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Productivity and Efficiency of Ukrainian Agricultural Enterprises

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About the Project "German-Ukrainian Agricultural Policy Dialogue" (APD)

The German-Ukrainian Agricultural Policy Dialogue provides policy advice to Ukrainian state authorities and business associations on reforming agricultural policy and legislation in accordance with principles of a market economy. In our advisory work, we take into account relevant German as well as international experience and practice (EU, WTO). The project is funded by the German Federal Ministry of Food and Agriculture under its Cooperation Program through GFA Consulting Group GmbH.

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ABSTRACT

This paper analyzes efficiency and productivity of Ukrainian agroholding farms and independent farms based on farm level data for crop and dairy production for the period 2008-2012 based on data envelopment analysis and total factor productivity measurement. Although agroholding farms are found to have higher and faster increasing yields by using a higher intensity, neither they exhibit on average a higher productivity nor higher profitability. A large heterogeneity in productivity and profitability scores is observed within both groups of farms and between different agroholdings. The observed dispersion in efficiency indicates that factors such as management skills, access to know-how and human capital as well as adjustment and learning costs may be crucial for agricultural productivity and that there is substantial room for efficiency improvements among both independent farms and farms belonging to agroholdings.

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EXECUTIVE SUMMARY

1. A **dualistic farming structure** is a key feature of the agricultural sector in Ukraine. Many smaller farms operate in parallel to a much smaller number of large farms. Partly these large farms are subsidiaries of agroholdings.
2. Today, **agroholdings** are estimated to **manage more than 6 mio. ha farmland or 27% of agricultural land** in use of agricultural enterprises. However, **land consolidation processes** towards large farm enterprises and agroholdings **seem to slow down**. Nowadays, agroholdings have particularly high shares in sunflower, wheat, rapeseeds, soybeans, corn, sugar beet, pork, and poultry production.
3. With 49% share in total production value in 2012, **small scale rural households are still a major producer type** in both, crop and animal farming. Their **production shares** are however **continually decreasing** and shifting towards larger independent farming enterprises and agroholdings.
4. The agricultural sector suffers an **underdeveloped business environment**. E.g., by the lack of qualified workforce (e.g. veterinary, agronomy and machinery services) in rural areas, limited access to capital, overdue tax reforms, the absence of a transparent and equal-access budgetary state support system. Land lease markets regulations, high regulatory barriers, lacking competencies and set-up of local authorities, underdeveloped investor services and infrastructural deficits constrain the development of the sector.
5. **Crop production** suffers from the high **disposition to weather risks**. Ukrainian crop farms need to develop management strategies which allow to cope with weather uncertainties. These strategies should not only address financial risks (e.g. through diversification) but also the production risk by applying yield stabilizing measures.
6. In the recent years, **agroholding farms generated an increasing share of their profit outside crop and animal production.** An important role can be seen in infrastructural investments such as in storage capacities which allow for additional value-added by enabling the farms to sell their produce at periods with better prices.
7. **Agroholding farms are comparably more productive** in terms of output per input unit such as per ha, labor unit or cow. However, the specific **input structure**

of **agroholdings** (in combination with respective input prices) increases their total costs and **lowers their profitability**. For the period 2008-2012, **agroholdings did not exhibit a significantly higher or lower efficiency than independent enterprises**. In recent years, agroholding farms seem to perform better.

8. The efficiency and productivity gaps among agroholding and independent farms decreased substantially between 2008 and 2012**. For recent years, increasing profitability and efficiency of agroholding farms** was driven by dynamic effects of increasing intensities. The benefits of growth, investments and higher intensities are time-lagged. Reasons for the time lags are **adjustment costs and learning.**
9. **Increasing farm size allows higher technical efficiency as well as it leads to higher profitability**, while a **higher share of animal production negatively affects farm profitability.** With increasing share of animal production in total production value, agroholding farms are more profitable than independent farms. Agroholding farms are either more selective or they are better able to manage animal production successfully.
10. The higher the use of capital per hectare the higher are technical efficiency and profitability. This suggests that **investments in assets cause higher productivity as well as financial benefits**. This finding also indicates **undercapitalization of Ukrainian farms** which might be closely related to the underdeveloped credit market which is characterized by high interest rates and constrained access to credit.
11. Currently, the **level of labor payments of the farms is lower than land costs.** This holds particularly true for agroholding farms which exhibit steadily and significantly increasing land rental costs while their labor costs increased only moderately and are on a similar level than those of independent enterprises. The **increasing land rental costs are very likely driven by aggressive growth strategies of agroholding farms**. As higher rental prices are correlated with lower efficiency scores and lower profits, these additional rentals are not leading immediately to higher profits.
12. Considering increasing land rental costs and the fact that most of the rented land is owned by rural inhabitants suggests that **leasehold payments as income**

source may in future be more important **for the rural population** than incomes from employment in agricultural enterprises. The **land sales moratorium secures the opportunity of the rural population to benefit from increasing agricultural productivity and value-added**. An introduction of a land sales market should ensure that the potential benefits of a more prospering agricultural sector and thus increasing benefits from landownership comes also to the benefit of rural areas and their inhabitants.

13. If the **downstream and upstream sectors of the agricultural value chain** would improve their efficiency, this could result in higher prices for the farms and thus in higher profitability of higher intensities. The same logic applies to an improved political and institutional environment. If the **macroeconomic, political and institutional deficits** of Ukraine can be overcome, this would create strong additional incentives for Ukrainian farms to extend production and to contribute even more than now to economic growth.
14. The **growth of agroholdings is driven by a better ability to deal with the existing deficits in the economic environment** of Ukrainian agriculture. In this environment, **agroholdings contribute to the development of Ukrainian agriculture and thus of the Ukrainian economy**. This contribution may even increase in the future, particularly if agroholdings are able to further exploit their productivity and economic potentials. From the side of their shareholders and other stakeholders (particularly international lenders), there is a huge pressure to do so. Those, which are not performing are likely to fail.
15. **Failures of agroholdings create certain societal risks**. Until now, these risks are limited through an increasing awareness within the agroholdings that economic performance is not just a question of size but rather a question of productivity. Moreover, if agroholdings are in financial trouble they are acquired by other holdings. As long as there are expectations by investors that agroholdings have positive prospects within Ukrainian agriculture and access to financial means, this kind of insurance continues to exist.
16. Political debates on regulating the growth of agroholdings or to limit size limits do not provide prospects for independent enterprises to overcome the existing deficits in the macroeconomic, institutional and political environment. To support independ-

ent enterprises, policy makers should focus on improving the agricultural business environment.

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LIST OF ABBREVIATIONS

BMI	Business Monitor International
CAP	Common Agricultural Policy
dt	Decitonnes
DEA	Data Envelopment Analysis
EU	European Union
FAT	Fixed Agricultural Tax
Ha	Hectares
IAMO	Leibniz Institute of Agricultural Development in Transition Economies
IPO	Initial Public Offering
OLS	Ordinary Least Square
t	Tons
TFP	Total Factor Productivity
UAH	Ukrainian Hryvnia
UCAB	Ukrainian Agribusiness Club
USD	United States Dollar
VAT	Value Added Tax

1 INTRODUCTION

Today, Ukrainian agriculture is characterized by a dualistic structure of agricultural production. On the one hand, huge agroholdings (ranging from 10 000 ha to more than 500 000 ha in size) and independent enterprises from 100 ha to more than 10 000 ha dominate crop and intensive livestock production. On the other hand, dairy and other labor intensive production is still dominated by rural households. Agroholdings are understood as horizontally and vertically integrated agricultural and agribusiness enterprises, which often have an explicit holding structure consisting on quite a number of legal entities.

After almost 15 years of recession and stagnation since 1990, structural developments in Ukrainian agriculture became very dynamic in the recent years. Particularly, there is an ongoing trend towards the consolidation of land resources in large agricultural enterprises and agroholdings despite some slowing down in its pace. According to Agri-Survey (2013) estimates, agroholdings manage over 6 million ha of farmland. This resembles 14% of total agricultural land of Ukraine and 27 % of all farmland in use of agricultural enterprises. The consolidation slowdown is the result of several factors. The key ones include a declining availability of financial resources for further growth and a range of administrative and regulatory restrictions. Also the livestock sector is undergoing a significant consolidation. Many households and medium-sized enterprises exited dairy production while only the group of dairy farms with herds of more than 1000 heads increased their production capacities.

These structural changes went recently along with increasing yields and an increasing intensification of production. To shed some light into this process, this study analyses the above mentioned structural developments and links them to productivity and efficiency developments. The focus of the analysis is limited on the one hand towards the crop and dairy sector and on the other hand on agricultural enterprises. In particular, the study compares agricultural enterprises which are independent with those which are controlled by agroholdings. The analysis is based on recent statistics as well as farm-level accounting data. The data covers particularly the period 2008 to 2012, which includes a period of highly fluctuating food prices as well as a severe international financial crisis. Particularly during the financial crisis, the agricultural sector revealed to be a stabilizing and stimulating force within the Ukrainian economy.

The key questions of this analysis are on the one hand, whether the recent structural changes and the intensification of agricultural production can be considered as a clear sign that Ukrainian agriculture finally was able to overcome the long period of recession and stagnation in order to become a strong and reliable supplier of agricultural products. On the other hand, the study aims to identify critical issues of the recent recovery. Herein, the study particularly quantifies productivity developments on different levels and identifies driving factors of productivity development. Special consideration is paid to the question whether agroholdings had a positive impact within this process. This is particularly relevant in order to assess their economic and social sustainability. Finally, the study connects the sectoral developments with the economic, political and institutional settings in order to draw policy recommendations.

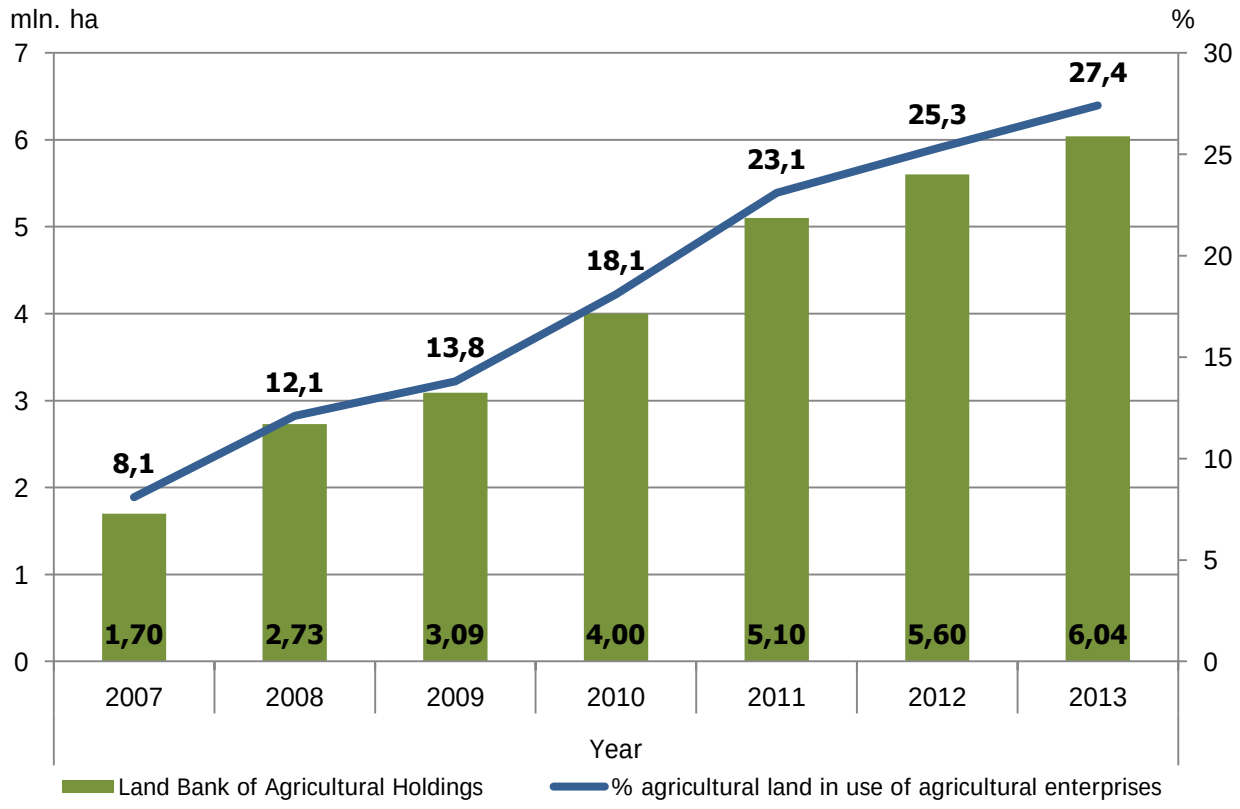
This study is structured in five sections. Following this introduction, section two presents an overview on recent structural developments. Section three continues with partial farm-level productivity developments. Section four analyzes efficiency, productivity and profitability scores by using more sophistic methodological approaches like data envelopment analysis, total factor productivity measurement and regressions which are applied to farm-enterprise level accounting data for the years 2008 to 2012. Section five summarizes the empirical results and links them to the political and institutional settings and draws policy recommendations.

