NON-ADOPTION OF CONSERVATION TILLAGE BECAUSE OF KNOWLEDGE GAPS? - A CASE STUDY FROM NORTH-EAST BULGARIA -

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Abstract

If applied properly conservation tillage is a technology which can increase farms economic situation through reducing energy input and saving time for operations and on the other hand is beneficial for the environment and plant growing through reducing the risk of erosion and preserving soil moisture. Adoption of a conservation tillage systems not only means having the appropriate machinery (e.g. disc harrows or harrows), but also the respective abilities and knowledge of how to use the machinery to serve the farmer's objectives. Several studies have investigated the impact of human capital on technology adoption in agriculture, for example, by considering variables such as schooling, age, and contact to extension agents. However, in the decision making process a farmer's perception of characteristics of a new technology such as its relative advantage, compatibility and complexity forms the persuasion of an individual to adopt or to reject an innovation. For the most, studies on technology adoption have been carried out for developing countries and the American continent. However, up to now there has been hardly any research on the adoption of agricultural technology in transition countries. This is surprising as one could have expected changes in farmers' adoption behaviour since the start of transition. In this paper we investigate farmers' perceptions and attitudes towards the adoption and use of conservation tillage systems in North-East Bulgaria. In particular, we study whether information deficits and knowledge gaps about the use of conservation tillage systems determine the farmers' perceptions and attitudes. We base our analysis on a case study involving interviews with 35 farm managers in the region. Results suggest that knowledge gaps and information deficits determine the adequate use of conservation tillage practices. Although farms have some machinery which can be used for conservation tillage practices (e.g. harrows), results suggest that farms do so very selectively. Farms perceive the technology as being appropriate only for a limited range of crops (e.g. cereals). For all other crops (including maize) it is not considered as a proper tillage system. Farmers' attitudes towards conservation tillage appears to contradict reasons accredited to conservation tillage in literature. Approved advantages of conservation tillage, for example the preservation of soil moisture are not connected by farmers with this system and perceived to be better in the conventional tillage system.

Keywords: conservation tillage, technology adoption, Bulgaria

Introduction

After 1990 like in many other transition countries, the agricultural sector in Bulgaria was privatized. Due to the uncertain situation in other sectors many people started with farming although they did not have any or only little knowledge about agriculture. Nowadays, farmers have to face more and more management tasks to ensure the economic surviving of their farm. Hence, they have to minimise costs wherever possible or increase the profitability of the production system. This is particularly relevant for

market-oriented arable farms which are producing and thus competing on the world market. In Bulgaria the majority of these farms is located in the North-East. This region is characterised by continental climate with low rainfall, forcing farmers to use the humidity as efficiently as possible and adopting to sensitive natural production conditions.

One way to face these challenges (reducing costs, managing efficiently moisture, etc.) on arable farms could be the adoption of minimum soil tillage systems (e.g. UNGER 1990, IRVINE et al. 2003 and CARTER 1994). This technology has widely been adopted in other countries in closer proximity to Bulgaria, e.g. Ukraine (KASSA 2006) and Hungary (ECAF 2007), but no studies for Bulgaria itself have been found.

This paper aims to discuss possible reasons for the adoption and non-adoption of conservation tillage (CT) on arable farms in North-East Bulgaria. The results are based on several expert interviews and a farm survey[1]. The expert interviews were conducted with 16 different stakeholders from the highest level of policy, science and industry in the preface in Sofia. The farm survey incorporates 48 arable farms in North-East Bulgaria. Results suggest that a lack of knowledge about the technology, its characteristics and use among farmers provide an explanation for non-adoption.

Conservation Tillage in Eastern Europe

Up to now there are only few studies available which deal with conservation tillage in Eastern Europe. Information about use is also rather few. For example, the European Conservation Agriculture Federation (ECAF) gives some data to the use of conservation tillage in Europe. As the only Eastern European countries Hungary and Slovakia are mentioned with 500.000 ha (representing 10% of the agricultural area) respectively 140.000 ha (representing also 10%) under the use of conservation tillage. The "Knowledge assessment and sharing on sustainable agriculture" (KASSA) –project investigated conservation agriculture practices in Europe. From the Eastern part of Europe Ukraine and Czech Republic were taken as case studies. The highest proportion of conservation tillage on the whole tillage among the investigated countries has been found in Ukraine with 24%, but also Czech Republic ranks with 18% on the top of the European countries. But these studies have been exceptions; most of the available literature is from the early 1990s or before and have not considered the developments and challenges of the future e.g. the accession of European countries. BUTORAC 1994, for example predicts that "conservation tillage will at least partially play the same role in the future that the plough had played in the past". He also outlined that the adoption of CT will not only be influenced by natural conditions but to a significant stake by social factors and tradition.

