Совершенствование учебного процесса осуществляется во многом благодаря сотрудничеству академии с ведущими университетами Германии, Франции, Великобритании, Голландии, США и участию в Европейских программах "TEMPUS", "TACIS", "INTAS". На базе зарубежных университетов ведется подготовка и переподготовка профессорско-преподавательского состава академии в форме кратко- и долгосрочных стажировок. Переподготовка преподавателей английского и немецкого языков осуществляется в летних школах, проводимых Британским советом, посольством США и институтом имени Гете на базе академии. Современной иностранной литературой обеспечиваются не только специальные кафедры экономического профиля, но и созданные методические кабинеты английского, французского и немецкого языков. В рамках договоров о сотрудничестве с зарубежными университетами и международных программ предусмотрена поставка в академию современной вычислительной техники.

Студенты, владеющие на достаточно высоком уровне иностранными языками, пользуются преимуществами при направлении на зарубежные культурно-ознакомительные и производственные практики, что является существенной мотивацией для углубленного и целенаправленного изучения.

Это дает основание полагать, что в ближайшем будущем будут подготовлены специалисты, способные обеспечить выполнение задач в области международного агробизнеса.

DIRECT SEEDING - CURRENT STATE AND ITS POTENTIALS IN EASTERN EUROPE

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Introduction

Among many farmers all over the world crop production without using the plow has become common practice. With regard to ever decreasing market prices for agricultural products a further reduction of costly tillage operations or even complete renunciation of soil labor would be desirable in modern farms. In this view direct sowing, i.e. planting without any preliminary tillage, is the final and logical consequence of this thought.

Besides its economical benefits the direct sowing system offers a series of ecological advantages which are of increasing global concern, e.g. effective erosion control, favorable water balance and reduced energy expenditure. It is estimated that the global emissions of carbon dioxide (CO_2) could be reduced by 3,3 Gt if the direct sowing system was applied in all suitable fields in the former Soviet Union (Gaston et al., 1993). Glazovskaya (1996) estimates the annual storage capacity for athmospheric carbon by improved humus formation in Russia to 2,5 Gt a^{-1}. In the contrary 400-750.000 t a^{-1} of fixed C are released to the atmosphere due to intensive tillage practices (Orlov, 1996). Savings of up to 16% of CO_2-emissions could be achieved if minimum-tillage or direct sowing were practiced in a global scale (CTIC, 1996).

In USA, South America and Australia the direct sowing system is already applied to more than 15 millions of hectares. Although conventional methods are still predominating in Europe an increasing number of European farmers are becoming aware of the benefits of the no-till cultivation method. There is mounting evidence that direct sowing offers great potentials, particularly to the great farms in the East of Germany and in Eastern Europe. The increasing interest of manufacturers of agricultural machinery to develop suitable equipment might serve as a reliable indicator for this tendency (Kuller, 1995).

Direct sowing must be considered as a new cropping system and scientific as well as practical expertise is required from nearly all agricultural disciplines in order to successfully introduce the system. Site specific peculiarities, e.g. climate, soils, crop rotations and socio-economic factors play an important role and should be known before the application of the system is taken into consideration. In order to avoid failures available information should be gathered and evaluated and further research should be undertaken.

This paper intends to evaluate the present state of no-tillage technology and to summarize the available knowledge. Preliminary results of ongoing research shall be presented and future research needs will be derived. Finally the implications of these thoughts to East European Agriculture will be discussed.

Available knowledge and further research needs

Site specific requirements

Best results can be expected in stable structured soils that are rich in potassium and humus. Clayey and loamy, biologically active soils show high potentials while sandy soils with low humus contents are less apt. Direct sowing is advantageous in stony shallow soils as less stones are lifted during tillage and wear to machine components is reduced to a minimum. Least potentials are in water-logged, poor drained soils as earthworm population and root development are adversely affected.

Favourable soil conditions prevail in many regions in the Russian Federation, e.g. North-west, Central, Volga-Vyatsky, Central clay-loamy, Povolgisky, North-Caucasus, Ural, West-Siberian and Eastern-Siberian. The total arable land in Russia is estimated to 1.640 billion hectares, 65,6% of which are leveled land and 34,4% are situated in mountain regions (Simakova et al. 1996).