2 STRUCTURAL DEVELOPMENTS OF UKRAINIAN AGRICULTURE

2.1 Farm sizes and structures in the Ukrainian crop and dairy sector

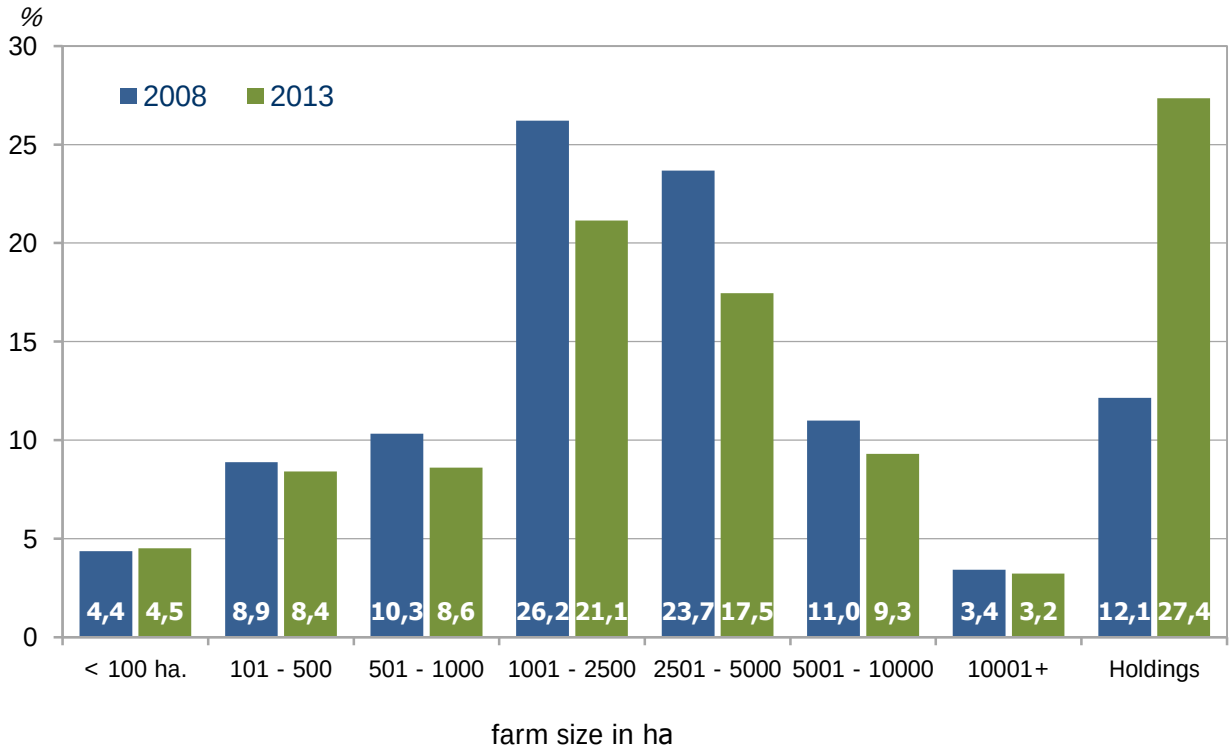
Over the past decade, Ukrainian agriculture experienced a significant consolidation of land resources in large agricultural enterprises and agroholdings. This process is still ongoing despite it recently was slowing down in its pace. According to Figure 1, agro-holdings had in 2013 already over 6 million ha of farmland under their control or 27 % of all farmland in use of agricultural enterprises. According to Figure 2, the very dynamic consolidation of Ukrainian land resources between 2008 and 2012 was mainly driven by the acquisition of enterprises cultivating from 1 to 5 thousand ha. This very group is featuring the most remarkable reduction of the share of independent enterprises – from 49.9 % down to 38.6 %.

Figure 1: Development of land bank of Ukrainian agroholdings



Source: AgriSurvey (2013)

Figure 2: Share of farmland in the landbank of agricultural enterprises dependent on size

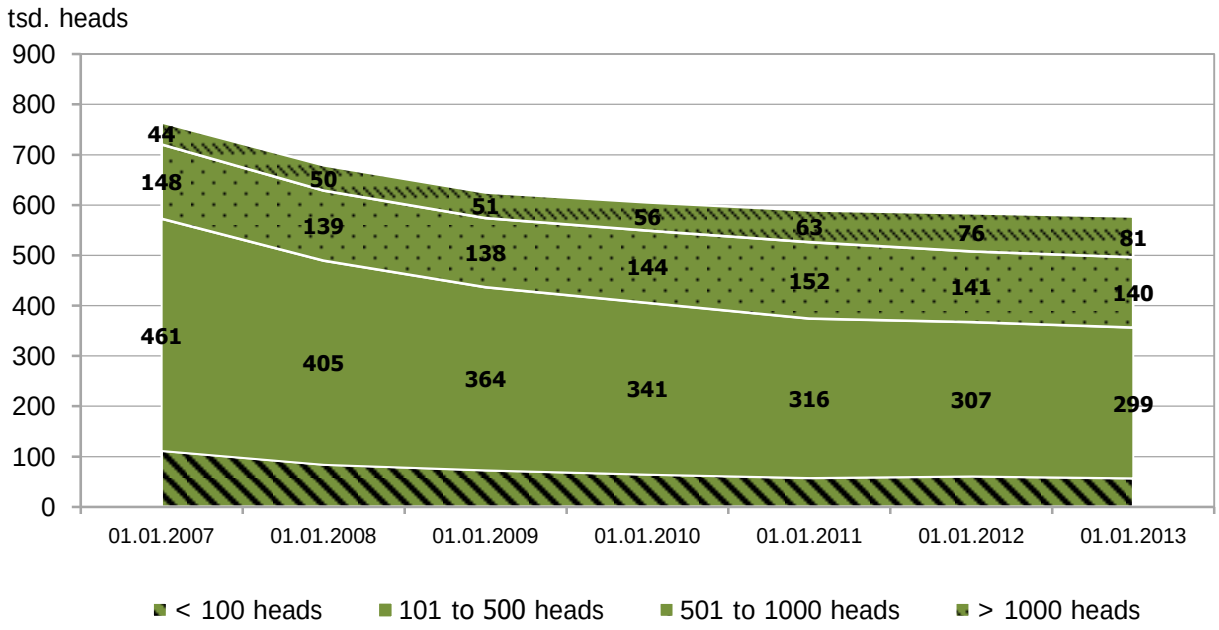


Source: AgriSurvey (2013)

The prospects of further land consolidation of large enterprises can be expected as moderate. Most companies will rather have to focus on improving production efficiency. Nevertheless, by 2015, the aggregated land bank of agroholdings may reach the level of 6.8-7.0 million ha (AgriSurvey 2013).

Comparable structural developments can be identified in the dairy sector. As of the beginning of the year 2000 there were 12.8 thousand dairy enterprises in Ukraine. By 2005, the total number of dairy farms decreased to 7.0 thousand. In the subsequent five years, the trend of a declining number of dairy farms combined with a simultaneous growth of large-scale dairy farms continued. The number of enterprises engaged in dairy farming by the beginning of 2013 made up 3.2 thousand. This trend is also reflected in Figure 3. Accordingly, only herds with more than 1000 heads increased in total numbers of cows, while herds with 500 to 1000 heads stagnated and farms with less than 500 heads declined.

Figure 3: Structural changes among enterprises engaged into milk production



Source: AgriSurvey (2013)

The total reduction of the number of dairy farms can partly be seen as a result of farm-land consolidation. Particularly, most agroholdings are focusing on crop production. Given limited access to finance as well as the high costs of financing long-term investments, many of them had little interest in investing into dairy farming. Another factor is outdated technologies at the majority of farms. Modernization would require huge investments. Even if modernization took place within agroholdings, the strategy was mostly to have fewer farms with more cows. To some extent, social aspects may have held this process back. Because animal production is often an important source of employment in rural areas, some agriholdings may have continued dairy farming to take account of stakeholder interests such as of local inhabitants who are also landowners and lease their land plots out to agroholdings.

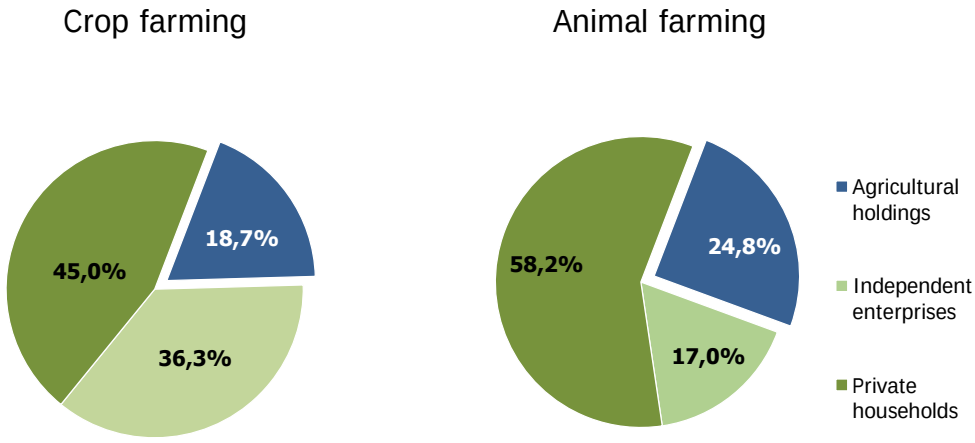
2.2 Role of agricultural enterprises in different sectors

The consolidation of farm land went along with a dramatical change in the value structure of Ukrainian agricultural commodity market during the period 2004-2012: the share of grains and oilseeds grew from about 13 % to more than 55 % while the shares of livestock and milk were decreasing from 35 % down to 20 % and from 45 % down to 20 %, respectively (BMI, 2012).

Having under their control 27 % of the land bank of agricultural enterprises, the total value of agricultural production by agroholdings accounted for UAH 46.26 billion or one fifth (20.7 %) of gross agricultural production in Ukraine in 2012 (AgriSurvey 2013). Among them, the share of the three largest agroholdings (MHP, UkrLandFarming and NCH) exceeded UAH 16.1 billion or 7.2 % of the gross output. Agroholdings have particularly high shares in sunflower, wheat, rapeseeds, soybeans, corn, sugar beet, pork and poultry production. In crop production, the share of agroholdings was 18.7 % in 2012. In animal production this share was 24.8 %.

The other groups of producers include on the one hand independent agricultural enterprises (of some 2,300 ha in size, on average) and family farms (up to 100 ha on average) which specialize mainly in the production of grains and oilseeds. The share of independent agricultural enterprises is approximately 30 % of total output while that of family farms accounts for 6.3 %. On the other hand, small-scale rural households have major shares in milk (78 %) and fruit and vegetables production (about 95 %). Their share in total production value is still 49 % but is continually decreasing.

Figure 4: Structure of gross output in 2012



Source: AgriSurvey (2013)

In 2012, agroholdings accounted for 30.6 % of total cereal crop production. They produced 27 % of total wheat, 42 % of total corn and 11 % of total barley production. The agroholdings increased particularly corn cultivation which allows for significantly higher yields than other crops. Sunflower production at agroholdings accounted for 17 % of the total harvest; 34 % of the total volume of soybeans harvested; and 48 % of the total rapeseed production in Ukraine. The share of agroholdings in sugar beet production made up 56 % of the gross sugar beet production. The particularly high shares for

corn, soybeans and rapeseed can be interpreted in a way that agroholdings are more innovative while independent agricultural enterprises seem to be more conservative. In sugar beet production, the high share of agroholdings is explained by vertical integration with sugar plants.

In the sector of animal production, the role of agroholdings is even more vital. In 2012, their share amounted to nearly a quarter of the gross output of animal farming. In the structure of total animal production (i.e. including production at agroholdings, independent agricultural enterprises, family farms and rural households), the main volumes of agroholdings were represented by aviculture and pork production (65 %). The shares of agroholdings in milk and egg production were equal to 25 % and 10 %, respectively (AgriSurvey, 2013).

In the dairy sector, the largest milk-producing agroholdings are also engaged in crop production. For most of them, milk production is rather a secondary business while crop production is the first priority. Only one of the top-15 dairy holdings is specialized in milk production; however, it also has crop production in its structure complementing forage production.

In 2012, total milk production in Ukraine increased by 2.7 % to 11.4 million tons. Small-scale (and technologically poor) rural households still dominate, amounting to 78 % of total production. However, their share is declining. This affects particularly deliveries to dairy processors. The share of processed milk delivered by households declined from 67 % in 2008 to 51 % in 2012. This trend seems to continue. On the other hand, agricultural enterprises increased total production by 21 % since 2008. In particularly, these farms increased their share in the deliveries of processors from 33 % to 48 %.

Table 1: Major indicators of milk production in Ukraine

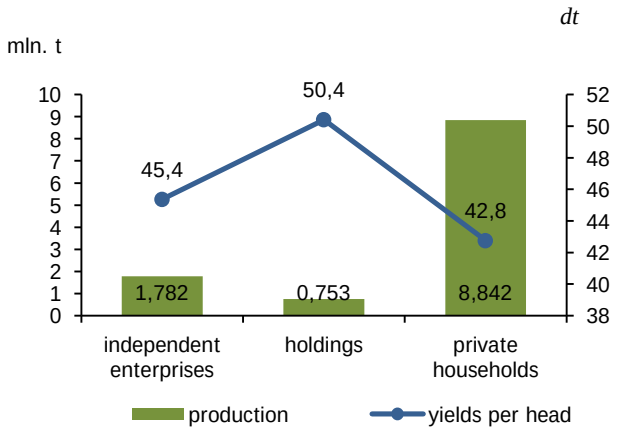
Indicator	2008	2009	2010	2011	2012	2012 to 2011, %
Milk production, million t	11.76	11.61	11.25	11.09	11.39	102.7
thereof agricultural enterprises, million t	2.09	2.24	2.22	2.25	2.54	112.9
thereof households and others, million t	9.67	9.37	9.04	8.84	8.85	100.1
Milk supplied for processing, million t	5.40	4.67	4.74	4.61	4.71	102.2
thereof agricultural enterprises, million t	1.72	1.86	1.89	2.03	2.28	112.3
thereof households and others, million t	3.68	2.80	2.85	2.51	2.41	96.0

Source: Derzhstat (2013)

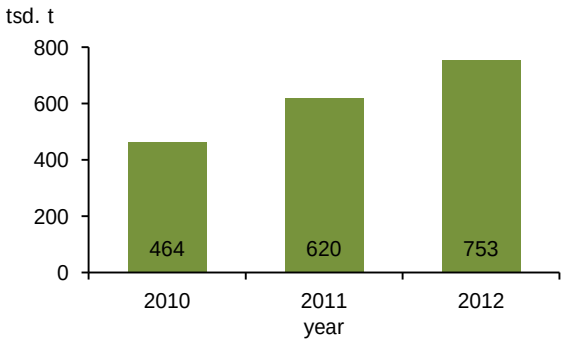
Noteworthy, agricultural enterprises were able to increase production despite decreasing cow numbers, i.e. due to productivity growth, which is, to great extent, the consequence of substantial investments between the years 2007-2011. In 2012, production of milk by agroholdings made up 753 thousand t or approximately 30 % of the total milk yield reported by agricultural enterprises. Agroholdings are maintaining their growth in dairy farming. Over the last two years, gross milk production at holdings increased by over 60 % – from 464 thousand t in 2010 up to 753 thousand t in 2012.

Figure 5: Structure and development of milk production

Structure of gross output and yields in 2012



Production development of agroholdings



Source: AGRISURVEY (2013)

2.3 Impacts on employment and rural development

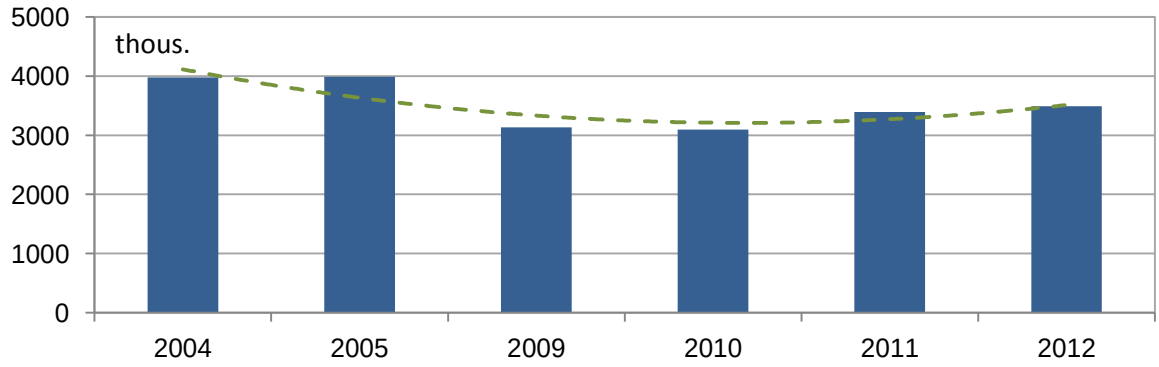
The ongoing restructuring of Ukrainian agriculture had significant impacts on employment and rural development. Until 2009 the number of employees in agriculture and forestry declined. Since then, the employment has recovered by approximately 10 %. However, the tendency toward the increase of agricultural labor figures is unlikely to be the sign of improving attractiveness of working conditions. The major share of working population continues to be shaped by self-employment in rural households. While the number of hired labor continues to decline – from 2008 to 2012, the number of employees in the industry decreased by more than 80 thousand to 700 thousand people – the share of self-employed continues to grow.