For Bulgaria there is no further reading available. Several studies, especially from the Pushkarov Institute of Soil sciences in Sofia, address Bulgaria's soils and erosion. Hence, erosion is one of the major reasons why CT is supported because of its ability to reduce wind and water erosion up to 90% (HOLLAND 2004), but these studies mainly deal with the influences on soil properties and the extend of erosion (KROUMOV and DOCHEV 2002), although their recommendation is to use more conservation tillage. In this context the North-East of Bulgaria was mentioned as one of Bulgaria's regions with severe wind erosion is occurring.

Expert interviews displayed the state of the art in conservation tillage where it's use tends to be rather low. The benefits of CT for the environment were described as neglectable and the only reason why experts could imagine to use CT was because of economics.

[1] We are thankful to Bozidar Ivanov for his assistance in carrying out the interviews.

Research Hypothesis

Keeping this in mind, with the available data we investigate the following hypothesis:
In the expert interviews (JUNGKLAUS and HAPPE 2007) it was already stated that Bulgarian farmers are not using conservation tillage because of environmental reasons. Also TEBRÜGGE and BÖHRENSEN (2001) found out that farmers in Europe as well as in USA are only motivated because of economic reasons. So our first hypothesis is

(1) Saving costs is the main reason for farmers to use CT.

Of course, obstacles exist in using the technology. Derived from literature (e.g. RUSU et al. 2006 and HOLLAND 2004) which mentions an efficient management of plant antagonists as one of the biggest obstacles of CT, we formulate the hypothesis

(2) Farmers consider higher pressure of weeds and diseases as the main obstacle for using CT.

TEBRÜGGE and BÖHRENSEN (2001) identified that farmers perceive the advantages different from the way conservation tillage is promoted (e.g. HALVORSEN et al. 2002 and PANELL et al. 2005). Finally, based on the results from expert interviews on conservation tillage in Bulgaria it appears that the understanding and the knowledge about CT itself and its properties does not seem to be widely distributed among farmers. So we estimate that

(3) There are knowledge gaps about conservation tillage.

Within our farm survey we are testing these hypotheses with some different questions.

Methodology and Data

In July 2006 we conducted interviews with 16 experts in Sofia (JUNGKLAUS and HAPPE 2007). The experts were from the highest level of policy, science, producing industry and consultancy. With the help of a predefined questionnaire consisting of open ended questions experts were asked about their opinions with respect to conservation tillage. They should describe from their point of view the extend (how much CT is used in Bulgaria) and obstacles as well as reasons why farmers adopt or reject the technology. However, the outcome of these expert interviews have been mixed up and no clear picture regarding the use and reasons for adoption and rejection of CT could be derived. But responses of the some experts indicate that there is a lack of knowledge to use conservation tillage properly. In addition, we conducted a farm survey in the North-East of Bulgaria with an extensive questionnaire. Farms were chosen based on the criterion of production range and size in North-East Bulgaria. The focus is on farms with arable production, since for other farms, e.g. with perennials and fruits and vegetables CT is of less interest. The farm size matters in that effect that smaller farms are more restricted to use CT effectively. So we set up the minimum farm size to 50 ha land area.

In the survey 47 different farms had been interviewed. As apparent from table 1 farms with different organisation forms had been queried. The average farm size of 1450 ha is high. However, it differs between different organisational forms with private farms (average of 468 ha) being the smallest producers. Contrary, the legal forms limited and stock companies are the biggest producers with 1989 ha resp. 1639 ha on average, but also cooperatives persist with big land area (1679 ha on average). Overall, these 47 farms account for a total agricultural land area of almost 70.000 ha.

