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Adoption Perspectives of Direct Seeding in the High Plains of Sétif - Algeria

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Abstract

This study aims to analyze the adoption perspectives of the Conservation Agriculture (CA) through the recognition of the cautions and advantages of cereal Direct Seeding (DS) in semiarid high plains of Sétif (Algeria). A survey covers a sample of 102 farms, including 28 farms practicing DS and 74 farms practicing conventional tillage of cereals, closely neighboring to each other. Results show that all farmers adopted DS have the commitment of continuing to adopt and expanding this technique. Indeed, they consider that DS acts positively on the economic return of the farm and other technical aspects. However, those farmers revealed a number of constraints regarding the technical (lack of control of seeders and infestation by weeds), social (illegal grazing) and economic aspects (higher costs of pesticide treatments). Moreover, many of the (74) non-adopters farmers expressed their willingness to adopt DS technology. In fact, this class of farmers considers that DS reduces mechanization operations and therefore, allows saving more time than conventional seeding. However, the adoption of DS is still facing constraints from the society and even at the individual level such as competition with ovine farming and the lack of conviction of farmers which are often conservative.

Keywords: Direct seeding, Adoption, cereals, CANA project, Sétif, Algeria.

1. Introduction

The emergence of Conservation Agriculture (CA) dates back to 1930 when the great plains of the USA were subjected to intense wind erosion induced by mechanical agriculture and caused considerable damage (Friedrich et al, 2011). Since the fifties, plowed lands diminish across the world for the benefit of the conservation work of soil (Blanco et al., 2007). In new tillage techniques, no-till farming or direct seeding (DS) techniques are no longer to present, there is an abundant, and varied literature highlights its advantages.

These techniques that meet the criteria of sustainable agriculture have been gradually imposed because they are motivated by many agronomic, economic, and environmental considerations. CA in this context is seen as a viable alternative that could provide a response to basic natural resource degradation and instability of agricultural production (Chabane, 2011). Globally, the DS in organic cover has grown considerably, currently; it covers an area of around 125 million hectares that are shared between the United States, Argentina, Brazil, Australia, and Canada (Friedrich et al., 2011). Adoption of CA in most parts of Africa is low with not more than one percent of cropped land on the continent under CA (Kassam, Friedrich, Shaxson, & Pretty, 2009).

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In the Maghreb countries, CA adoption remains low and cultivated areas are variable from country to another. Meanwhile, these countries share the same concerns and become aware of the risks that may derive from the misuse and prolonged use of the conventional tillage techniques. Also, in the Maghreb, pedoclimatic conditions are unfavorable and may accentuate the degradation of soil, seen the global climate change. In Algeria, annually degradation of soils is aggravated by tools and ancient methods of tillage. According to Lahmar et al (2011), the dry farming was applied widely in the high plains of Sétif- Algeria, this tradition date back to the second half of the 19th century. Nevertheless, these methods have demonstrated economic and ecological deficiencies. The attachment of farmers to ancestral agricultural methods is among the obstacles that prevents the adoption of new technologies. The behaviour farmers towards their tillage methods are of primary interest. The time which will take depend on agricultural policies and extension efforts.

According to Bouzerzour (2006), the local adoption of conservation agriculture has emerged in 2002. As first step, the objective was to demonstrate to farmers that is possible to have high levels of productivity, using DS methods and also to keep the potential of land with simplified technology, even to ensure sustainability of land quality (Zaghouane et al., 2005), of course, with a gradual and continuous passage extending from the reduction of agricultural tools to the complete elimination of any mechanical action on the ground (Chevrier and Barber, 2002). The Algerian agriculture has lagged behind the development of DS adoption, despite the great potential that can draw from this technique.

Unfortunately, Algeria remains on the sidelines of DS progress made by the two neighboring countries (Morocco and Tunisia). In recent studies conducted on CA adoption, quantitative approaches are usually used in showing scale, trends, patterns, and tendencies. However, qualitative methods can provide information on social dimensions and processes influencing CA adoption and additional information on how and why various factors influence the adoption of an innovation (Progress, 2012). However, these two methods are limited when used separately. Mixed methods research is an approach to inquiry that combines or associated quantitative and qualitative strategies (Creswell, 2009). Mixed methods approach offers an opportunity to draw strengths from each research strategy in a single study (Johnson & Onwuegbuzie, 2004).