Crop residues and mulching

Permanently covering the soil is a basic requirement for a successful direct sowing system. It can be realize by leaving crop residues in the field or by growing cover crops after the harvest of the main crop. Experiences from England show that removal or burning of crop residues (CR) might result in long term yield decreases of more than 30%. Organic soil cover protects the soil from erosion and enables development of biologic activity. Mulch offers sound conditions for the earthworm population which is crucial for formation of a natural pore system. However, some crops, e.g. cotton, soybean and lupine produce only little amounts of residues which might result in soil cover rates less than 70%. In this case mulch supplementation should be taken into consideration.

Tillage intensity has increased biological activities in no-tilled land (Kornmann, 1997) and the presence of CR on the soil surface has improved soil resistance to compaction from tractors and harvesters (Maillard et al., 1997). In regions with high snowfall, CR-cover could contribute to a reduction of high soil losses during snow melting, which are estimated to 700 kg a^{-1} ha^{-1} (Orlov, 1996). Long term observations of Maillard et al. (1997) and Casico (1997) showed reduced erosion and improved water infiltration under no-till conditions.

Weed control

The common, indirect measures to control weed pressure, e.g. crop rotation, inter cropping, fertilization are fully applicable to the direct sowing system. In addition direct sowing offers some more features: By avoiding soil tillage weed emergence can effectively be suppressed. Higher biological activity in no-tilled soils accelerates decomposition of weed seeds and thus reduces weed infestation.

In view of herbicide utilization direct sowing requires some precautions. Herbicides must not be harmful to the soil organisms. Soil effective herbicides might be less performant when applied in covered soils. Herbicides that have an affect on leaves should therefore be preferred. Long term experiences show that direct sowing does not mean higher herbicide demand. On the contrary, in numerous cases savings in pesticides have been observed. In addition there was no change in herbicide's effectiveness on four cropping systems including no-till after more than 25 years of practice (Mayor and Maillard 1992, 1993, 1996).

The most practiced crop rotations in Belarus are sugar-beet/winter wheat, winter barley or winter wheat/rape, winter wheat/winter barley, maize/winter wheat, potato/winter barley. Thus weed control can be achieved by using pre-seeding herbicides pre-emergence and post-emergence herbicides as recommended by Basch and Buhrnsen (1997).

Technical issues

At present there are worldwide more than 60 manufacturers of machinery that is suitable for direct sowing. Basic requirements to direct sowing equipment are low soil disturbance, and trouble free operation even in soils covered with high amounts of organic matter. There are two main principles of mulch penetrating mechanisms, i.e. by rigid tines and discs coulters. When operating the machine in dense soil cover furrow cleaner might be necessary to avoid blocking of the coulters.

Experiments under field conditions of coulter removers have shown good performance with working drive speeds up to 12 km h^{-1} (Rump, 1997). For heavy and wet residues, hard soils and sod, the disc coulters direct drills could be ideal, due to their V-wheel which pushes soil in and around the seedbed (Lessier, 1997).

Economical considerations

On large farms cropping systems, profitable cereal production is impossible to obtain by using 3-4m wide, PTO-driven machines. Apart from larger working widths and more powerful tractors, ploughless tillage also allows large farms to reduce costs considerably. At the University of Hohenheim experiments were carried out in order to compare the economic potentials of different tillage systems, i.e. conventional, conservation and no-till, for large farms (100 ha). Working time requirements for the different systems are shown in Table 1.

Results of the economical considerations for seedbed preparation are presented in figures 1 and 2. For farm sizes up to 1.000 ha a rapid decrease in costs for seedbed preparation can be observed for all types of cultivation and for all types of soils. In general, the costs for no-till cultivation are significantly less than for conventional and for conservation tillage. It becomes clear that, on large farms, cultivator drilling (Airseeder) and direct drilling are the only alternatives to traditional tillage methods using ploughs. On farms with several thousands hectares, ploughless tillage with PTO-driven machines - a method that is often applied in western Germany - is clearly more expensive than conventional tillage with a plough (Kuller, 1997).