Furthermore, taking into account the limited ability of agricultural labor market to expand, the issue of new spheres of employment in rural areas is crucial. Today a proper-

ty of the agricultural labor market is a long-term trend toward the increase of both official and unofficial unemployment figures in rural areas. The self-employed population partly belongs to the group of unofficially unemployed. The share of rural population, employed in an informal sector of economy, currently accounts for 47.5%, while the share of urban population is 11.6%.

According to the State Statistics Service of Ukraine, the share of wages in the structure of crop production cost amounted to 8.8 %; in animal production, this figure was at the level of 9.7 % in 2011. At the same time, average wages in agriculture are much lower than those in the general economy. Evidently, reduction of employment figures is less driven by the objective to reduce labor costs but due to introduction of modern technologies which has a more general aim – i.e. to optimize the use of other resources, reduce losses and improve quality of production.

Figure 6: The number of persons working in agriculture and forestry of Ukraine



Source: State Statistics Service of Ukraine (2012)

In general, agroholdings engage much more than individual enterprises in animal production which is more labor intensive than crop production. Bookkeeping figures of a sample of Ukrainian agricultural enterprises (which are further analyzed in section 3) show for 2012 on average a significantly higher number of employees per 100 ha in farms belonging to agroholdings than in independent enterprises. Also, agroholdings tend to invest more actively into the development of value chains. This facilitates alternative employment in rural areas, e.g. at grain storage facilities. To some extent, the growth of agroholdings may nevertheless have contributed to the reduction of employment rates. On the one hand, there is a tendency that larger farms have a lower number of employees per ha (cf. Table 2). Also, agroholdings may have streamlined produc-

tion activities of poorly performing farms which they acquired. However, the acquired enterprises were in many cases in financial stress. Thus the jobs provided by these enterprises were not secure. Thus, one can assume that employment is rather dependent on the structure of a farm's production than on size or organizational form.

Table 2: Employment in agricultural enterprises, by enterprise area

Size of an enterprise, thousand ha	> 5,0	3,0 – 5,0	2,0 – 3,0	1,5 – 2,0	1,0 – 1,5	0,5 – 1,0	0,1 – 0,5	Total
Number of enterprises in group	568	842	1132	854	1156	1046	774	6372
Average size of a land bank, ha	8 360	3 810	2 440	1 730	1 230	740	330	2 660
Number of employees/100 ha	1,6	1,8	1,9	1,9	1,8	2,1	2,9	2,0

Source: AgriSurvey (2012a)

A specific additional employment issue of agroholdings is their corporate structure. Particularly, agroholdings employ a substantial number of high salary employees in central offices which are located in urban areas. This reduces the taxable base in rural areas and, accordingly, the revenues of regional budgets. The problem can be solved through amendments to the existing legislation which would provide for salary accounting both at the legal address and at the actual production site.

Given the capital and knowledge intensity of modern farming (Boehlje and Gray 2009), agroholdings as well as independent enterprises depend on the availability of well-trained employees at their production sites. Thus both should have a strong interest in adequate rural infrastructures which provides sufficiently attractive living conditions for employees and their families. Important issues are social security as well as infrastructure and lack of entertainment. Otherwise, particularly well-educated young people from rural areas will refuse to return after their education to villages.

In general, social activities of agroholdings are organized via so-called social contracts with rural communities. In terms of such contracts, agroholdings pay on average UAH 30 to UAH 40 per hectare to rural communities. These payments differ in the range of UAH 20 to 100, depending on a region and the level of competition for lease of land plots. The problem is that the major share of local budgets is spent for salaries to officials and utility payments and, thus, the role of local budgets in co-financing rural development activities is limited.

Another practice of agroholdings involves establishing charity funds (UCAB, 2014). These funds are financed from different sources, including agroholdings themselves as well as third parties such as companies representing other sectors in the particular region and donor organizations. In general, the issues of both employment and social infrastructure in rural areas depend on local public activities and state programs for the development of entrepreneurship and cooperation. However, actual financing of such programs is very limited.

The issue of rural development requires also more meaningful approaches at the governmental level. The structure of rural areas has still many features of the Soviet economic system when collective farms were responsible for the development of rural areas. In Ukraine, no concept of the state policy in the sphere of rural development has yet been defined. Therefore, agricultural enterprises need to establish direct contacts with rural inhabitants in order to define and address the first priority issues of the social infrastructure.

2.4 The Ukrainian agribusiness environment

Managerial and human capital deficits

While the decrease in labor intensity is partly driven by modernization, the agricultural sector of Ukraine nevertheless lacks qualified workers. According to AgriSurvey (2012b), 40 % of agricultural enterprises urgently need qualified labor in spheres such as agronomy, veterinary and machinery. As a result, 51 % of agricultural enterprises are ready to employ "fresh" university graduates with little work experience and educate them on-site. However, only 10 % of the graduates are interested to work in rural areas while 67 % prefer to work in cities. These concerns primarily reflect poor living conditions in rural areas.

In general, structural misbalances in agricultural employment are persisting. The number of low-qualified labor in rural areas is high because of both low level of education and non-willingness of qualified employees to work in rural areas. At the same time, agricultural enterprises need employees with at least basic knowledge of modern technologies. Internship proposed by agricultural universities is rather formal. Its conditions (1 to 2 months and difficulties to obtain an individual lecture schedule during internship) do not allow for accessing necessary practical skills. Moreover, agricultural enter-

prises use such internships neither to adapt students to modern technologies nor to assess their qualifications. State programs of qualification improvement also have little effectiveness.

Given these problems, a number of agroholdings have developed their own educational and qualification improvement programs which involve selection of students, their preparation and adaptation to employment at agricultural enterprises. Examples include the programs of the agroholdings MHP and Mriya, job exchange and AgriSchool of Ukrainian Agribusiness Club.

Noteworthy, more and more agricultural universities declare their willingness to strengthen cooperation with the industry, develop updated educational plans, invite lecturers from agricultural enterprises, etc. However, insufficient equipment of the universities and lack of practical experience of the university tutors reduces positive effects of this cooperation (cf. Koester et al. 2010).

Financial deficits

The poor macroeconomic development of the Ukrainian economy, the volatility in exchange rates as well as increasing risk aversion on international financial markets after the recent financial crises led to a restricted access of Ukrainian companies to sources of external finance. In particular, despite announced plans, no agrarian companies have managed to complete IPOs in recent years. A positive sign was that some companies (MHP, UkrLandFarming, Mriya, etc.) succeeded in attracting about USD 1.6 billion through Eurobonds at the beginning of 2013, although a major share of this volume was consumed to serve the liabilities of those companies. Raising long- and medium-term loans on the domestic market is yet limited because of high interest rates of Ukrainian commercial banks. While interest rates of loans in international currencies fluctuate around 10 %, interests for loans in the national currency fluctuate around 15 % (NATIONAL BANK OF UKRAINE 2013). Access to financial resources is also complicated because of limited possibilities to use mortgage by agricultural enterprises. Because of the moratorium on farmland sales, land plots cannot be purchased and used as a mortgage - though one has to be aware that the purchase of land would also bind even higher amounts of capital.

At the same time, the development of new financial instruments is lagging behind. For example, implementation of hedging strategies is little effective, even despite the intro-

duction of the so-called Black Sea Futures. The positive effect of this instrument is diminished partly due to specifics of local monetary policies and partly due to little understanding on the part of agricultural producers.

Low governmental support

Due to high state budget deficit, the Ukrainian government has only limited resources to support agriculture:

- In the last years, the state program on compensation of interest rates on commercial bank loans to agricultural enterprises stopped due to a tight state budget.
- Budgetary financing of the state leasing companies is limited. As a rule, they are refinanced through leasing payments. Besides, state leasing programs are mainly provided for domestically produced machinery which is characterized by a low level of demand of agricultural producers.
- Intervention policy of the government at the food markets is becoming more and more commercial, i.e. state agents use the same prices as private companies. This mitigates price support and is also the consequence of the State Budget deficit. In essence, the aim of the current intervention policy is to prevent food price increases rather than to support farmers.

At the same time, the government tries to introduce alternative instruments in order to support agricultural producers' access to finance:

- First of all, the so-called agrarian insurance pool has been established.[1] However, the number of companies in the pool is small. The State Budget does not allow to contribute to the cost of insurance services and there exist also regulatory misbalances.
- Second, the government makes efforts to establish the Guarantee Fund for warehouse receipts. Respective laws have already been adopted,[2] whereas secondary legislation is still lagging behind. Besides, grain market players disagree with some clauses of the legislation, especially those which limit the ability of the participants of the Guarantee Fund to influence the fund itself. Thus, the legislation needs to be amended. If the amendments were in place, access of agricultural producers to loans could improve whereas grain stored in the certified silos could be used as a mortgage.

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1 http://uaip.com.ua/
2 http://zakon0.rada.gov.ua/laws/show/5493-17

- Third, the law on agricultural receipts has been adopted.[3] The law was developed based on Brazilian experience. However, secondary legislation is also missing which does not allow for implementing of agricultural receipts. The overall logic of this instrument is to provide more guarantees to input suppliers by means of the future grain crop sales. As expected, the test version of the agricultural receipt system will be launched in 2014.

Thus, the problem of access to finance is still one of the most important issues for Ukrainian agriculture today. It makes agricultural enterprises depend on the market situation. If prices are favorable, the volumes of investments grow and technologies are modernized. Conversely, if prices are low, the volume of investments falls down.

The two major sources of support for agricultural producers in Ukraine are VAT benefits[4] and fixed agricultural tax (FAT). The latter, in particular, exempts agricultural enterprises from paying tax on profit. In nominal terms, the volume of these benefits grew from UAH 1.5 billion in 2001 up to over UAH 18 billion in 2012. At the same time, in 2001-2012, there were changes in taxation which significantly reduced real tax benefits for the sector.

First of all, it applies to the non-reimbursement of VAT at export of cereals and oilseeds. Estimations show that non-reimbursement of VAT at export leads to decrease of purchase (procurement) prices amounting to over UAH 9 billion in total; this implies that the balance of tax benefits (including VAT exemptions and FAT) in 2012 made up about UAH 8.5 billion only. Only in 2014, VAT reimbursement at exports was partly re-established.

Another significant change that took place was exemption of mandatory contributions to the State Pension Fund from the list of taxes, levies and contributions replaced by FAT. This process developed between 2005 and 2009, and starting from 2010 agricultural businesses are making contributions to the State Pension Fund, later on replaced by a unified social contribution. In 2012, estimated tax burden related to labor cost made up over UAH 5 billion, and with it taken into account, the volume of tax benefits for agriculture reduced down to UAH 3.4 billion (in equivalent of preferential regime effective in 2001).

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[3] http://zakon4.rada.gov.ua/laws/show/5479-17

[4] Article 209 of Tax Code of Ukraine

Thus, while "nominal" value of tax benefits and preferences looks very impressive, real benefits and preferences decreased remarkably between 2001 and 2012. The share of tax benefits in the gross output decreased from 6 % in 2001 down to 3 % in 2012. This means that ongoing growth of agricultural production in Ukraine is taking place against the background of shrinking volumes of tax incentives (UCAB, 2013).

The new government has already announced its intentions to change significantly the system of taxation, including taxation of agriculture.

In general, to improve the investment attractiveness of agriculture, the reform of tax and budgetary state support should involve the following steps:

- Establishment of foreseeable and stable taxation conditions in the mid-term perspective (7 to 10 years)
- Enabling of equal access to state support programs (formal requirements towards recipients, listing of all recipients compliant with the requirements, and proportional distribution of the available support)
- Publicity, i.e. publication of all farmers, enterprises and companies which receive state support in order to provide for controls over transparency od distribution of state support.

Despite the existing differences between the Ukrainian agricultural policy and the CAP, these steps would signify approximation to the EU regulation principles.

Institutional deficits

According to the Global Food Security Index developed by The Economist's Intelligence Unit, the main problems in assuring food availability by the Ukrainian agri-food sector are corruption and low political stability. A high level of corruption primarily stems from a large number of unnecessary regulatory procedures and, consequently, excessive regulation in agriculture as well as in the related sectors such as input and food industries. At the same time, political instability is often the result of populist policies which contribute, for example, to lowering of state support of agriculture in favor of "more social" initiatives.

Land lease market[5]

The relations in the field of land use in Ukraine are still subject to some regulation novelties. For instance, legislative novelties related to transfer to the new system of registration of ownership and use rights to land had nearly put land lease market to complete halt in the first half of 2013.

There are still problems regarding legislative requirements to compliance with the rules on crop rotation. Despite informal ban on checks and inspections upon compliance with the said rules, the latter did not become either clearer or better adapted for implementation.

Review of the normative monetary value of agricultural land that led to the growth of an average land rent payment from UAH 347/ha in 2010 up to UAH 618/ha in 2013 shall also be considered as a restrictive factor for improvement of productivity in the short run.[6]

Centralization of state land management within the State Agency for Land Resources has also proven to be ineffective. Agricultural producers experienced huge difficulties in concluding rent contracts for state-owned lands. Such barriers generally put constraints on market entry. Moreover, these constraints are measurable. For examples, investors have to pay USD 250-500 per ha for the transfer of mid-term land rent rights (it is also possible to transfer land rent rights through the transfer of corporate rights). Thus, such direct and indirect expenses of agricultural producers lead to a reduction of rent payments to landowners.

Although the existing business environment is not very favorable, it featured some positive developments. For instance, many agroholdings reduced the practice of aggressive land consolidation instigated by the influence of the investment component according to which land was treated simply and purely as a floating asset. Nowadays further consolidation of land resources is more targeted. An exception in this context is made by enterprises and agroholdings which have large liabilities and are offered for sale with a substantial discount (UCAB, 2013).

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[5] There is no full-fledged land market in Ukraine. According to the Land Code of Ukraine, moratorium on land sales is effective by January 1, 2016.