Table 1: Structure and organisation form of interviewed farms

Organisation of farm			Average rm area	Conservation tillage		
	Number	%		Full user	Partial user	Non-user
Private farm	8	17,02	468	1	6	1
Cooperative	11	23,40	1670	0	11	0
Limited company	9	19,15	1989	0	9	0
Joint stock company	11	23,40	1639	0	7	4
Other	2	4,26	950	0	1	1
Tenant	6	12,77	1531	0	3	3
Total	47	100	1450	1	37	9

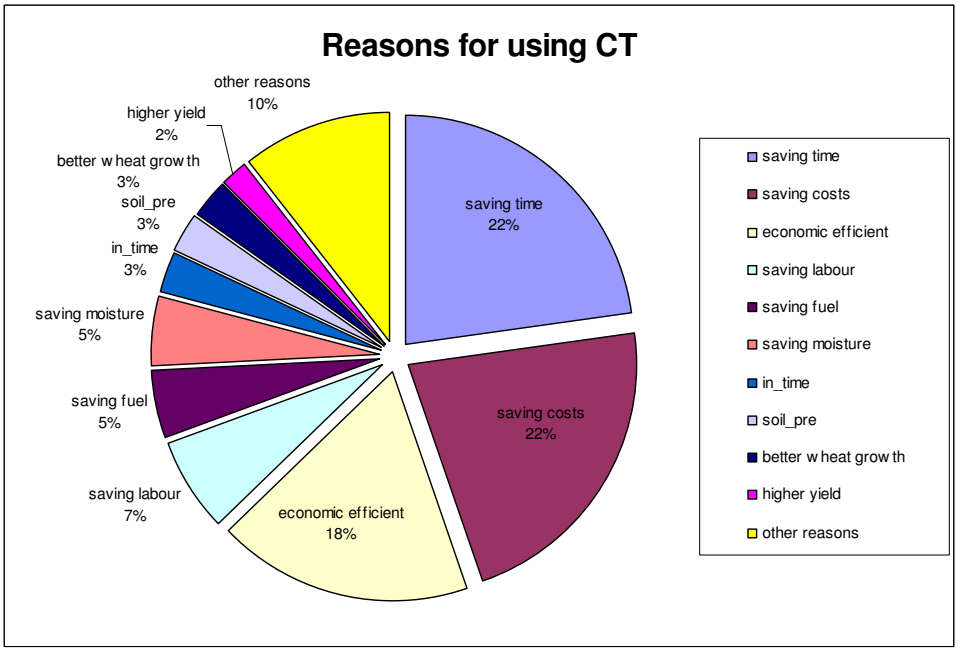
As shown in table 1, only one farmer was using conservation tillage (in that case direct seeding) on the whole farm, while the majority (79%) used it at least on a small amount of the farm. Only nine farmers did not use any conservation tillage.

Results

The farm managers were directly asked to state their reasons for using or not using conservation tillage respectively for not using it to a greater extend. The questions were open ended, but limited to three statements per question. However, during the interviews this often did not suffice and respondents mentioned much more reasons. In that case farmers were asked to give the three most important reasons from their point of view.

Use of Conservation Tillage

As 38 farms are using conservation tillage at least to a little extend we got 103 statements why they are using CT. From the results we could clearly derive that using conservation tillage is mainly done because of economic effects (see figure 1).