The present work aims to characterize local farms and to define economic and social logics of DS adoption, through the examination of a sample of 102 farms, 28 farms of which are DS adoptive and 74 farms are non adoptive. Even more, the study attempts to assess the impact of “Conservation Agriculture in North Africa project” (**CANA project**) on the DS adoption. On the basis of these results, it would be appropriate for the agricultural policies makers to initiate or to review policies capable to preserve sustainable resources at the farm level and beyond.

2. Material and Methods

2.1 Geographical location of Surveyed Farms

The study area is situated in the central zone of Sétif Province, it occupes an area of 1502.75 km², characterized by a continental semiarid climate, which is marked by a high north-south rainfall gradient, ranging from 250mm to 500mm (Rouabhi 2014). Surveyed farms are spread over 10 municipalities, namely: *Ain Oulmène, Ksar El abtal, Bir Hadada, Guellal, Guidjel, Mezloug, Ain Arnat, Sétif, El Ouricia and Béni Fouda* (Figure 1).

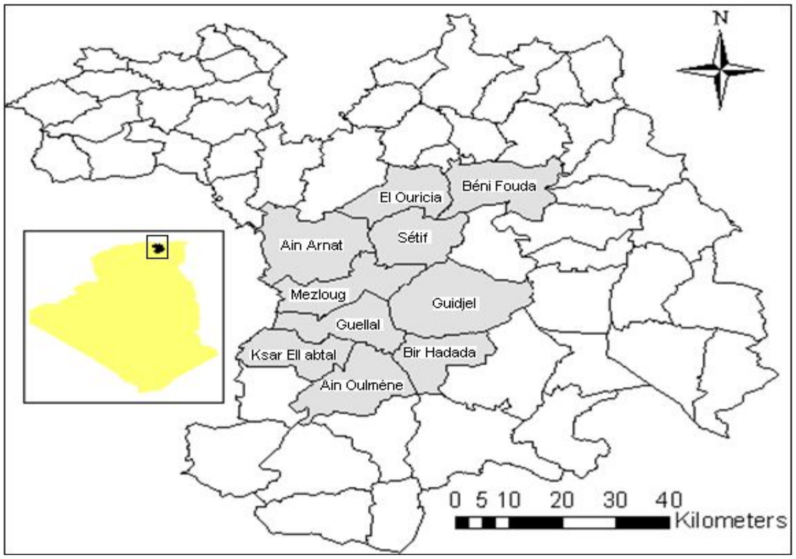

Figure 1: Geographical location of the study area

2.2 Background and the objectives of the study

This study is part of a project entitled "Adapting Conservation Agriculture for Rapid Adoption by Smallholder Farmers in North Africa" (CANA Project) http://cana-project.org/. It comes within a scientific cooperation including three North Africans research institutes (ITGC-Algeria), (INRA-Morocco), (INGC-Tunisia), the Australian Center for International Agricultural Research (ACIAR) and ICARDA. The project duration spans from 2012 to 2015; its geographical scope includes three platforms namely: Sétif (Algeria), Chaouia-Ouardigha (Morocco) and Fernana (Tunisia) spread over different bioclimatic levels. The project aims in its socio-economic objective to promote the adoption of DS through the diagnosis of constraints and advantages of this technique inside and outside the farms.

Known by its socio-economic importance, Sétif region occupies a very important place of national cereal crop production, it is characterized by a very constraining climate, typical of semiarid climate. To this end, Sétif platform was retained within the CANA project to assess the adoption of DS in Algeria. Target farmers are chosen by the *Institut Technique des Grandes Cultures* (ITGC-Sétif). Indeed, ITGC aims to sensitize and popularize this technique among farmers, by granting them technical and financial aids in order to join CANA project. The objective of this study is to establish a typology of local farms and to draw a contrast between the advantages and cautions of DS adoption for both adoptive and non-adoptive farms. Our contribution aims to assess DS adoption and predict chances of success through subjective judgments of farmers, based on economic and social indicators. Thus, the results of this research will provide a decision making tool for extension workers and decision makers in the agricultural field.