Table 1. Soil cultivation and seedbed preparation (productivity: 8 ha/h)

	Soil type	
Tillage systems	**Light**	**Heavy**
Conventional tillage - ploughing, separated	ploughing/seedbed preparation/drilling; 3 separated operations (2 ploughs with 8 tines, 1 seeder of 12 m width of 150hp) 4 hours	ploughing/seedbed preparation/drilling; 3 separated operations (2 ploughs with 8 tines, 1 seeder of 12 m width of 150hp) **5 hours**
- ploughing combined	ploughing/seedbed preparation and drilling combined; 2 operations (2 ploughs with 8 tines; combination of soil preparation and seeding tools of 4m width 190hp) **4 hours**	ploughing/seedbed preparation and drilling combined; 2 operations (2 ploughs with 8 tines, combination of soil preparation and seeding tools of 4m width with 190hp) **5 hours**
Conservation tillage - ploughless	cultivator or disc harrow/seedbed preparation and drilling combined in 2 operations **4 hours**	cultivator or disc harrow/seedbed preparation and drilling combined in 2 operations **5 hours**
- rotary drilling	-	4 implements combination (rotary/seeder, 4m width, 350 hp), one operation **4 hours**
- cultivator drilling (Airseeder)	cultivator/drilling (9 m width, 350hp) **1 hour**	cultivator/drilling (9 m width, 350hp) **1 hour**
No-till (direct seeding)	special seeding machine in one operation (9 m width and 250hp) **1 hour**	special seeding machine in one operation (9 m width and 250hp) **1 hour**

Source: Kuller 1996

When considering the economic effects of conversion from tillage to conservation tillage one should always keep in mind that the changes are a complex process. A successful conversion requires precise planning and preparation. An economical evaluation of the conversion requires a full-cost pricing of the complete crop production. Simple machinery cost calculations or break-even analyses are insufficient. The largest effect of the conversion occurs in labour productivity, which might increase dramatically (Linke, 1997).

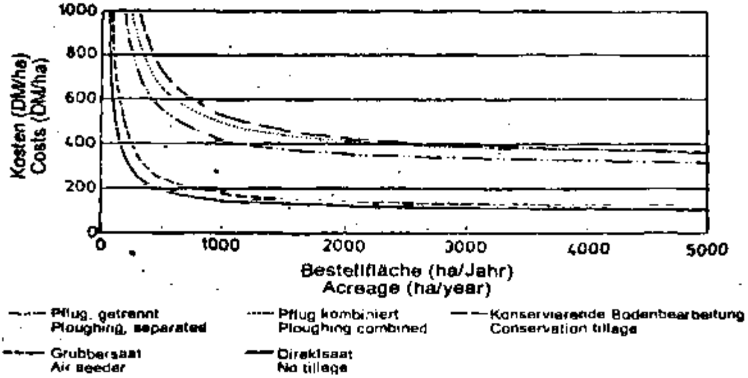

Figure 1. Costs for seedbed preparation in light soils.

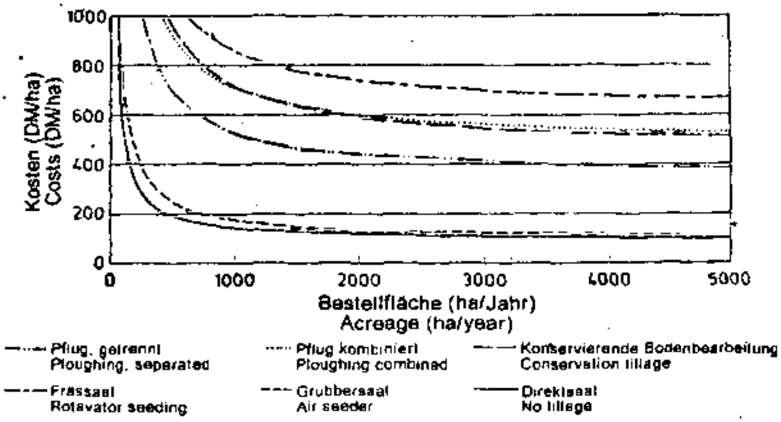

Figure 2. Costs for seedbed preparation in heavy soils

Conclusions and Recommendations

Direct sowing, i.e. no-tillage combined with effective crop residue management has proved to be a highly efficient cropping system that offers answers to both, agro-economical as well as ecological questions of global concern. In many regions of the world the benefits of direct sowing have already been recognized and appreciated. There is increasing evidence that direct sowing will play an important role also in European farming systems. A great potential can be assumed for the East European large-scale farming systems.

In view of the encouraging results that are already available further research and development in order to adapt the system to the prevailing conditions in Eastern Europe seems to be highly promising. Site-specific solutions are required to minimize fertilizer and pesticide expenditure. From the technical point of view emphasis should be put on the development of optimized machinery for soil opening in moist soils with high amounts of crop residues.

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