[6] The normative monetary value of land is the indicator determined by The State Agency for Land Resources of Ukraine with the aim to calculate rates of land tax and fixed agricultural tax as well as to provide the base for land rent payments. Average RMV was established at the level of UAH 20,635.02 per hectare as of 01.01.2014.

Regulatory barriers

Deregulation in several spheres took place in the last months. For instance, in the input industry, each batch of imported agrichemicals has had to be approved by the State Veterinary and Phyto-Sanitary Service. This practice was abolished in April 2014. In agriculture, obligatory technical control of machinery was abolished in June 2014. At sales, an unnecessary practice of grain quality certification has also been eliminated.

At the same time, for example, there is double licensing at the market for crop protection products whereby companies first undergo licensing procedures at imports and then at sales at domestic market. Small family farms and cooperatives are subject to tax discrimination because they are not eligible for VAT exemptions in contrast to medium-size and large agricultural enterprises. The procedure of quarantine and phyto-sanitary certification is too complicated whereas the order of railcar delivery at grain transportation is not transparent.

The law on amendments to several legislation acts on reduction of permits (#1193-VII, 09.04.2014) provides for abolition of a number of permission documentation and procedures. However, the number of regulatory barriers is still high.

The role of local authorities

The role of the departments of agro-industrial development of the rayon and oblast administrations is not fully tailored to the interests of agricultural producers. Their functions include collection of operational statistical data (in addition to the periodic data collection by the State Statistics Service); administration of the programs of budgetary support of agriculture (which, in conditions of limited budgetary financing should have been carried out in a semi-automatic mode); and administrative functions which are not normal for the market economy (e.g. influence on producers in order to achieve a "desirable" structure of sowing areas). Regional authorities are responsible for provision of stocks (e.g. grain) which is contradictory in terms of a unitary state as well as in view of budgetary limitations/deficits. This issue is, thus, also subject to administrative influence and, sometimes, even restrictions of grain transportation. Local administrations are also eligible to approve increase of prices for social products if the price growth is higher than 1 %.

At the same time, local authorities lack qualified specialists in law, economics and technologies who could provide necessary consultations to agricultural producers, especially

small farmers and rural households. Only few oblasts have regional programs for agricultural development. In addition to poor support and unnecessary frictions, rural authorities lack financial resources and institutional capacities to support rural development. This negatively affects the agricultural sector to develop towards becoming attractive for young and qualified individuals.

Absence (non-realization) of programming

Despite declarations, Ukraine has not implemented the strategy of mid-term budget planning. Volumes and directions of the state support of agriculture are defined annually and can be changed significantly from year to year. The volumes of actual financing do not meet the plans approved according to the programs being run.[7] In many cases, distribution of the state support is made by the so-called competition commissions and the majority of agricultural enterprises cannot get access to this source of finance. Transparent access criteria (e.g. consideration of all applications with subsequent distribution of money according to the applied sums) are not used.

Absence of adequate maintenance of investment projects

At the stage of planning of investment projects, investors always face additional organizational and material costs because local authorities are often "investor-unfriendly". Local authorities are unable to provide investors with the full package of necessary project documentation. As a result, investors have to communicate with many other organizations to obtain necessary permits. Very often, realization of investment projects requires improvement of the existing infrastructure (construction of roads, electricity lines, etc.). Despite these objects are then commonly used, (at least partial) compensation of costs from local or state budgets is absent.

In general, Ukrainian agricultural policy makers are aware of the factors that constrain the development of the sector. Despite a number of problems is often solved untimely, most of them are on the agenda or partly solved, e.g. the issue of deregulation. To some extent, regulations can be improved as part of the obligations in terms of the Deep and Comprehensive Free Trade Area with the EU which provide for e.g. recognition of compliance of the controlling authorities, improvement of customs procedures, state procurement procedures, etc.

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[7] http://zakon0.rada.gov.ua/laws/show/1158-2007-%D0%BF/page4

A number of issues are too complex to have simple solutions. For example, one can consider the following cause-and-effect cycle "low tax burden for agricultural enterprises – low level of financing of rural areas – unattractiveness of rural areas for young professionals – labor deficit – low production efficiency – unreadiness to pay more taxes". At the same time, some obvious decisions, including those mentioned in this paper, could facilitate further improvements of efficiency and productivity of Ukrainian agriculture.

3 PRODUCTIVITY IN THE CROP AND DAIRY SECTOR: A FARM-LEVEL PARTIAL FACTOR PRODUCTIVITY ANALYSIS

Recent productivity developments of agroholdings and independent agricultural enterprises will first be evaluated by a partial analysis of key production areas. The focus is on production of wheat, corn and sunflower as the major crop commodities and raw milk as one of the main products of the Ukrainian livestock sector.

In the period 2010-2012, agroholding farms harvested 17 % higher yields of ***winter wheat*** than independent farms with an increasing tendency (Table 3). Higher productivity figures resulted from more intensive production technologies at agroholdings. The cost of production was 8 % higher on average at agroholdings than at agricultural enterprises. At the same time, high production costs caused on the one hand a higher profit per ha while at the same time a lower profitability rate in terms of the ratio of profit divided by costs. High production cost at agroholdings is particularly related to higher material cost – first of all, the cost of fertilizers.

Table 3: Productivity of winter wheat production at agroholding and individual enterprises[8]

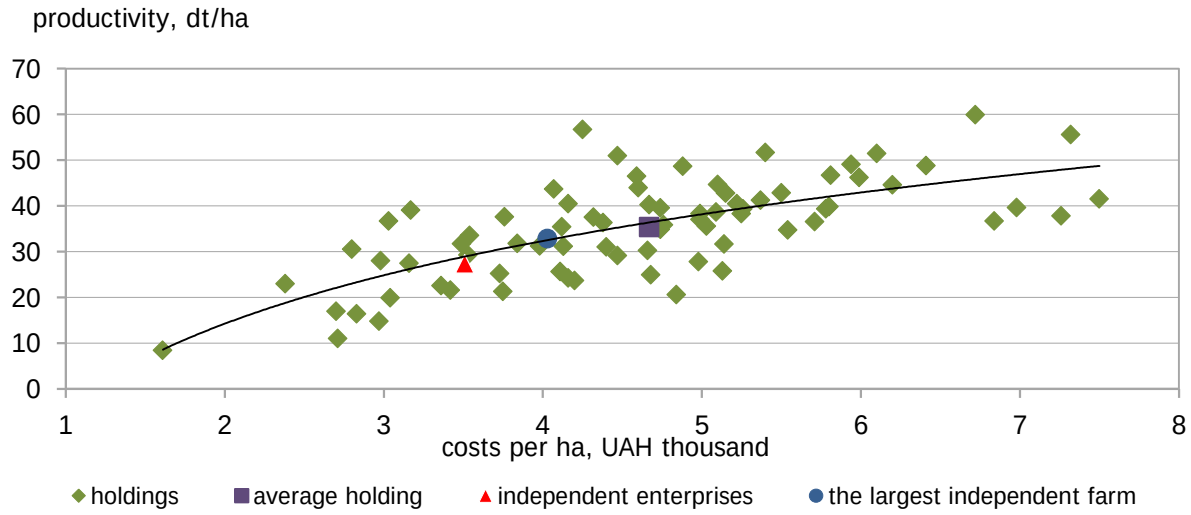
	Agroholdings			Individual enterprises			Ratio agroholdings versus enterprises, 3 years average, %
	2010	2011	2012	2010	2011	2012	
Yield, dt/ha	30	39	35	28	34	27	117
Cost, UAH/t	995	976	1321	843	909	1287	108
Sales price, UAH/t	1136	1361	1596	1068	1306	1529	105
Profit, UAH/ha	423	1502	962	630	1350	653	110
Profitability, %	14	39	21	27	44	19	-

Sources: AgriSurvey (2011, 2012a, 2013)

The correlation of yields and production cost is illustrated in Figure 7 and demonstrates that there is still a number of agricultural enterprises with low intensity and low-cost production technologies and, respectively, low yields. Reasons are unfavorable climatic conditions, limited availability of technologies and equipment as well as limited access to finance.

[8] Average UAH/EUR and UAH/USD exchange rates were as follows: in 2010, UAH 10.53/EUR and UAH 7.94/USD; in 2011, UAH 11.09/EUR and UAH 7.97/USD; in 2012, UAH 10.27/EUR and UAH 7.99/USD.

Figure 7: Correlation of yield and cost of wheat production in specialized wheat farms in 2012



Source: AgriSurvey (2013)

Figure 7 also reveals that quite a number of agroholding farms achieved higher yields. However, many of them produced at very high costs. Partly, this may be explained by the unforeseeable droughts in certain Ukrainian regions in 2012. These droughts however affected particularly the southern and eastern regions which usually have anyway lower yield levels. From an economic point of view and in an ex post perspective, it seems at least for 2012 that intensive farms which harvested more than 4 t/ha achieved the last ton/ha of additional yield often at an extra cost of more than 2000 UAH/ha, which makes it unprofitable. Similar effects can be observed for other crops.

Agroholdings demonstrated also higher productivity in ***corn*** production than independent enterprises. In contrast to wheat production, even the cost figures were lower at agroholdings which, in combination with higher yields and higher prices, led to a significantly higher profitability in absolute and relative terms than that of independent agricultural enterprises. Noteworthy, lower cost per unit of production at agroholdings has been achieved through higher yields which can be assumed to be the result of better use of technologies. Interestingly, and similar to the case of other crops, agroholding enterprises showed lower yield reductions in 2012. In comparison with 2011, corn yields at agroholdings decreased only by 18 % while corn yields at independent agricultural enterprises dropped by nearly 31 %. Reasons may on the one hand be found in

superior technologies and on the other hand in regional concentrations. It is also worth to mention that the profitability of corn was much higher than that of wheat.

Table 4: Productivity of corn production at specialized agroholdings and individual enterprises

	Agroholdings			Agricultural enterprises			Ratio agroholdings versus enterprises, 3 years average, %
	2010	2011	2012	2010	2011	2012	
Yield, dt/ha	48	75	61	46	67	46	116
Cost, UAH/t	795	732	1043	795	746	1146	96
Sales price, UAH/t	1251	1408	1541	1233	1307	1497	104
Profit, UAH/ha	2188	5070	3038	2014	3759	1615	139
Profitability, %	57	92	48	55	75	31	-

Sources: AgriSurvey (2011, 2012a, 2013)

The productivity of ***sunflower*** was slightly higher at agroholdings than at independent enterprises, whereas the latter showed at least in 2011 a significantly higher profitability at lower production cost.

Table 5: Productivity of sunflower at specialized agroholdings and independent enterprises

	Agroholdings			Agricultural enterprises			Ratio agroholdings versus enterprises, 3 years average, %
	2010	2011	2012	2010	2011	2012	
Yield, dt/ha	17	20	18	16	20	17	102
Cost, UAH/t	1 640	1814	2298	1558	1625	2216	107
Sales price, UAH/t	3 057	3221	3623	3021	3225	3582	101
Profit, UAH/ha	2409	2814	2385	2340	3200	2322	97
Profitability, %	86	78	58	94	98	62	-

Sources: AGRISURVEY (2011, 2012a, 2013)

As described in the previous section, ***milk*** yields in 2012 were on average 11 % higher for agroholdings than those of independent agricultural enterprises. Table 6 depicts some production indicators of independent producers. Noteworthy, there is a steady trend towards further exit of smaller farms with less than 500 t to 1000 t per year. The most productive group of independent milk producers is producing 5000 to 10000 t per year with the average cow population of 948 cows and almost 67 dt of milk per year and head.

Table 6: Grouping of independent milk producers by volumes of milk production in 2011-2012

year	group, t	Σ of farms	output, t		Cow population, head		Δ of population, cows a year, thousand head	Yield per head in group, dt
			average	%	average	Share		
2011	Less than 100	1516	27.8	2.6 %	13.9	5.1 %	-4.98	19.9
2012		1381	27.0	2.1 %	13.3	4.5 %	-4.52	20.3
2011	101 – 500	848	250.9	13.0 %	94.3	19.5 %	-7.81	26.6
2012		785	254.6	11.2 %	89.2	17.6 %	-6.53	28.5
2011	501-1000	401	714.1	17.5 %	211.8	20.7 %	1.18	33.7
2012		367	727.9	15.0 %	194.8	18.1 %	-1.60	37.4
2011	1001-2500	316	1577.7	30.5 %	362.7	27.9 %	2.33	43.5
2012		330	1555.1	28.8 %	330.1	27.6 %	1.98	47.1
2011	2501-5000	108	3392.9	22.4 %	635.4	16.7 %	0.86	53.4
2012		121	3326.2	22.6 %	571.7	17.5 %	-1.61	58.2
2011	5001-10000	29	6177.6	11.0 %	1059.0	7.5 %	1.23	58.3
2012		45	6348.7	16.0 %	948.3	10.8 %	3.93	66.9
2011	over 10001	4	12477.5	3.1 %	2707.0	2.6 %	1.23	46.1
2012		6	12605.4	4.2 %	2519.5	3.8 %	0.56	50.0
2011	Total	3222	507.5	100.0 %	127.5	100.0 %	-5.95	39.8
2012		3035	586.9	100.0 %	131.7	100.0 %	-7.78	44.6

Source: AgriSurvey (2013)

In 2012, economic efficiency of milk production at agroholdings decreased as compared to 2011 as well as compared to independent agricultural enterprises. The main reason behind this development was a sharp decline of farm-gate prices. According to official statistics, farm-gate prices decreased by 12.5 % while production cost grew by 5.3 % in 2012. As a result, average profitability of milk production dropped from 18.5 % down to 2.3 %. However, most specialized farms managed to maintain positive profitability of milk production.

Table 7: Productivity of milk production at agroholdings and independent enterprises, 2012

	Agroholdings		Independent enterprises	
	Average	TOP-5*	Average	Large farms (>5 thousand t a year)
Gross milk yield, dt/head	50,41	58,54	44,20	64,52
Production cost, UAH/dt	261	210	236	232
Full cost, UAH/dt	282	226	260	261
Production cost per 1 head, UAH thousand	13,01	12,28	10,43	14,95
Sales price, UAH/dt	278	284	270	284
Production profitability, %	6,5	35,4	14,5	22,5
Full profitability, %	-1,5	25,5	3,9	8,7
Income per head of dairy herd, UAH	-200	3270	405	1357

Source: AgriSurvey (2013),
*In terms of profitability

4 PRODUCTIVITY, EFFICIENCY AND PROFITABILITY OF DAIRY AND CROP FARMS

In order to analyze recent productivity developments of agroholding farms and independent agricultural enterprises, we apply efficiency and productivity analyses based on a sample of farm-level accounting data of agricultural enterprises which are specialized in crop and/or dairy farming and were provided by State Statistics Service of Ukraine. The dataset covers the years 2008 to 2012 and has been cleaned by excluding outliers. Moreover, prices have been deflated to exclude price effects. After presenting the data and data preparation in section 4.1, section 4.2 analyses on the one hand general trends of productivity and efficiency developments and tries to separate drivers of total factor productivity change in efficiency change and technical change. In section 4.3, the drivers of the developments are analyzed in more detail by focusing on the determinants of efficiency and productivity of agricultural enterprises.