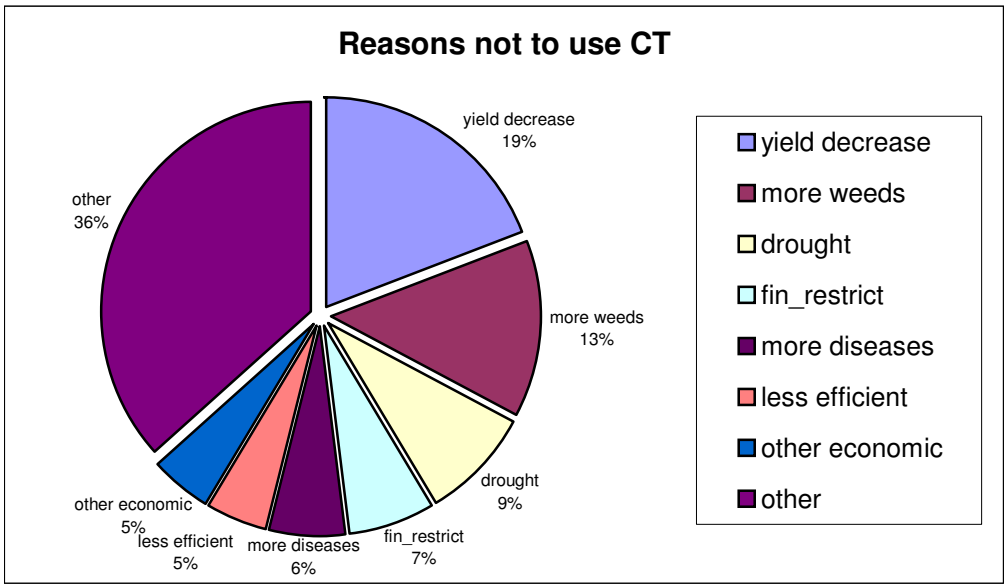
Overall, it was used because of saving certain resources from the economic point of view. “Saving costs”, “saving time” and the comparatively higher “economic efficiency” together with less often termed “saving labour” (7%) and “saving fuel” (5%) accounted for almost ¾ (74%) of all statements. With “saving moisture” the first argument with an agronomic background rather than an economic was addressed, but it was only stated by 5 farmers.

Similarly, other agronomic reasons were found rarely which are related to the production system. Only three farmers mentioned “better wheat growing conditions” and a much more favourable “soil preparation”. Two farmers even accredited higher wheat yields to the conservation tillage system. However, there are some other arguments which are quantitatively not relevant, but show some interesting motivation why farmers use it. For example, only one farmer is using it because she was thinking that it is a far better “ecological” tillage system and that farmers should have a responsibility towards nature. Another farmer deemed the climatic conditions in the region with low rainfall and high temperatures in summer as convenient for the use of conservation tillage. The climatic conditions were mentioned by another farmer as well but he favoured CT, because in his opinion deep ploughing increases the danger of frost losses in his opinion. However, we had expected more farmers attesting the climate conditions as favourable for the use of CT.

Non-Use or Non Extension of Conservation Tillage

Subsequently, the nine farmers who are not using conservation tillage were asked why they are not using it and the 37 partial users of CT were asked why they are not extending their use. The only full-user was excluded from this issue. As statements did not show any differences regarding the groups (non-user and partial user) we combined them in figure 2. Altogether we got 99 statements. Expected statements which veer towards certain crops in the crop rotation making ploughing necessary or capacities are too limited did not occur.

Figure 2: Reasons why farmers are not using or not extending conservation tillage



Unsurprisingly, like in other studies which examined the adoption factors of conservation tillage (e.g. CLEARFIELD and OSGOOD 1986 and CARTER 1994), farmers in the survey were significantly influenced by the fear that yields will decrease and furthermore weeds and diseases will spread. That yields will go down was one of the main reason (19%) for farmers not to use respectively extend conservation tillage on their land. The other important reason was that weeds and diseases (together 19%)

will spread much more than with ploughing and thus expenses for plant protection treatments will rise. More surprising was that 9% of the respondents stated that they will not extend or that they are not using CT because of drought. For this group ploughing is the better system to preserve the soil moisture. Limited financial resources to buy and implement machinery for conservation tillage were stated by 7% of the questioned farmers.

For the question why farmers are not using CT we got many different statements which were given just by one or two farmers. However, four farmers attested CT not to be applicable on the soils in the region. Furthermore, it evolved that CT is not suitable for crop rotation with only wheat and maize, that the vegetation is too bad for usage and that organic material is not buried enough in and thus make later operations more difficult. Some statements even show some new aspects of CT which have to be questioned against the background of the known literature. For example, this tillage should not be applicable in the region because the mixing of soil is not sufficient and thus phosphate mineralisation is worse than with the plough. Another was referring to the machinery which should not fit to the Bulgarian conditions. Finally, one farmer said that he would use CT if there just would be some state support.

Discussion and Conclusion

Farmers in the North-East of Bulgaria used conservation tillage mainly because of economic reasons. Contrary, some of them are not using it or do not want to extend the use on their farm because of decreasing yields and increasing pressure from weeds and diseases.