2.3 Sampling and methodology

The sample includes in total 102 farms, with 28 DS adoptive farms, adhering to the CANA project and 74 farms practicing conventional tillage of cereals, non adoptive farms were chosen from the vicinity of the DS adoptive farms. The survey will emphasize on the likelihood of success of the DS adoption through the feelings and judgments of both adoptive and non adoptive farms. Indeed, both of them seemed to have the same socioeconomic anchorage, that's why we consider in combination non adoptive farms in this study, which will be the next target for future expansion of this technology. It should be noted that the adoption of DS goes against the local agro-pastoralists considerations, wherein, their production system is based on breeding and grazing fallow, this will generate some resistance effects, which will have in turn a negative impact on profitability of conservation agriculture (Lahmar, 2011). Therefore, it would be more appropriate to seek a compromise to preserve the pastoral potential and to enjoy the advantages of DS.

2.4 Questionnaire and data collection

A face to face interview was carried out with the holder of the farm, therefore a serie of data were gathered around:

- Socio-economic data
- Cultivation and animal productions
- Water resources and the evolution of DS practice
- Advantages and cautions derived from DS adoption

Finaly, the total number of resulting variables amounts to 174, including 94 numerical and 80 qualitative variables. Not all variables will be used in this study, some of them will undergo a filtering, and others will be selected on the basis of their discriminating power to be used in the multivariate analyses.

2.5 Tools and Data Analysis

Statistical treatment was based on classification and characterization analyzes. The statistical package "SPSS V.18" was implemented for setting the following tests:

2.5.1. Two-Step Analysis

The Two-Step analysis was developed by Chiu et al., (2001), it was used as a classification method for transforming numeric variables into ordinal variables, which will be used later as multiple nominal variables in the Categorical Principal Component Analysis (CatPCA). Indeed, the " cohesion silhouette " is a digital quantity used to evaluate the reliability of the Two-Step test and determine the quality of separation of groups (Tan et al., 2006); a value greater than 0.5 means that the groups are well separated (Elleithy, 2010 Mooi and Sarstedt, 2011).

2.5.2. The categorical principal components analysis (CatPCA)

The categorical principal components analysis is a newly developed multivariate statistical tool (Leunda et al., 2009), used in the simultaneous processing of batches variables of different types (quantitative and qualitative). This method is particularly well suited to exploration surveys.

3. Results and discussions

3.1 The socio economic environment of farms

Based on the observed data, we will try to analyze the endogenous socio-economic environment of the farms, ie the information describing the quality of the farm holder (age, education level, Adherence to subsidy programs and investment on equity) (Table 1). Because of the similarity of the typologies, the treatment of socio-economic aspects will consider all of the surveyed farms. Indeed, most of them practice cereals as a dominant activity.

3.1.1. The level of education

The level of education of farmers is relatively satisfactory. Indeed, 51% of surveyed farmers have university and secondary level, primary and medium education levels record a rate of 41.2%. However, farmers with no education have a rate of 7.8%, this finding goes against the figures given by Anseur (2009) and Rouabhi (2014), which show that the low level of education is widespread throughout the regions of Algeria. In this context (Bedrani et al; 2001) underline that the level of education is among the factors that inhibits the technical and agronomic progress.

3.1.2. The age of farmers

According to D'Souza et al., (1993), Nkamleu and Coulibaly (2000) and Adeoti et al., (2002), age and education level are two significant variables that explain the adoption of an innovation within the farm. In the study area, the average age is 43.28 ± 1.05 years. The Two-Step analysis demostrates three age groups: the young and the middle age with a frequency 37.25% for each, with respective averages of 32 and 44 years. Whereas, the advanced age group record an average of 57 years with a rate of 25.4% (Table 1).