4.1 Data base

Sample and data cleaning description

The farm data available for the technical efficiency and the total factor productivity analyses contains a total of 2058 observations of Ukrainian farms of various legal forms and sizes for a five-year unbalanced panel of 2008-2012 and total of 1170 observations for a balanced panel of the same period. Agroholding farms represent 24 % and 21 % of the total number of farms in the samples, respectively. The numbers of observations in the final samples were obtained after a rigorous cleaning of the original sample of 2857 observations (cf. Table 8). The objective of the data cleaning was (i) to obtain a data set that is appropriate for an efficiency analysis of crop and milk production and (ii) to eliminate observations with unreliable data values or other extreme values in a number of ratio indicators. The selected partial indicators were thus chosen to depict outlying performance reporting and extreme structural farm characteristics. Two standard data cleaning procedures were combined in order to obtain a suitable and reliable data set - histogram analysis and three standard deviations threshold procedure. In the final stage of the data cleaning, super efficiency values were used to eliminate observations with extreme performances (i.e. maximum super efficiencies should not exceed a value of 1.5). The number and share of observations eliminated in each step of the data cleaning is reported in Table 8 (list of ratio indicators used for outlier identification

and the number of outliers in each indicator are presented in Table A-1 and Table A-2 in the Appendix).

Table 8: Results of data cleaning

	2008	2009	2010	2011	2012	2008-12
Total number of observations in the original database	625	594	583	547	508	2857
Number of outlying observations (in one or more ratio indicators)	151	139	152	126	132	700
Share of outliers in total number of observations	0.24	0.23	0.26	0.23	0.26	0.25
Excluded due to missing values or deviating specialization	9	8	8	12	9	46
Ebservations excluded due to very high super efficiency (>1.5)	17	13	4	15	4	53
Total number of excluded observations	177	160	164	153	145	799
Share of exclusions compared to the original database	0.28	0.27	0.28	0.28	0.29	0.28
Number of observations after cleaning - unbalanced panel	**448**	**434**	**419**	**394**	**363**	**2058**
Number of observations after cleaning - balanced panel	**234**	**234**	**234**	**234**	**234**	**1170**
Representation of Agroholding farms (Ahf)						
Number of Ahf in total number of observations (before cleaning)	172	141	130	122	118	683
Share of Ahf in total number of observations (before cleaning)	0.28	0.24	0.22	0.22	0.23	0.24
Number of Ahf in total number of observations (after cleaning)	126	101	98	85	77	487
Share of Ahf in total number of observations (after cleaning)	0.28	0.23	0.23	0.22	0.21	0.24
Number of Ahf in balanced panel (after cleaning)	48	48	48	48	48	48
Share of Ahf in balanced panel (after cleaning)	0.21	0.21	0.21	0.21	0.21	0.21

Compared to the sectorial review presented in the first part of the report, the farms in the sample are mainly farms specialized in crop production (90 % of the total production value is on average generated by crop production). There are no farms specialized in milk production. On average, milk production in farms producing milk represents 15 % of total production value. The maximum share of milk production value in total production value corresponds to 50 %.

Methodology and variables

Technical efficiency is estimated using a standard Data Envelopment Analysis (DEA) method that represents a non-parametric, linear programming-based approach. The model is specified as a multiple output - multiple input problem (see Table 9 for varia-

bles description), and assumes output-oriented optimization with constant returns to scale. The analysis is carried out on balanced as well as unbalanced panel data[9] for 2008-2012 with respect to individual years' frontiers. The disadvantage of the method is its limitation in controlling for data (measurement) errors and effects of differences in production conditions (e.g., land quality). Therefore, the data cleaning was carried out before the analysis. Advantage of the method is its relative simplicity and the lacking need of a priory assumptions on the statistical distribution of the technical efficiency scores and the error term.

Table 9: Summary statistics of variables for DEA model, averages 2008-2012

DEA model variables - unbalanced panel	Obs	Mean	Std. Dev.	Min	Max
Crop production value (tsd UAH) *)	2056	21098	70567	21	1100000
Milk production value (tsd UAH) *)	653	5507	15041	1	188548
Value of other animal production (tsd UAH) *)	1052	3572	14240	5	201697
Labor units (persons)	2058	133	430	1	7792
Total land (ha)	2058	4929	13470	29	156426
Material costs and depreciations (tsd UAH)	2058	14514	49223	18	717768
From that - depreciation	2058	804	2769	0	54879
- material cost (without services)	2058	10622	36515	0	534076
- services	2058	3089	13067	0	201267
DEA model variables - balanced panel					
Crop production value (tsd UAH) *)	1170	22339	71645	340	1100000
Milk production value (tsd UAH) *)	363	7415	18440	11	188548
Value of other animal production (tsd UAH) *)	530	4791	17918	12	201697
Labor units (persons)	1170	147	501	1	7792
Total land (ha)	1170	4827	13014	255	147753
Material costs and depreciations (tsd UAH)	1170	15334	50590	170	575747
From that - depreciation	1170	855	2830	0	38526
- material cost (without services)	1170	11391	39182	85	534076
- services	1170	3088	11839	0	201267

Note: All monetary values are expressed in nominal values.
*) The number of observations and statistics in the table refer to observations with non-zero values.

The DEA model includes three output and three input variables. Output variables are represented by crop production, milk and other animal production values. The production value is derived from production sales values.[10] This approach thus considers the

[9] The balanced panel consists of farms for which data for all years is available. The unbalanced panel also includes farm observations of farms for which not for every year data was available.

[10] Net sales scaled by the share of production cost of produced production to production cost of sold production.

real sales prices in aggregating the farms' production values. Such a measure has the benefit of possibly reflecting differences in product quality as well as the technical ability to produce. Among the three input variables, two are expressed in natural values (quantities) - land in number of hectares and labor in number of employed persons in the given year. The third input variable represents a sum of material costs and depreciations as an indicator of capital costs. These two input categories are pooled together into one variable as a significant share of material cost is represented by services provided by third parties. Such services do not entail purely provision of material, but also their application that reduces the need for own machinery, equipment or other capital (it could explain, why some of the farms display zero depreciations). This joint variable is expressed in nominal monetary terms. The use of nominal values in the DEA model is possible, since technical efficiency scores were derived with respect to production frontiers specific to each year. Tables 10 to 12 provide main statistics for the listed DEA variables in total for the years 2008-2012, different groupings (by years, regions and farm type categories) as well as for balanced and unbalanced panel.

Despite great variability in farm sizes represented in the sample, average farm size with respect to used land area is ca. 4900 ha. Average Ukrainian farm size is some 2100 to 2300 ha. Accordingly, the data selection and data cleaning affected the representativeness. Partly, this may be explained by the fact that the focus of this analysis is on crop and milk production. As indicated in Table 10, farms in the sample demonstrate further tendencies of land acquisition and farm growth. At the same time, they have been further decreasing the number of employees per hectares of land. The significant increase of production value is closely related to the development of agricultural output prices, but it also depicts yield growth of some commodities such as milk. As for expenses for material and capital, the farms are characterized by very low value for depreciations. It corresponds to ca 5 % of total costs, while material costs (incl. services) represent ca. 65 % of total costs. More than 20 % of all material costs result from services provided by external parties.

Specific attention in this study is paid to the differences between agroholding and independent farms. Agroholding farms represent 24 % of all observations. Comparison of output and input variables between independent and agroholding farms (Table 12) reveals that agroholding farms in the sample are on average more than seven times larger than independent farms. This can be explained by the fact that several agroholdings

are organized in very large units. Furthermore, agroholding farms are more specialized in crop production than independent farms. These two types of farms also significantly differ in their input structure. Agroholding farms have a lower share of depreciations in total costs than independent farms. In addition, agroholding farms are found to use services from external parties more extensively than independent farms. More on structural differences will be provided in the next section.

Table 10: Summary statistics (nominal values) of variables for DEA model for individual years 2008-2012

DEA model variables - unbalanced panel	2008			2009			2010			2011			2012		
	Obs.	**Mean**	Std. Dev.	Obs.	**Mean**	Std. Dev.	Obs.	**Mean**	Std. Dev.	Obs.	**Mean**	Std. Dev.	Obs.	**Mean**	Std. Dev.
		1253			**1456**			**1994**			**2872**			**3251**	
Crop production value (tsd UAH) *)	448	**4**	32233	433	**0**	45423	418	**9**	66245	394	**4**	95210	363	**5**	96385
Milk production value (tsd UAH) *)	163	**2851**	6401	139	**3309**	7879	126	**6128**	13863	117	**7913**	19430	108	**9012**	23798
Value of other animal production (tsd UAH) *)	252	**2765**	12717	228	**2831**	12203	212	**4013**	16529	191	**4214**	16301	170	**4470**	13335
Labor units (persons)	448	**134**	448	434	**126**	410	419	**137**	436	394	**134**	445	363	**131**	407
Total land (ha)	448	**4241**	10964	434	**4831**	12885	419	**5292**	15126	394	**5167**	14042	363	**5220**	14313
					1075			**1385**			**1848**			**2123**	
Material costs (tsd UAH)	448	**9844**	31877	434	**1**	33200	419	**4**	46982	394	**0**	61376	363	**3**	66701
From that - depreciation	448	**508**	2069	434	**770**	3450	419	**727**	2414	394	**935**	2832	363	**1156**	2892
- material cost (without services)								**1027**			**1327**			**1567**	
	448	**7282**	23699	434	**7773**	25779	419	**0**	34211	394	**3**	43982	363	**6**	50791
- services	448	**2054**	8273	434	**2209**	7719	419	**2857**	12135	394	**4271**	18602	363	**4402**	16223
DEA model variables - balanced panel															
		1295			**1506**			**1971**			**3076**			**3319**	
Crop production value (tsd UAH) *)	234	**1**	34199	234	**0**	44644	234	**8**	57625	234	**9**	100359	234	**4**	94125
											1014			**1096**	
Milk production value (tsd UAH) *)	76	**4018**	8747	75	**4861**	10355	73	**7608**	16035	70	**7**	23070	69	**0**	27500
Value of other animal production (tsd UAH) *)	107	**4880**	19180	107	**4474**	17232	107	**4869**	20326	108	**5424**	20703	101	**4271**	9814
Labor units (persons)	234	**156**	578	234	**152**	535	234	**149**	494	234	**147**	494	234	**132**	385
Total land (ha)	234	**4663**	13336	234	**4776**	12834	234	**4767**	12512	234	**4905**	12777	234	**5025**	13687
Material costs and depreciations (tsd UAH)		**1031**			**1218**			**1386**			**1924**			**2106**	
	234	**0**	34703	234	**3**	40076	234	**8**	44659	234	**2**	60877	234	**7**	65147
From that - depreciation	234	**613**	2686	234	**778**	2863	234	**788**	2780	234	**1054**	3356	234	**1041**	2373
- material cost (without services)								**1035**			**1410**			**1561**	
	234	**7784**	27544	234	**9087**	32067	234	**9**	33816	234	**6**	45720	234	**6**	51352
- services	234	**1912**	6661	234	**2318**	8383	234	**2721**	9509	234	**4082**	16104	234	**4409**	15297

*) The number of observations and statistics in the table refers to observations with non-zero values. For the derivation of technical efficiency scores, these were replaced with zeros.

Table 11: Summary statistics of variables for crop farms and farms producing milk, 2008-2012

DEA model variables - unbalanced panel	Crop farms			Milk producing farms		
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Crop production value (tsd UAH) *)	996	**11767**	29942	651	**40445**	115659
Milk production value (tsd UAH) *)	0			653	**5507**	15041
Value of other animal production (tsd UAH) *)	0			646	**5232**	17775
Labor unit (persons)	996	**45**	81	653	**304**	721
Total land (ha)	996	**3215**	9061	653	**8305**	19879
Material (incl. services) and depreciations (tsd UAH)	996	**6863**	15269	653	**29954**	81916
From that - depreciation	996	**498**	1958	653	**1357**	3921
- material cost (without services)	996	**4858**	11842	653	**22296**	60674
- services	996	**1507**	4124	653	**6302**	21916
DEA model variables - balanced panel						
Crop production value (tsd UAH) *)	638	**9830**	16243	363	**50290**	122048
Milk production value (tsd UAH) *)	0			363	**7415**	18440
Value of other animal production (tsd UAH) *)	0			362	**6729**	21411
Labor unit (persons)	638	**39**	41	363	**383**	852
Total land (ha)	638	**2433**	2506	363	**10216**	22170
Material (incl. services) and depreciations (tsd UAH)	638	**5742**	9945	363	**36801**	85969
From that - depreciation	638	**419**	831	363	**1819**	4802
- material cost (without services)	638	**3891**	5474	363	**28047**	67005
- services	638	**1432**	4387	363	**6935**	19847

Table 12: Summary statistics of variables for agroholding and independent farms, 2008-2012

DEA model variables - unbalanced panel	Independent farms			Agroholding farms		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Crop production value (tsd UAH) *)	1569	**8409**	14585	487	**61980**	134817
Milk production value (tsd UAH) *)	469	**2195**	3769	184	**13949**	25882
Value of other animal production (tsd UAH) *)	813	**1371**	2921	240	**11013**	28119
Labor unit (persons)	1571	**63**	92	487	**358**	829
Total land (ha)	1571	**2349**	2956	487	**13253**	25472
Material cost and depreciations (tsd UAH)	1571	**5454**	9453	487	**43739**	94048
From that - depreciation	1571	**427**	1039	487	**2020**	5199
- material cost (without services)	1571	**4178**	7302	487	**31408**	70029
- services	1571	**850**	1824	487	**10311**	25367
DEA model variables - balanced panel						
Crop production value (tsd UAH) *)	930	**8022**	9861	240	**77818**	144361
Milk production value (tsd UAH) *)	265	**2680**	3994	98	**20221**	31601
Value of other animal production (tsd UAH) *)	418	**1447**	1811	112	**17270**	36311
Labor unit (persons)	930	**61**	78	240	**482**	1030
Total land (ha)	930	**2215**	2221	240	**14950**	26073
Material cost and depreciations (tsd UAH)	930	**5075**	6226	240	**55089**	101839
From that - depreciation	930	**392**	686	240	**2650**	5768
- material cost (without services)	930	**3952**	5018	240	**40215**	79760
- services	930	**731**	1145	240	**12224**	23981

4.2 Development of total factor productivity

The analysis of total factor productivity (TFP) change reveals only an insignificant productivity change during the analyzed period 2008-2012 (see Table 13). The annual changes, however, display distinct fluctuations in the TFP between the individual years (Figure 8). This development is influenced mainly by changes in technical efficiency in crop production. On average, 90 % of the total production value in the sample is generated by crop production and even most dairy farms achieve significant shares of their revenues from sales of crop production (on average some 85 %). Thus the TFP changes for the whole sample and for crop farms show analogical trends, though TFP changes are less pronounced for dairy farms. In particularly, the TFP changes closely mirror the average yield changes of main crops that are largely influenced by weather conditions. Figure 9 shows particularly for 2012 high regional yield differences which explain the particularly high efficiency drop in 2012. As poor weather conditions affect particularly the last years, one may nevertheless assume that there is a positive trend in total factor productivity.