Saving costs and saving time were the most mentioned statements to use conservation tillage. As a third strong statement farmers announced that CT is from the economic point of view more efficient than the conventional system. This results seem to correspondent strongly with findings in other studies, TEBRÜGGE and BÖHRENSEN (2001), CARTER (1994) and ZENTER et al. 2002. This provides some evidence that or first hypothesis *"saving costs is the main reason for farmers to use CT"* applies in Bulgaria's North-East. Improvements in plant production respectively plant growth are an also-ran and were considered by less than 5% of the respondents.

More interesting was the question why farmers are not using CT. A possible decrease in yield and the challenge to face a higher weed and disease pressure are obstacles farmers have to cope with (e.g. LANKOSKI 2006 and TEBRÜGGE 2002). But anyway the system can be economic advantageous if the decrease in costs (see statements in figure 1) is higher than increase in input factors (chemicals) and the decrease in yields (LANKOSKI 2006). The farmers in the survey also reported the increase of weeds and diseases as a major obstacle connected with the use of CT. Thus we can find some evidence for our second hypothesis *"farmers consider higher pressure of weeds and diseases as the main obstacle for using CT"*. But for farmers more weeds are not necessarily connected with more diseases and so some mentioned only on of these two statements. So the weeds are considered by the farmers a little more restrictive to the use of CT, than diseases. Together they are as important as the other main argument not to use CT, the decrease in yields.

The question why farmers are not using or not extending the use of CT delivered some surprising statements which seem to contradict strongly with some results found in literature.

1. Already in the expert interviews a high share of experts stated that the soil in North-East Bulgaria was too heavy to implement CT successfully. Soil analyses show that especially on the locations of the interviewed farms the predominant soil type is ordinary chernozem (BULGARIA SOIL AGENCY 2006). Yet, this particular soil type was (in almost similar conditions) under investigation in a study by ZENTER et al. (2002) and valued as suitable for CT. Even on the "other side of the Danube" in Romania trials like described in GANGU et al. (1999) and in

NISTOR and NISTOR (2002) came to different results. Furthermore, farmers who used CT to a greater extend did not agree with this argument.

A possible explanation was given by some farmers who showed an internal study about for cooperatives in 1984. Results indicated that the present machinery - which had been from western producers at that time - was too fragile and not well adapted to the comparatively higher requirements on machinery (larger working capacity, higher pulling power, etc.) in Bulgaria's cooperatives with agricultural land of some 1000 ha.

2. Too little rainfall, respectively drought, was also a reason for some farmers not to use CT. The rainfall in North-East Bulgaria is around 400 to 450 mm/a. These are more or less the same conditions UNGER (1990) describes in his report where he compared CT with the conventional system and highlighted advantages of CT. Furthermore, a number of studies, e.g. CLEARFIELD and OSGOOD (1986), HALVORSEN et. al. (2002) and IRVINE et al. (2003) suggest the use of CT because of little rainfall.

3. One farmer believed that under CT the rain permeation into soil is much lower. Others perceived the plough as the better tillage system to preserve the soil moisture. Studies like UNGER (1990) and HOLLAND (2004) oppose this opinion. Following them the lower operation depth and the hindering of furrow compaction provides better soil pore system and thus a more permeable environment for occurring rainfall.

4. HOLLAND (2004) describes some effects CT has on the environment like improvement on soil structure that should be also desired by farmers. None of the respondents gave any of these arguments. Based on this one can carefully follow that environmental impacts may not be important or farmers are not aware of them.

These findings may give us some evidence that some farmers have not a very in depth knowledge about CT and thus our third hypothesis *"there are knowledge gaps about conservation tillage"* applies also for (some) farms in North-East Bulgaria. Farmers use CT mainly because of economic advantages. Environmental concerns and tackling unfavourable natural production conditions appear not to influence decision making. Yet, it appears that many of the interviewed farmers are not aware of the characteristics of CT.

Summarising the results, we find that Bulgarian farmers have indeed the feeling that they are using CT because of its potential for saving costs and time. Obstacles can be found in the concerns that yield is going down and the pressure caused by weeds and diseases is increasing. An interesting finding was that the third most mentioned constraint for the use of CT was the belief, that the climate is too dry and that these are unfavourable conditions for the application of CT. In a lot of other cases the dry climate and the demand for conserving soil moisture had been the motivation to establish conservation tillage.

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