3.1.3. Membership in the governmental subsidy Programs

The treatment of this aspect describes the proximity and the relationship between farmers and the administration of agriculture, thus their ability to adhere in governmental programs of extension and subsidy.

This indicator may inform us about the succes opportunities of adoption projects. The motivation of farmers to adhere in governmental programs is very low, where 88.2% of them have never adhered. This is probably due to the lack of extension and motivation of farmers, the complication of administrative procedures and a weak financial sector. Salhi (2012) points out that a low rate of adherence to aid programs returns to adverse administrative conditions (bureaucracy, delays of studies and difficulties to access to credits).

3.1.4. The investment on equity

All surveyed farmers have undertaken investments on equity in other agricultural sectors ouside cereals; this shows considerable multidisciplinary agricultural activities in the study area. These investments have as objectives: the response to the annual cash flow deficit and strengthening the financial capabilities of farms. The most part of the investments on equity is within breeding and intensive cultivation activities, particularly in the central and the southern part of Sétif region (Kebbab and Kebaili, 2010; Elkolli and Mokhneche 2012).

Table 1: Variables describing the quality of the holders of surveyed farms

Variables	Modalities	Number of farmers	Percentage %
Education level	No education	8	7.84%
	Primary	6	5.88%
	Medium	36	35.29%
	Secondary	41	40.19%
	University	11	10.78%
Age classes	Advanced age	26	25.49%
	Middle age	38	37.25%
	Young age	38	37.25%
Adhesion to subsidy programs	No	90	88.23%
	Yes	12	11.76%
Investment on equity	No	0	0.0%
	Yes	102	100.0%

3.2. Hierarchy of farms according to the Utilized Agricultural Area (UAA)

The Two-Step analysis was used to classify farms on the (UAA) into three separate homogeneous classes. The results showed the formation of three groups with a “cohesion silhouette” greater than 0.8. The first group contains 62 farms, with an average UAA of 11.53ha. This group represents the "small scale farming" typology with only three DS adoptive farms. While the "medium scale farming" occupies 26.47% of the number of farms with an average UAA of 34.42ha, including 12 DS adoptive farms. The "large scale farming" displays an UAA average of 77.58ha, with 12.74% of the total number of farms with a bimodal distribution and relatively sparse (Figure 2). This finding corroborates the results obtained by Rouabhi et al., (2014) for the area classes in the northern region of Sétif.

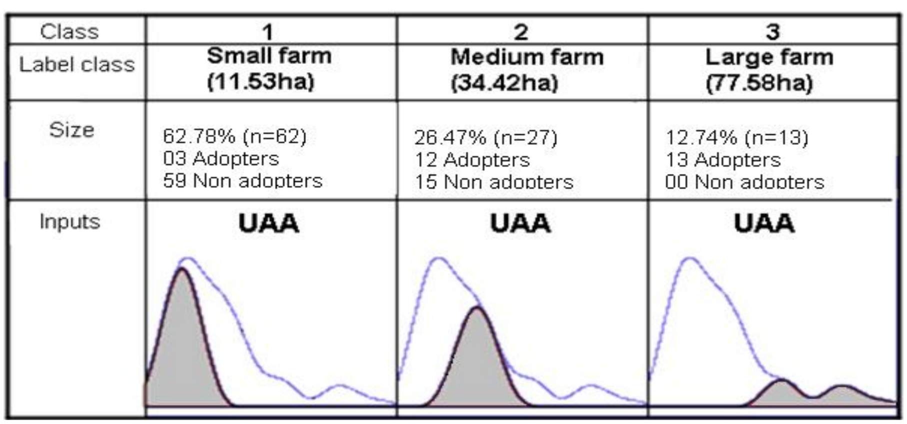

Figure 2: Classes of area resulting from Two-step analysis.

3.3. Typology Analysis

The understanding of agricultural operating system in a given region often involves establishing typologies. The identification of similar groups with the same characteristics and functioning allow comparison between comparable entities. Therefore, this will enable judgment of their evolution and will develop appropriate recommendations.