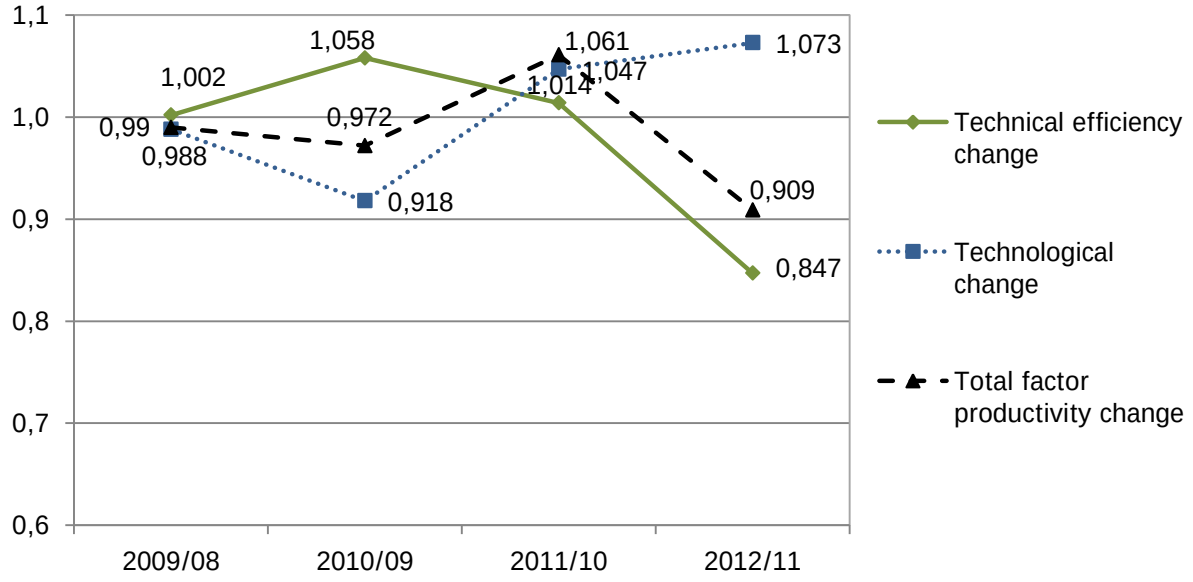
Table 13: Total factor productivity (TFP) and profitability change, 2008-2012

year	Nr. obs.	Efficiency change	Technical change	Pure tech. efficiency change	Scale efficien-cy change	TFP change	Profita-bility change
Whole sample							
2009/08	234	1.002	0.988	1.012	0.989	0.990	0.817
2010/09	234	1.058	0.918	1.041	1.016	0.972	1.689
2011/10	234	1.014	1.047	1.008	1.006	1.061	1.217
2012/11	234	0.847	1.073	0.860	0.985	0.909	0.801
mean	*936*	*0.977*	*1.005*	*0.978*	*0.999*	*0.981*	*1.077*
Crop farms (100 % crop production)							
2009/08	127	0.996	0.991	1.011	0.985	0.987	0.749
2010/09	126	1.101	0.861	1.085	1.015	0.948	2.077
2011/10	126	1.009	1.106	1.011	0.998	1.116	1.138
2012/11	132	0.808	1.090	0.805	1.003	0.880	0.734
mean	*511*	*0.972*	*1.007*	*0.972*	*1.001*	*0.979*	*1.068*
Milk producing farms (share of milk production > 0 %)							
2009/08	75	1.022	0.968	1.023	0.998	0.989	0.788
2010/09	73	1.007	1.072	0.991	1.016	1.080	1.439
2011/10	70	1.030	0.949	1.002	1.029	0.978	1.377
2012/11	69	0.904	1.018	0.954	0.947	0.920	0.777
mean	*287*	*0.989*	*1.001*	*0.992*	*0.997*	*0.990*	*1.050*

Note: The values are geometric means of individual farm values.

The annual weather effects, however, cannot fully explain the considerable swings between technical efficiency and technical progress in the analyzed period. Figure 8 illustrates that the gap between efficiency and technical change is particularly large in two periods, namely 2010/2009 and 2012/11. The TFP change between 2009 and 2010 is determined by a significant increase in technical efficiency and simultaneously a technological drop. This suggests that the performance differences between farms markedly decreased as the 'best' farms in the sample did not exceed the performance of other farms to the level of 2009. The efficiency and technical changes between 2011 and 2012 show the opposite development, i.e., the performance differences between farms significantly increased.

Figure 8: Average annual technical efficiency, technological and total factor productivity changes, whole sample - balanced panel, 2008-2012.



Note: The annual average changes correspond to geometric means of the individual farms' changes in the respective indicators between years.

Figure 9: Regional development in winter wheat yields (dt/ha), 2008-2012 (balanced panel).

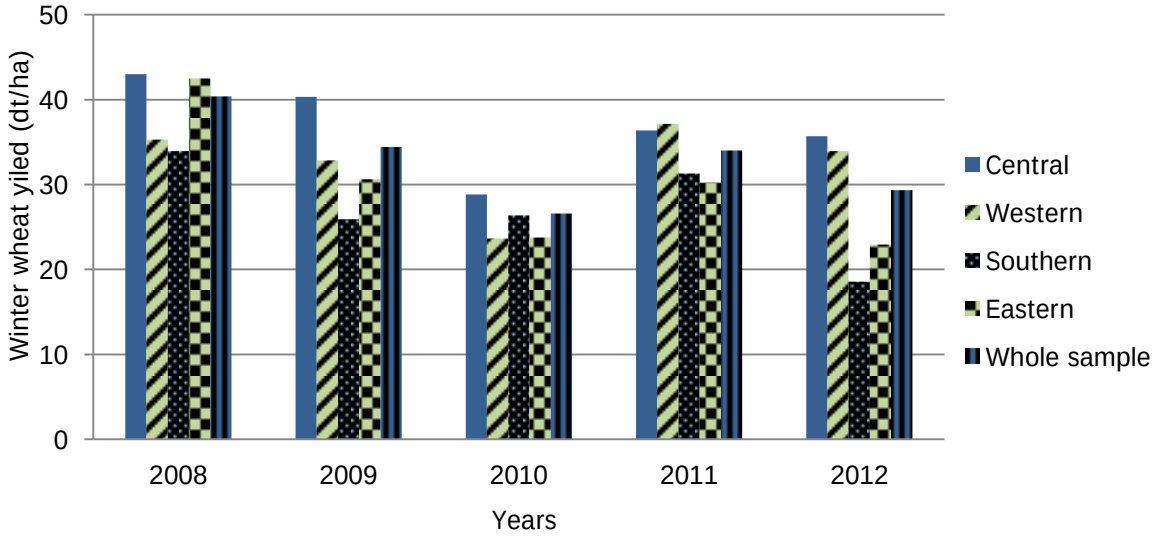


Table 14 shows technological differences between farms with higher and lower TFP change scores and their development over time. The two-group mean-comparison test reveals that

farms with greater TFP change compared to farms with lower TFP change are more profitable. Moreover, they significantly differ in characteristics such as capital intensity, use of material (variable inputs) and the share of services in material cost.[11] In more recent years, TFP change is positively affected by higher intensities, i.e. by the use of higher investment in capital (machinery) and material costs (direct/variable inputs) and the use of services. This is particularly true for 2012. On the other hand, a high share of material and capital cost in crop production cost is related to a less positive TFP change. This may indicate that a higher use of materials increases TFP only if also complementary inputs are used at appropriate levels as well. Interestingly, these factors are not labor and land, as the two groups show little differences in labor costs and rental prices.[12] More important seem to be costs for services which are higher for farms with a positive TFP change. One explanation may be that costs for labor and land are still quite low compared to other costs. The share of both cost categories together is still less than 20 % of total production costs and even smaller than the average profitability rate.

Within the group of better performing farms, the share of agroholding farms is on average higher than in the other group. The numbers shown in Table 16 support this finding. Accordingly, agroholding farms had on average a significantly higher TFP change. The main driver of this effect has to be seen in a positive efficiency change and less in a technical change. This has to be understood in the sense that underperforming agroholding farms were better able to catch up towards the productivity of the most productive farms than independent farms. One explanation for this development could be that agroholdings support underperforming farms by investments, intensification or restructuring. Another explanation could be that agroholdings grow mainly by the acquisition of poorly performing farms. These farms are however not immediately be more efficient after the acquisition. The improvement of their efficiency takes time. Accordingly, efficiency increases seem to be less important than effects resulting from technical change. I.e., the most productive

[11] Please note that farms with greater TFP change have on average higher technical efficiency scores, greater crop yields and higher profitability.

[12] An exception are rental prices in 2012. On the one hand, this may be caused by the fact that the drought in 2012 particularly affected the regions in the south and east which anyway have lower yield levels (cf. Figure 9). On the other hand, this may be caused by the increasing competition for land resulting from booming food prices since the second half of 2010.

agroholding farms could only slightly increase their productivity level. Correlation fields presented in Chapter 3, demonstrate that only a minor gap exists between average and optimal productivity indicators. This underscores that it is to some extent senseless for agricultural enterprises to increase productivity as this will lower profitability. Thus, at a relatively low level of fixed costs (e.g. rent payments, if compared with developed countries), optimal productivity is also lower.

The increases in TFP of agroholding farms can mainly be attributed to specialized crop farms. For farms with milk production there is no significant difference between agroholding and independent farms in TFP change. This can either be understood in the way that agroholdings particularly focused on improving the efficiency of crop production or that they were less successful in improving the productivity of dairy production. The latter is in accordance with Table 7 which shows that milk production of agroholding farms was on average not profitable. Obviously, there are still significant deficits in most dairy farms.

Table 14: Comparison of selected structural characteristics of farms with lower and higher TFP change values, 2008-2012

	Number of observations		Farm groups mean value		Two-group mean comparison test	
	TFP change values ≤ median	TFP change values > median	TFP change values ≤ median	TFP change values > median	t-value	Prob.
Production value (price adjusted) (tsd UAH)	**468**	**468**	**17003**	**23630**	**-1.611**	**0.054**
2009	117	117	17252	17962	-0.100	0.460
2010	117	117	15452	19844	-0.625	0.266
2011	117	117	21316	24907	-0.365	0.358
2012	117	117	13993	31803	-2.059	0.020
Profitability	**468**	**468**	**0.140**	**0.293**	**-7.838**	**0.000**
2009	117	117	0.083	0.189	-2.990	0.002
2010	117	117	0.169	0.289	-3.083	0.001
2011	117	117	0.181	0.378	-4.693	0.000
2012	117	117	0.129	0.318	-5.060	0.000
Total production cost per hectare of land *)	**468**	**468**	**3.524**	**3.756**	**-1.830**	**0.034**
2009	117	117	2.618	2.515	0.579	0.282
2010	117	117	3.046	3.181	-0.671	0.251
2011	117	117	4.245	3.969	1.127	0.131
2012	117	117	4.187	5.357	-4.417	0.000
Material cost + depreciations per in crop prod. (nomin. values) per ha of arable land *)	**467**	**466**	**2.116**	**2.286**	**-2.116**	**0.017**
2009	117	117	1.573	1.462	1.054	0.147
2010	117	117	1.938	1.697	2.030	0.022
2011	117	116	2.512	2.629	-0.738	0.231
2012	116	116	2.442	3.369	-5.457	0.000
Labor cost in crop prod (nomin. values) per ha of arable land *)	**467**	**465**	**0.273**	**0.274**	**-0.0745**	**0.470**
2009	117	117	0.216	0.213	0.164	0.435
2010	117	117	0.242	0.256	-0.613	0.270
2011	117	116	0.325	0.295	1.140	0.128
2012	116	116	0.311	0.335	-0.875	0.191

	Number of observations		Farm groups mean value		Two-group mean comparison test	
	TFP change values ≤ median	TFP change values > median	TFP change values ≤ median	TFP change values > median	t-value	Prob.
Share of material cost + depreciations in crop prod in crop prod. costs	**468**	**468**	**0.788**	**0.731**	**5.333**	**0.000**
2009	117	117	0.782	0.711	3.473	0.000
2010	117	117	0.799	0.702	4.349	0.000
2011	117	117	0.784	0.763	1.026	0.153
2012	117	117	0.787	0.746	1.823	0.035
Share of services in total material costs	**468**	**468**	**0.165**	**0.175**	**-1.237**	**0.108**
2009	117	117	0.176	0.162	0.704	0.241
2010	117	117	0.164	0.176	-0.762	0.224
2011	117	117	0.176	0.176	0.037	0.485
2012	117	117	0.144	0.188	-2.693	0.004
Land rent per ha of land *)	**468**	**468**	**0.389**	**0.411**	**-1.318**	**0.094**
2009	117	117	0.254	0.260	-0.342	0.366
2010	117	117	0.328	0.317	0.498	0.309
2011	117	117	0.395	0.410	-0.537	0.296
2012	117	117	0.580	0.658	-1.872	0.031
Share of agroholding farms	**468**	**468**	**0.190**	**0.220**	**-**	**-**
2009	117	117	0.205	0.205	-	-
2010	117	117	0.162	0.248	-	-
2011	117	117	0.214	0.197	-	-
2012	117	117	0.179	0.231	-	-

Note: The grouping of farms into the two groups of farms with lower and higher TFP change values is based on median value of TFP change. The grouping is done for each year separately.

Table 15: Two-group mean-comparison test of TFP, efficiency and technical change differences between independent and agroholding farms.

