *et al*. (2011) pointed out that the introduction of NT technology could lead to competition between cereals and sheep farming. Conflict between farm's neighborhoods could arise from the scarcity of pasture areas. It should be noted that NT is a technique that aims to reabsorb the annual grazed fallow to ensure a permanent vegetative cover, which may cause pressure on sheep's pasture areas. Locally, sheep farming has a social anchoring and is well integrated with cereal practices. Thus, the introduction of new technologies should take into account the local habits and values.

3.4.2.3. Technical constraints

Depending on climate and soil type, eliminating tillage may lead to a physical deterioration of soil, so it is not advisable to eliminate tillage altogether in soils with a clay content below 15%. While this is less of an issue in the study area where soils are heavy and crops are harvested in summer and seeding takes place in autumn where soils are dry. NT gives the soil more stable structure and contributes to increase soil organic matter (Chan, 2008), hence, soil compaction would be reduced after a few years of practice. Indeed, Farmers who considered that NT increase soil compaction made their judgment on the basis of a short period of experience.

In 2016, the constraint of "Infestation by weeds" was still taken into account by 18% of farms against 32% during CANA project. Perez *et al*. (1998) outlined that infestation by weeds is the major problem for the NT cropping; indicating that *Bromus ssp* and other weeds could have a conclusive role in direct seeding. Furthermore, 10% of farms in 2016 raised the problem of the emergence of new crop diseases. Indeed, keeping stubble residues on the surface of soil lead to the emergence of fungal pathogens.

Abusive use of pesticides in NT has an economic, environmental and human health concerns. The use of "Glyphosate" animated more and more the controversy. In fact, repeated use of the same herbicide resulted in weeds resistance. "Glyphosate" became ubiquitous in ecosystems, affecting aquatic and terrestrial organisms and creating health problems in human populations (Morin, 2009). The development of NT techniques has been accompanied by an increasing use of herbicides necessary for controlling the development of weeds which is no longer assured in part by agronomic techniques. Conservation systems are therefore efficient, but at high costs of chemical inputs, then the farmer should not be penalized by having to pay higher chemical expenses (Williams, 1997).

4. Conclusion

It is clear that all the classification criteria favor the NT system, going through wheat yield, cost of production, time of labor, fuel consumption and the gross margin. Despite there are 71% of farms among the sample who dropped out of the NT adoption, that makes sense to ask the question. Probably, finding the answer involve other dimensions more than the quantitative analysis. Moving backward to the eight farmers; why did guys maintain the NT? Certainly, they have typical and interesting characteristics that should be underlined. These farmers have a predisposition to undertake new technologies and they were totally convinced of the NT adoption and their decision seemed to be conclusive. They have high levels of education and agricultural training; most of them possess NT drill with a powerful tractor. They respect CA concepts regarding compliance with the use of crop rotation with legumes and the stubble residues cover. That's certainly the recipe to get a good grain yield. These criteria seemed are keys to success, for this purpose, it is recommended to take into account these characteristics to select farms candidates, likely to adhere to future adoption projects of NT in the region. Agricultural policies should be more involved in the NT adoption; it should be noted that the most eminent problem facing NT adoption process is the unavailability of NT drill and its high cost of rental services. A new local manufacturing prototype of NT seeder named "BOUDOUR" is currently in the testing phase. According to the extension services, this NT seeder will be shortly available on market at an affordable price and its acquisition will be subsidized at a level of 30% via the governmental fund of agricultural subsidy "FNDIA". In spite of that, efforts are still not enough to achieve a high level of NT adoption. Efforts should emphasize on the improvement of the technical levels of farmers by strengthening the agricultural extension machinery, training, workshops and innovation research. Indeed, the innovation research has a paramount effect on the NT adoption in the local conditions, the implementation of complementary scientific disciplines namely: agronomy, ecology, sociology…etc could provide solutions for CA adoption and then ensure farm sustainability.

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