The CatPCA in relation to the biophysical variables (animal and plant) has gone through preliminary screening variables. Indeed, the variables taken into account are those which have enfranchised a large internal variability threshold. Therefore, maintained ones which will be treated as effective variables are nine (Table 2)

Table 2: Selected variables used in CatPCA

Variable	**Acronym**
Agricultural area conducted by raifed regime (ha)	*Rainfed*
Agricultural area conducted by irrigated regime (ha)	*Irrigated*
Agricultural area occuped by cereals (ha)	*Cereals*
Agricultural area occuped by fodder (ha)	*Fodder*
Agricultural area occuped by plantation (ha)	*Plant*
Agricultural area occuped by market gardening (ha)	*Gargening*
Number of greenhouse	*platiculture*
Bovine livestock (head)	*Bovine*
Ovine livestock (head)	*Ovine*

While the area class variables are treated as additional variables. The resulting model explains 70.43% of the total variability (Table 3), wherein the first and the second axis express respectively 49.54% and 20.89% of the total variability.

Table 3: Model summary derived from the CatPCA

Dimension	Variance explained	
	Eigenvalue	Inertia (%)
1	4.46	49.54
2	1.89	20.89

The factorial map following the CatPCA suggests the formation of three typologies relating to the most discriminating variables. The first axis records a high discrimination in relation to the size of cultivation activities, especially *Cereals*, *Fodder and Gardening.* While the second axis symbolizes the the agricultural activities, it separates the activities of plantation and Plasticulture on one side and the other side breeding activities (*Bovine* and *Ovine*) (Figure 3). It should be noted that, the small scale farming in general is atypical.

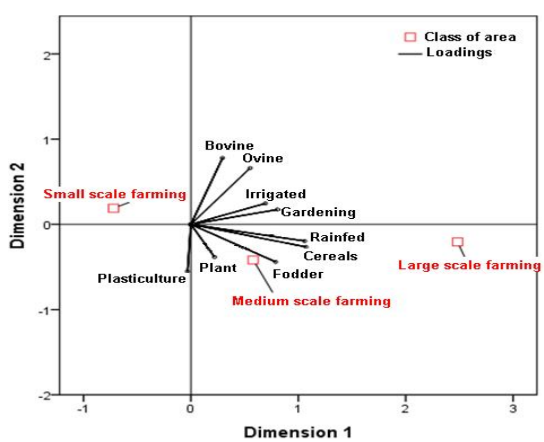

Figure 3: Loadings of the most discriminating variables in relation to area classes

3.4. Cautions of direct Seeding adoption within the different area classes

One second CatPCA was conducted by maintaining the previous nine variables, the projection of constraint variable modalities over area classes will allow us to illustrate and determine the batch of constraints for each area class. Indeed, the masking of nine variables in Figure 4, allows a clear visualization of associations between the constraints modalities and area classes. Farmers with large farming scale consider that the DS adoption faces economic and financial constraints. This can be apprehended by the weakness of the annual cash flow, caused by the poor diversification of the agricultural activities, mainly basing on rainfed crops (cereals). However, the medium scale farming reports a social constraint, namely illicit grazing of DS areas by pastoralists neighbors. Since antiquity, there was a social compromise between local rural communities (cultivators and pastoralists), through which the annual fallow is assigned for grazing, without exception for the livestock of land owners and neighborhood. So it is clear that the objective of the resorption of fallow induced by DS technology will produce social conflict and negative pressures on livestock. While, DS constraints for the small farms are personal, where farmers are less convinced by the adoption of DS since this typology is usually engaged in livestock production.