Indicators	Time period	Number of observations		Mean		Diff. [(mean 0)- (mean *)]	Pr(|T|>|t|) or Pr(|T|<|t|)
		Independent farms	Agroholding farms	Independent farms (mean 0)	Agroholding farms (mean*)		
Full sample							
TFP change	2009/2008	186	48	1.037	1.010	0.026	0.309
	2010/2009	186	48	0.974	1.149	**-0.175**	**0.000**
	2011/2010	186	48	1.104	1.087	0.017	0.367
	2012/2011	186	48	0.928	1.094	**-0.167**	**0.003**
	Mean	744	192	1.011	1.085	**-0.075**	**0.003**
Efficiency change	2009/2008	186	48	1.031	1.089	-0.058	0.132
	2010/2009	186	48	1.051	1.271	**-0.220**	**0.000**
	2011/2010	186	48	1.066	0.982	**0.084**	**0.028**
	2012/2011	186	48	0.870	0.959	**-0.088**	**0.031**
	Mean	744	192	1.005	1.075	**-0.071**	**0.003**
Technical change	2009/2008	186	48	1.008	0.929	**0.079**	**0.000**
	2010/2009	186	48	0.934	0.912	0.022	0.198
	2011/2010	186	48	1.040	1.110	**-0.070**	**0.000**
	2012/2011	186	48	1.072	1.111	**-0.039**	**0.028**
	Mean	744	192	1.013	1.016	-0.002	0.416
Subsample - crop farms (100 % crop production)							
TFP change	2009/2008	102	25	1.044	1.044	0.001	0.498
	2010/2009	101	25	0.931	1.249	**-0.318**	**0.000**
	2011/2010	101	25	1.168	1.154	0.014	0.429
	2012/2011	105	27	0.905	1.118	**-0.213**	**0.011**
	Mean	409	102	1.011	1.141	**-0.130**	**0.001**
Efficiency change	2009/2008	102	25	1.032	1.142	**-0.110**	**0.100**
	2010/2009	101	25	1.077	1.465	**-0.387**	**0.000**
	2011/2010	101	25	1.069	0.990	0.079	0.130
	2012/2011	105	27	0.839	0.939	**-0.099**	**0.082**
	Mean	409	102	1.003	1.130	**-0.127**	**0.001**
Technical change	2009/2008	102	25	1.016	0.917	**0.099**	**0.000**
	2010/2009	101	25	0.867	0.848	**0.019**	**0.078**
	2011/2010	101	25	1.098	1.167	**-0.068**	**0.002**
	2012/2011	105	27	1.085	1.151	**-0.065**	**0.020**

Indicators	Time period	Number of observations		Mean		Diff. [(mean 0)- (mean *)]	Pr(|T|>|t|) or Pr(|T|<|t|)
		Independent farms	Agroholding farms	Independent farms (mean 0)	Agroholding farms (mean*)		
	Mean	409	102	1.017	1.023	-0.006	0.361
Subsample - milk producing farms (milk production > 0 % of total production values)							
TFP change	2009/2008	55	20	1.021	0.995	0.026	0.334
	2010/2009	53	20	1.112	1.083	0.029	0.324
	2011/2010	50	20	0.978	1.047	-0.068	0.101
	2012/2011	50	19	0.940	0.959	-0.019	0.382
	Mean	208	79	1.014	1.022	-0.007	0.407
Efficiency change	2009/2008	55	20	1.045	1.047	-0.002	0.488
	2010/2009	53	20	1.006	1.070	-0.064	0.110
	2011/2010	50	20	1.063	1.014	0.049	0.177
	2012/2011	50	19	0.929	0.916	0.014	0.406
	Mean	208	79	1.012	1.013	-0.001	0.482
Technical change	2009/2008	55	20	0.977	0.950	**0.027**	**0.053**
	2010/2009	53	20	1.114	1.015	**0.099**	**0.021**
	2011/2010	50	20	0.925	1.035	**-0.111**	**0.000**
	2012/2011	50	19	1.012	1.044	**-0.032**	**0.067**
	Mean	208	79	1.008	1.011	-0.003	0.430

4.3 Technical efficiency results of crop and animal production

The analysis of total factor productivity in section 4.2 led to the conclusion that during the time period 2008 to 2012 there were some fluctuations in total factor productivity but no significant increase. Neither the agricultural enterprises benefited on average significantly from technical change nor from increases in efficiency. However, the analysis showed also that there was a substantial heterogeneity among farms. For instance, farms with a higher intensity and particularly agroholding farms managed to increase their productivity.

Sample average results and development over time

The estimated technical efficiencies indicate that there are significant differences in technical performance among Ukrainian farms (Tables 16 and 17). The average score of 0.64

in Table 16 implies that, in the period of 2008-2012, farms in the sample had on average the potential to increase their production by 56 % using the same level of inputs.[13] This ratio, however, also includes performance differences originating from differences in production conditions. Therefore, it is not explicit, how much more production could have been achieved by improving farms' technical and managerial practices. The development of technical efficiency scores shows fluctuations in technical performance differences among farms between individual years. Since there is no clear trend, the fluctuations unlikely represent systematic changes in managerial practices, but rather changing production conditions such as weather effects. The development of technical efficiency levels shows considerable drops in 2009 and 2012. This can be explained by substantial regional yield differences which affect indirectly the relative efficiency scores.

Tables 16 and 17 further reveal that, over the years 2008-2012, farms in the sample achieved on average a profitability of crop and animal production of almost 20 %. The profitability developments reflect besides average annual yield changes also input and output price developments. For instance in 2010, yields dropped significantly while profitability increased as result of increasing output prices. There are, however, significant differences in profitability between production lines. Crop production was profitable over the whole time period, although significant fluctuations occurred. Milk production was on average profitable, nevertheless, in 2009 and 2012, it was connected to losses. In 2009, dairy farms may have suffered from the financial crisis and a drop in milk prices. In 2012 Russia imposed a ban on Ukrainian dairy products.

Despite the illustrated yield and profitability fluctuations, the farms show systematic productivity improvements. These are apparent on partial performance measures that are not affected by the price development or weather-related production conditions. For instance, milk yields show steadily increasing tendencies over the five years.

[13] The slightly higher value of technical efficiency for balanced panel can result from measuring technical efficiency to lesser observations, however, as profitability results suggest, the farms that remained in the sample over the whole period of the five years are actually slightly better performing farms.

Table 16: Mean values of technical efficiency, profitability and partial productivity indicators, 2008-2012 (unbalanced panel)*

	Obs.	2008-12	2008	2009	2010	2011	2012
Technical efficiency	2058	0.640	0.622	0.638	0.667	0.672	0.598
Profitability (crop and animal production)	2058	0.176	0.131	0.092	0.206	0.267	0.199
Profitability of crop production	2058	0.234	0.197	0.136	0.270	0.331	0.250
Profitability of animal production	1070	-0.121	-0.107	-0.122	-0.136	-0.107	-0.136
Profitability of milk production	653	0.021	0.002	-0.058	0.103	0.096	-0.028
Milk yield (kg/cow)	671	3541	3068	3546	3555	3732	4024
Winter wheat yield (dt/ha)	1951	32.9	40.1	33.8	26.7	33.2	29.0
Winter barley yield (dt/ha)	840	28.2	34.7	31.3	23.4	27.6	23.7
Summer barley yield (dt/ha)	1580	25.2	32.5	24.0	19.1	23.6	24.6
Crop production yield (dt/ha)	2048	3.734	2.784	2.607	3.448	4.912	5.312
Arable land/labor in crop production (ha/employee)	2047	69.7	61.0	70.9	73.4	70.3	74.0
Total production value/labor unit (tsd UAH/employee)	2058	208	132	148	196	278	312
Crop prod. value/labor in crop prod. (tsd UAH/employee)	1963	281	329	243	286	231	313
Animal prod. value/labor in animal prod. (tsd UAH/employee)	1056	71	50	56	71	90	100
Milk prod. value/labor cost in milk prod. (tsd UAH/employee)	651	5.756	5.108	4.946	6.553	6.817	5.717

Table 17: Mean values of technical efficiency, profitability and partial productivity indicators, 2008-2012 (balanced panel)*

	Obs.	2008-12	2008	2009	2010	2011	2012
Technical efficiency	1170	0.674	0.666	0.660	0.704	0.704	0.634
Profitability (crop and animal production)	1170	0.207	0.166	0.136	0.229	0.279	0.224
Profitability of crop production	1170	0.265	0.232	0.174	0.290	0.350	0.278
Profitability of animal production	535	-0.088	-0.054	-0.058	-0.101	-0.098	-0.130
Profitability of milk production	363	0.020	0.013	-0.048	0.098	0.088	-0.049
Milk yield (kg/cow)	367	3751	31.82	36.86	37.65	39.10	42.66
Winter wheat yield (dt/ha)	1141	33.0	40.4	34.4	26.6	34.0	29.3
Winter barley yield (dt/ha)	484	28.5	35.0	31.7	23.0	28.3	25.2
Summer barley yield (dt/ha)	961	25.3	32.5	24.0	19.6	24.5	24.7
Crop production yield (dt/ha)	1167	3.884	2.685	2.648	3.465	5.048	5.592
Arable land/labor in crop production (ha/employee)	1167	64.6	59.2	65.7	64.9	65.6	67.9
Total production value/labor unit (tsd UAH/employee)	1170	211	131	144	188	281	309
Crop prod. value/labor in crop prod. (tsd UAH/employee)	1118	257	300	219	324	205	234
Animal prod. value/labor in animal prod. (tsd UAH/employee)	529	78	58	61	74	96	104
Milk prod. value/labor cost in milk prod. (tsd UAH/employee)	363	5.899	5.263	5.150	6.760	6.755	5.635

Note: Profitability denotes profits from sold production (net sales - full costs of sold production) to costs of sold production.

Comparison between agroholding and independent farms

In order to compare independent and agroholding farms with respect to technical efficiency as well as regarding several partial performance indicators such as yields of selected commodities, labor productivity, farm-level profitability and farm-level profitability of main products, two-group mean comparison tests are applied and tested regarding statistical significances of the differences. Figures are presented in Tables 18 to 20.

According to Table 18, there is no significant difference in efficiency between individual enterprises and farms belonging to agroholdings. Looking at the different years, the differences are only for 2011 in favor of individual enterprises. According to Table 18, agroholding farms achieve nevertheless significantly higher yields than independent farms for crop production as well as for milk production. Besides these partial productivities, agroholding farms also achieve higher labor productivities than independent farms. According to Table 19, independent farms are found to farm with higher labor intensity and have higher labor costs compared to output. This is mainly due to a higher number of labor units per hectare of land. The volume of labor cost per hectare of arable land does however not differ significantly because agroholding farms pay on average significantly higher wages than independent farms.

Different results than for land and labor productivity, however, are found regarding the joint productivity of material and capital (depreciation value). Agroholding farms display a significantly lower ratio of production value to the sum of material and capital costs. There are however differences between crop and animal production. In animal production, agroholding farms achieve better results, while in crop production, which dominates the production, individual farms show higher productivity of capital and material costs. These counteracting partial productivities may jointly explain the small differences in technical efficiency between agroholding and independent farms.

Table 18 shows moreover for agroholding farms a significantly lower profitability. This profitability gap relates mainly to profitability differences of crop production, while they are smaller but also significant for animal production. The explanation for these discrepancies may be that a higher intensity does not always payoff. One reason may be found in unexpectedly poor weather conditions which classify farms with intensity levels appropriate for optimistic expectations in an ex post perspective as allocatively inefficient. Another reason might be that higher intensities may not payoff immediately. For instance, a new production strategy causes learning costs. Such rather dynamic effects

may explain why according to Table 18 the efficiency and particularly the productivity differences between agroholding and individual enterprises declined sbstantially between 2008 and 2012.

To elaborate on the deviations for the results on technical efficiency and profitability, Table 19 presents further coefficients. The comparison of input-use practices indicates - as mentioned before - that agroholding farms produce with a significantly higher cost intensity than independent farms. Agroholding farms apply materials such as fertilizers, pesticides and other agricultural chemicals or feed with significantly higher intensities per hectare or cow. On the other hand, independent farms seem to use significantly more capital per hectare than agroholding farms which is indicated by higher depreciations. Despite of the higher absolute costs for material costs and depreciation per ha in agroholding enterprises, the share of these costs compared to total costs is lower for agroholding enterprises than for individual enterprises. Obviously, agroholding farms are even more cost intensive in other input categories. Indeed, agroholding enterprises report markedly higher costs for services which replaces partly the use of own machinery. Further factors that may contribute to agroholding farms' production costs is the significantly higher rental price for land and a significantly higher volume of 'other' costs per hectare of land.

Overall, the higher production intensity of agroholding farms contributes to a higher absolute productivity (yields), while their specific input structure (in combination with respective input prices) increases their total costs even more and lowers their profitability. The later observation again suggests that there are either certain allocative inefficiencies specific to agroholding farms (i.e., higher cost resulting from non-optimal input use with respect to prices) or that certain benefits of these higher intensities emerge rather in future periods. The latter point is also supported by the fact that in recent years the agroholding farms generate a significantly higher value added (cf. Table 20). The increased value-added is however only partly translated in higher profits. The costs for land increase as well and particularly for agroholding farms.

The fact that the higher variable input use and the different input structure are specific to agroholding enterprises suggests that farm integration in holdings facilitates better access to production inputs. However, profitability figures as well as input structures differ among enterprises of each group and are subject to the enterprises' respectively

the individual holdings' strategies. Particularly, the strongly increasing land costs suggest that particularly some agroholdings apply aggressive growth strategies.

According to Table 20, the profitability level on the enterprise level is significantly higher for crop production than for milk production. This applies to both types of enterprises but particularly for holding enterprises and which may be explained by the fact that many enterprises have own elevators and storage capacities. Holding farms achieved on the enterprise level between 2008 and 2012 an average profit of 730 UAH/ha while it was just 283 UAH/ha with agricultural production. For the individual enterprises these figures are 855 UAH/ha respectively 563 UAH/ha. The differences between agricultural profitability and total profitability increased between 2008 and 2012 particularly for agroholding enterprises. In 2012, agroholding enterprises achieved even a profit per ha which was 284 UAH/ha higher than that of individual enterprises while it was 230 UAH/ha lower in 2008.

The generally increased profitability figures raise several questions. One question is whether they are sufficient to ensure a further successful development of the enterprises. This is particularly relevant given the high price and yield volatilities as well as the difficulties of the Ukrainian banking system and the high costs of finance. Another question is how the profitability relates to the general value-added. Therefore, Table 20 allows comparing the total value added as well as the enterprises spendings for land rents and wages. Accordingly, only some 50 % of the value added is paid for wages and land together. While rental costs increased by some 300 % between 2008 and 2012, labor costs increased only by some 30 %. As a consequence of these increases, individual enterprises spent in 2012 22 % more for land rentals than for wages. Agroholding enterprises paid even 85 % more for land than for labor.

Given that most Ukrainian farm land is still owned by small private landowners which live in rural villages, these figures lead to the hypothesis that earnings from renting out land to agricultural enterprises may be more important for the rural populations than income from employment on agricultural enterprises. It may be worth to test this hypothesis in more detail and to study also potential implications. Especially, this makes sense in view of the fact that there are about 6.5 million owners of land shares in Ukraine and 4.5 million of them rent their shares out. At the same time, the number of hired workers in agricultural enterprises is only 700 thousand as according to the official statistics.