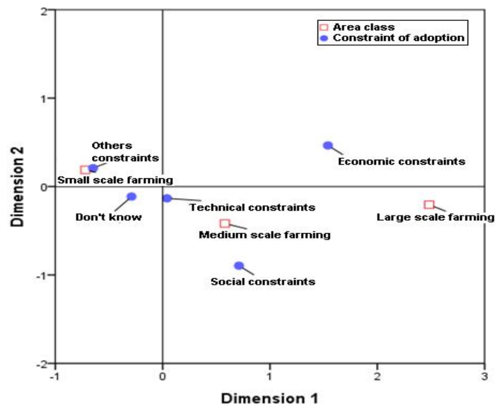

Figure 4: Association between constraints of DS adoption and the different area classes

3.5. Motivations of direct Seeding adoption within the different area classes

A third CatPCA was conducted on the nine variables, the two variables: "*area class*" and "*adoption motivation*" were considered as additional variables. In this case, the analysis does not show a clear association between motivations of adoption and area classes (figure not shown), because the DS motivations are almost similar for all farmers. In order to clarify this shade, a fourth CatPCA has been carried by adjusting "*adoption motivation*" as an effective variable in the test. Thus, a clear graphical improvement was obtained (Figure 5) where, the second axis is more discriminating according to the "*adoption motivation*" and small farms are more motivated than large and medium farms.

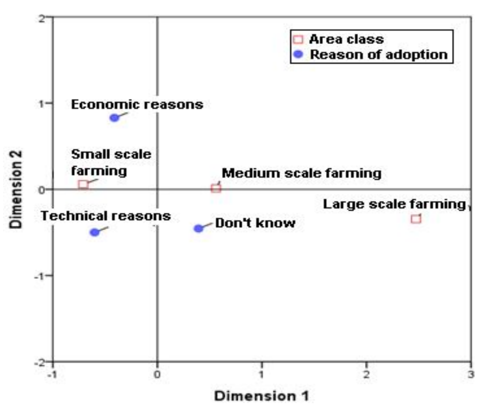

Figure 5: Association between motivation of DS adoption and the different area classes

In the section below, the diagnosis of some aspects related to the sample, including DS adoptive and non adoptive farmers will allow us to refine the results and identify different views for each sub sample.

3.6. Assessment of direct seeding within the adoptive farms

Large part of adoptive farmers (89%) believes that the main reason for adopting DS returns to minimize the mechanization. Whereas, 11% of them believe that saving more time is decisive in this choice (Table 4). According to Maaroufi (2004), this technique allows the farmers to reduce many cultural practices and to benefit the time and economic burdens of plowing and preparing soil before sowing. The reactions adoptive farmers, show that 61% expressed strong satisfaction and 25% have moderate satisfaction, against 14% are less satisfied (Table 4). Indeed, this part of non satisfaction comes from the problems of infestation by weeds, which is often associated with the DS technique. Aibar (2006) considers that DS technology requires a very close control of the weed flora which can compete with the crop and cause significant decreases in yield. However, it should be noted that the installation of DS will generate some divergence, so DS aims to reduce the annual fallow, at the same time; it creates pressure on ovine breeding by minimizing grazing areas. Bensaid (2011) points out that the introduction of DS technique could lead to a competition between stubble and sheep farming. Indeed ovine farming has a local social value, well integrated with cereal practices. Thus, the introduction of new technology should take into account the preservation of the balance functioning and the local farming multidisciplinary.

Table 4: Appreciation of DS according to adoptive farmers

Variable	Modalities	Rate of response (%)
DS adoption motivations	Minimizing mechanization	89%
	Saving more time	11%
DS adoption satisfaction level	Low	14%
	Medium	25%
	High	61%

3.6.1. Evolution of direct seeding areas within adoptive farms

Interviewed farmers began the DS adoption since 2005. Indeed, the evolution of DS's total area was a small increase during the first years; it revolves around an average of 4 to 5 hectares between 2005 2009. From 2009 it has experienced a significant increase, especially for durum wheat, which occupied an area close to 30ha in 2013. Moreover, this area has experienced a remarkable growth in 2014, where the average area has reached 100 hectares for durum wheat and ten hectares for soft wheat and barley (Figure 6). Note that this increase is significantly affected by the adherence of farmers in the CANA project. These results show that artificial incentives are still a common feature in CA projects. However, once the project ends farmers may stop practicing CA because they no longer get the artificial incentives (Progress, 2012). Therefore, in CANA project, person in charge try to win trust of farmer by providing many facilities as technical and financial incentives. CANA project through the ITGC, a local agricultural structure which is closer to farmers, subsidizes cultural operations and the acquisition of inputs, in order to encourage them to adopt DS and popularize this technique. Vanclay (2011) has shown that winning the trust of farmers in development interventions and extension is essential for adoption of new technologies.

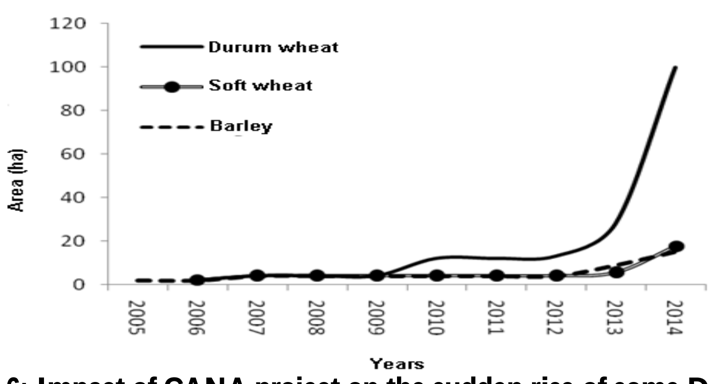

Figure 6: Impact of CANA project on the sudden rise of some DS crops

3.7 Assessment of direct seeding within the non adoptive farms

It was found that all non adoptive farmers have a preliminary and superficial idea about the DS, and this view differs from one farmer to another. A large part of non adopters express their commitment to adopt DS, whereas, the rest of them seem hesitant to undertake this experience for various reasons.

Non adoptive farmers consider that DS adoption should provide some benefits on the economic and the social levels. Where 51.16% consider that the DS confers less of mechanization, which will have a positive economic impact on the income return. In a related development, 20.93% of the farmers consider saving more time as a determinant factor. However, a portion of 12, 79% considers that improving yield efficiency and crop resilience against drought are among the reasons for the DS adoption (Table 5). (Dumanski, et al , 2006; Twomlow & Hove, 2006) suggest that CA agronomic practices are essential for soil and water conservation, sustainable optimal production and also important as a response to climate change.

Table 5: Main observed motivations of DS adoption in non adoptive farms

Observed motivations of DS adoption	Rate of farms (%)
Technical motivations	
Mitigating effect of drought	12.79%
Improving quality of the soil	1.16%
Facilitating access to the field	1.16%
Economic motivations	
Minimizing mechanization	51.16%
Saving more time	20.93%
Improving yield	12.79%

3.8 Constraints of DS adoption according to the adoptive and non adoptive farms

Through the survey, many constraints have been raised by the adoptive and non adoptive farmers. For convenience, we have arranged in table 6, the observed set of constraints in homogeneous groups namely: economic, technical, social and personal constraints. Results show that the majority of DS adoptive farmers consider that higher phytosanitary treatment costs (36.11%) and infestation by weeds (25%) represent the major constraints. However, non adoptive farmers consider two major constraints facing an efficient DS adoption, namely: competing with ovine breeding within farm (37.78%) and lack of conviction (33, 33%).

Table 6: Observed constraints of DS adoption according to adoptive and non adoptive farmers

Observed constraints	Rates in Adoptive Farms	Rates in non Adoptive Farms
Technical constraints		
Competition with ovine breeding within the farm	5.56%	37.78%
Do not have a powerful tractor	5.56%	2.22%
Lack of extension	2.78%	4.44%
Soil compaction	5.56%	6.67%
Infestation by weeds	25.00%	4.44%
Trouble to manipulate the DS seeder	2.78%	--
No adequacy between farm size and DS Seeder	--	2.22%
Increase of pesticides	2.78%	--
Economic constraints		
Increase of expenses of weeding	36.11%	
Deficiency of DS hire services	8.33%	2.22%
Negative impact on yield	2.78%	6.67%
Social and personnal constraints		
Conflict with neighboring pastoralists	2,78%	--
Lack of conviction	--	33,33%

Since a general view, it was found that the perception of the observed constraints differs from sub-populations to another. The technical constraints are almost equiprobable for both adoptive and non-adoptive farmers. However, it should be noted that "*Competition with ovine breeding within the farm*" is governing technical constraint for non adoptive farms. While, in adoptive farms technical constraints are governed by "*Infestation by weeds".*Actually, this little experiment began to popup the real problem of the DS adoption, mainly the weed control. Indeed, the infestation of fields by Bromus species is a serious problem, because Bromus species are very vigorous weeds, competing with crops and developing a herbicide resistance. Their development is promoted mainly by crop succession on the same field, simplification of tillage and their great multiplication capacity and spread (Karkour, 2012). Judicious herbicide mixtures and rotation in addition to agronomic practices such as the adoption of delayed seeding and increased seeding rates can also reduce selection pressure by reducing in-crop weed populations (Walsh and Powles, 2004).

Significant patterns in figure 7 show that an adoptive farmer is impacted by economic constraints, while non-adoptive farmers are influenced by subjective constraints. From this finding, we suggest as the efforts related to the promotion of this technology will be focused on the financial and technical inputs for adoptive farmers. However, non-adoptive farmers should have more awareness and technical encouragement.

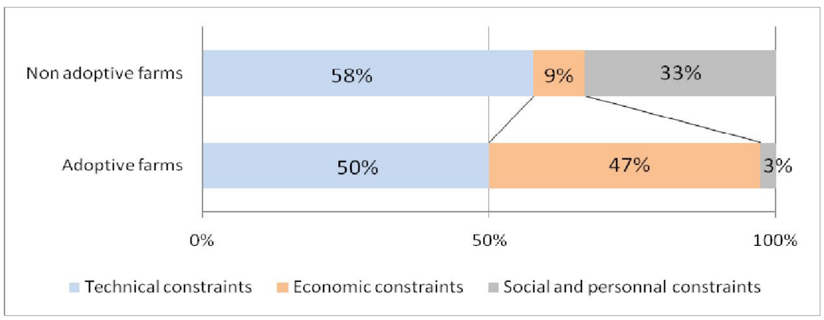

Figure 7: Major DS constraints according to adoptive and non adoptive farms

4. Conclusion

Agronomic, technical, and economic benefits of DS on the profitability and sustainability of farming are obvious. In Algeria, the DS adoption can be hindered by the socioeconomic context as the lack of farmers' associations, competition with pastoralism, high cost of inputs and equipment and lack of effective extension. To appreciate the DS adoption, it is necessary to conduct an analysis on farm scale, taking into account agronomic intended benefits, economic feasibility, social constraints, and impact on natural resources. The results show that the DS adoption is influenced by economic and technical reasons; unfortunately, it lacks motivations emanating from aspects of sustainability. Climate variability is one of the most arousing concerns for local rainfed agriculture; the DS will play some roles in mitigating effects of climate and ensure a stability of returns over the long term. Some constraints of DS adoption are inherent in the functioning of farming systems, as the relations between crops and livestock.

The socioeconomic and technical constraints will compromise rapid and efficient adoption, but they can easily be exceeded by government extension efforts and technical support especially for the most motivated farms. However, "the CANA project effect" may signal a misleading reality in the short term, because of its ephemeral benefits. So, it will be more appropriate to assess the project after it will be over. For this purpose, We should consider the results with care and have a long follow-up for more ten years to endorse the findings. In Algeria, research and monitoring of the DS adoption is a less developed research field, for this purpose, priority may be given to synthesis of DS knowledge through scientific interdisciplinary approaches and the preservation of natural resources research. Moreover, public policies should accompany search results by institutionalizing support mechanisms and awareness for DS adoptive farmers such as: direct financial subsidies for the acquisition of seeders, introducing premiums for crops cultivated by DS technology, and demonstrating the role of DS in the sustainability of the farms.

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