The same applies to the finding that particularly in recent years individual and agroholding enterprises achieved profits which were substantially higher than the farms' spendings for rentals and wages together. Particularly interesting would be to answer the question what happens with the profits of individual and agroholding enterprises and which share remains in the rural areas and is reinvested in agricultural production.

Table 18: Comparison of mean values of technical efficiency, profitability of agricultural production and partial productivity indicators between independent farms and agroholding farms, averages 2008-2012 (unbalanced panel)

	Number of observations		**Mean value**		Two-group mean comparison test	
	Independ. farms	Agrohold. members	**Independ. farms**	**Agrohold. farms**	t-value	Prob.
Technical efficiency	1571	487	**0.643**	**0.631**	1.245	0.107
Technical efficiency (only 2008)	322	126	**0.628**	**0.607**	1.067	0.143
Technical efficiency (only 2009)	333	101	**0.638**	**0.639**	-0.071	0.472
Technical efficiency (only 2010)	321	98	**0.668**	**0.660**	0.384	0.351
Technical efficiency (only 2011)	309	85	**0.680**	**0.644**	1.572	0.058
Technical efficiency (only 2012)	286	77	**0.596**	**0.606**	-0.363	0.358
Profitability rate of crop and animal production	1571	487	**0.166**	**0.080**	6.930	0.000
Profitability rate of crop production	1571	487	**0.449**	**0.307**	7.019	0.000
Profitability rate of animal production	830	247	**-0.039**	**0.009**	-2.014	0.022
Profitability rate of milk production	488	183	**0.097**	**0.166**	-2.204	0.014
Profit (production) per ha (tsd. UAH/ha)	1571	487	**0.563**	**0.283**	5.303	0.000
Profit (prod.) per ha (only 2008) (tsd. UAH/ha)	322	126	**0.310**	**0.003**	4.602	0.000
Profit (prod.) per ha (only 2009) (tsd. UAH/ha)	333	101	**0.237**	**-0.029**	3.685	0.001
Profit (prod.) per ha (only 2010) (tsd. UAH/ha)	321	98	**0.542**	**0.317**	2.190	0.015
Profit (prod.) per ha (only 2011) (tsd. UAH/ha)	309	85	**0.915**	**0.643**	1.776	0.038
Profit (prod.) per ha (only 2012) (tsd. UAH/ha)	286	77	**0.872**	**0.712**	0.921	0.179
Milk yield (dt/cow)	490	181	**33.366**	**40.956**	-6.325	0.000
Winter wheat yield (dt/ha)	1483	468	**30.971**	**38.830**	-11.853	0.000
Summer wheat yield (dt/ha)	289	65	**22.851**	**25.646**	-1.798	0.037
Winter barley yield (dt/ha)	690	150	**27.257**	**32.324**	-4.966	0.000
Summer barley yield (dt/ha)	1209	371	**24.052**	**28.849**	-7.422	0.000

	Number of observations		**Mean value**		Two-group mean comparison test	
	Independ. farms	Agrohold. members	**Independ. farms**	**Agrohold. farms**	t-value	Prob.
Crop production yield (tsd. UAH/ha)	1562	486	**3.518**	**4.427**	-7.417	0.000
Arable land/labor in crop production	927	240	**65.593**	**60.909**	1.573	0.058
Total production value/labor (tsd. UAH/employee)	1571	487	**194.594**	**252.023**	-6.398	0.000
Crop prod. value/labor in crop prod. (tsd. UAH/employee)	1496	467	**215.438**	**489.676**	-6.338	0.000
Animal prod. value/labor in animal prod. (tsd. UAH/employee)	814	242	**68.537**	**78.992**	-2.596	0.005
Milk prod. value/labor cost in milk prod. (tsd. UAH/employee)	467	184	**5.581**	**6.200**	-3.390	0.000
Total prod. value/(material cost + deprec.)	1571	487	**1.878**	**1.675**	7.272	0.000
Crop prod. value/(material cost + deprec. in crop prod.)	1569	487	**1.976**	**1.725**	7.898	0.000
Animal prod. value/(material cost + deprec. in animal prod.)	818	235	**1.427**	**1.522**	-2.460	0.007
Milk prod. value/(material cost + deprec. in milk prod.)	469	184	**1.771**	**1.776**	-0.118	0.453

Note: The results of two-group mean comparison test are partially affected by fixed effects, i.e. the same observations occurring several times in the sample due to using panel data. However, when significant differences were found for the whole panel, significant differences still remained, at least in most of the years, when tested for individual years.

Table 19: Comparison of mean values of farm characteristics between independent and agroholding farms, averages 2008-2012 (unbalanced panel)

	Number of observations		**Mean value**		Two-group mean comparison test	
	Independ. farms	Agrohold. members	**Independ. farms**	**Agro-hold. farms**	t-value	Prob.
Share of crop production in total production value	1571	487	**0.886**	**0.911**	-2.899	0.002
Share of milk production in animal production value	818	244	**0.299**	**0.425**	-5.831	0.000
Total costs per hectare (tsd UAH/ha)	1571	487	**3.080**	**4.056**	-9.695	0.000
Share of *material and capital costs* in total costs	1571	487	**0.697**	**0.714**	-3.271	0.001
Share of crop production-related *material and capital costs* in total crop production costs	1569	487	**0.760**	**0.791**	-3.432	0.000
Share of animal production-related *material and capital costs* in total animal production costs	833	238	**0.746**	**0.698**	1.008	0.157
Share of milk production-related *material and capital costs* in total milk production costs	492	184	**0.666**	**0.669**	-0.266	0.395
Crop production-related *material and capital costs* per hectare of arable land (tsd. UAH/ha)	1562	486	**1.857**	**2.646**	-12.261	0.000
Milk production-related *material and capital costs* per milk cow (tsd. UAH/cow)	490	181	**4.361**	**5.623**	-5.459	0.000
Share of *material costs (excl. services)* in total production costs	1571	487	**0.540**	**0.506**	5.746	0.000
Share of crop production-related *material costs (excl. services)* in total crop production costs	1569	487	**0.573**	**0.546**	3.386	0.000
Share of milk production-related *material costs (excl. services)* in total milk production costs	492	184	**0.620**	**0.599**	2.220	0.013
Crop production-related *material costs (excl. services)* per hectare of arable land (tsd. UAH/ha)	1562	486	**1.377**	**1.803**	-9.332	0.000
Milk production-related *material costs (excl. services)* per milk cow (tsd. UAH/cow)	489	181	**4.047**	**4.973**	-4.449	0.000
Share of *depreciations* in total production costs	1415	473	**0.060**	**0.033**	10.325	0.000
Share of crop production-related *depreciations* in total crop production costs	1409	471	**0.070**	**0.038**	10.323	0.000

	Number of observations		**Mean value**		Two-group mean comparison test	
	Independ. farms	Agrohold. members	**Independ. farms**	**Agro-hold. farms**	t-value	Prob.
Crop production-related *depreciations* per hectare of arable land (tsd. UAH/ha)	1564	486	**0.157**	**0.122**	3.302	0.001
Milk production-related *depreciations* per milk cow (tsd. UAH/cow)	409	171	**0.218**	**0.347**	-3.949	0.000
Share of *services* in total production costs	1571	487	**0.104**	**0.177**	-13.218	0.000
Share of crop production-related *services* in total crop production costs	1569	487	**0.125**	**0.209**	-12.363	0.000
Share of milk production-related *services* in total milk production costs	480	184	**0.021**	**0.034**	-3.771	0.000
Crop production-related *services* per hectare of arable land (tsd. UAH/ha)	1562	486	**0.323**	**0.721**	-15.287	0.000
Milk production-related *services* per milk cow (tsd. UAH/cow)	490	181	**0.733**	**1.106**	-1.804	0.036
Share of *labor costs* in total production costs	1568	487	**0.112**	**0.081**	10.088	0.000
Share of crop production-related *labor costs* in total crop production costs	1565	487	**0.109**	**0.079**	9.347	0.000
Share of milk production-related *labor costs* in total milk production costs	486	181	**0.238**	**0.215**	3.141	0.001
Crop production-related *labor costs* per hectare of arable land (tsd. UAH/ha)	1558	486	**0.257**	**0.250**	0.572	0.284
Number of employees in crop production per hectare of arable land (employees/ha)	1561	486	**0.023**	**0.020**	1.934	0.027
Milk production-related *labor costs* per milk cow (tsd. UAH/cow)	486	181	**1.425**	**1.664**	-3.768	0.000
Labor costs per employee (without social payments) (tsd. UAH)	1571	487	**12.602**	**13.731**	-3.032	0.001
Land rental price per ha	1571	487	**0.310**	**0.387**	-6.350	0.000
Share of *other (unspecified) costs* in total costs	1568	487	**0.078**	**0.101**	-6.694	0.000
Other (unspecified) costs per hectare of land (tsd. UAH/ha)	1568	487	**0.249**	**0.427**	-10.258	0.000

Table 20: Comparison of evolution of enterprise level profitability and value added between independent and agroholding farms

	Unbalanced panel					Balanced panel				
	No. of observations		Mean value		Significance	No. of observations		Mean value		Significance
	Independ. farms	Agrohold. members	**Indepen. farms**	**Agrohold. farms**	Prob.	Independ. farms.	Agrohold. members	**Indepen. farms**	**Agrohold. farms**	Prob.
Profit rate	1571	487	**0.212**	**0.060**	0.000	930	240	**0.184**	**0.109**	0.000
Profit rate (only 2008)	322	126	**0.186**	**0.048**	0.000	186	48	**0.205**	**0.077**	0.001
Profit rate (only 2009)	333	101	**0.115**	**-0.020**	0.000	186	48	**0.156**	**-0.018**	0.000
Profit rate (only 2010)	321	98	**0.170**	**0.129**	0.061	186	48	**0.168**	**0.184**	0.323
Profit rate (only 2011)	309	85	**0.231**	**0.150**	0.001	186	48	**0.247**	**0.164**	0.003
Profit rate (only 2012)	286	77	**0.130**	**0.125**	0.437	186	48	**0.143**	**0.140**	0.464
Profit per ha (tsd. UAH/ha)	1571	487	**0.855**	**0.730**	0.030	930	240	**0.893**	**0.979**	0.167
Profit per ha (only 2008) (tsd. UAH/ha)	322	126	**0.611**	**0.381**	0.008	186	48	**0.642**	**0.460**	0.084
Profit per ha (only 2009) (tsd. UAH/ha)	333	101	**0.453**	**0.206**	0.003	186	48	**0.509**	**0.246**	0.012
Profit per ha (only 2010) (tsd. UAH/ha)	321	98	**0.786**	**0.733**	0.334	186	48	**0.714**	**0.985**	0.035
Profit per ha (only 2011) (tsd. UAH/ha)	309	85	**1.355**	**1.244**	0.280	186	48	**1.387**	**1.568**	0.212
Profit per ha (only 2012) (tsd. UAH/ha)	286	77	**1.134**	**1.418**	0.098	186	48	**1.211**	**1.636**	0.063
Value added per ha (tsd. UAH/ha)	1571	487	**1.509**	**1.451**	0.217	930	240	**1.579**	**1.789**	0.019
Value added per ha (only 2008) (tsd. UAH/ha)	322	126	**1.058**	**0.956**	0.162	186	48	**1.090**	**1.004**	0.275

	Unbalanced panel					Balanced panel				
	No. of observations		Mean value		Significance	No. of observations		Mean value		Significance
	Independ. farms	Agrohold. members	**Independ. farms**	**Agrohold. farms**	Prob.	Independ. farms.	Agrohold. members	**Independ. farms**	**Agrohold. farms**	Prob.
Value added per ha (only 2009) (tsd. UAH/ha)	333	101	**0.970**	**0.768**	0.021	186	48	**1.052**	**0.826**	0.043
Value added per ha (only 2010) (tsd. UAH/ha)	321	98	**1.421**	**1.375**	0.368	186	48	**1.357**	**1.729**	0.011
Value added per ha (only 2011) (tsd. UAH/ha)	309	85	**2.094**	**2.103**	0.483	186	48	**2.158**	**2.556**	0.049
Value added per ha (only 2012) (tsd. UAH/ha)	286	77	**2.115**	**2.535**	0.041	186	48	**2.236**	**2.830**	0.029
Land rental costs (tsd. UAH/ha)	1571	487	**0.310**	**0.387**	0.000	930	240	**0.336**	**0.446**	0.000
Land rental costs (only 2008) (tsd. UAH/ha)	322	126	**0.173**	**0.251**	0.000	186	48	**0.181**	**0.241**	0.000
Land rental costs (only 2009) (tsd. UAH/ha)	333	101	**0.233**	**0.285**	0.002	186	48	**0.250**	**0.285**	0.034
Land rental costs (only 2010) (tsd. UAH/ha)	321	98	**0.290**	**0.343**	0.004	186	48	**0.303**	**0.398**	0.000
Land rental costs (only 2011) (tsd. UAH/ha)	309	85	**0.344**	**0.456**	0.000	186	48	**0.372**	**0.522**	0.000
Land rental costs (only 2012) (tsd. UAH/ha)	286	77	**0.540**	**0.723**	0.000	186	48	**0.576**	**0.786**	0.000
Labor costs per ha (tsd. UAH/ha)	1571	487	**0.344**	**0.334**	0.252	930	240	**0.350**	**0.364**	0.255
Labor costs per ha (only 2008) (tsd. UAH/ha)	322	126	**0.273**	**0.323**	0.018	186	48	**0.267**	**0.302**	0.172
Labor costs per ha (only 2009) (tsd. UAH/ha)	333	101	**0.284**	**0.278**	0.421	186	48	**0.294**	**0.295**	0.485
Labor costs per ha (only 2010) (tsd. UAH/ha)	321	98	**0.345**	**0.299**	0.110	186	48	**0.340**	**0.347**	0.443

	Unbalanced panel					Balanced panel				
	No. of observations		**Mean value**		Significance	No. of observations		**Mean value**		Significance
	Independ. farms	Agrohold. members	**Independ. farms**	**Agrohold. farms**	Prob.	Independ. farms.	Agrohold. members	**Independ. farms**	**Agrohold. farms**	Prob.
Labor costs per ha (only 2011) (tsd. UAH/ha)	309	85	**0.396**	**0.402**	0.440	186	48	**0.400**	**0.466**	0.095
Labor costs per ha (only 2012) (tsd. UAH/ha)	286	77	**0.440**	**0.394**	0.155	186	48	**0.448**	**0.409**	0.233

Farm level determinants of technical efficiency and profitability

Method and variables

In this section, previously discussed technical efficiency scores and farm-level profitability measures are regressed upon a number of variables that may contribute to the explanation of technical efficiency and profitability variation among farms. The explanatory variables take account of several structural farm characteristics such as size, specialization or vertical integration in a holding company, input use intensity, but also subsidies and value added tax received by farms. The regression analysis considers also a number of control variables such as year or regional dummies (cf. Table 21) and is based on the unbalanced panel data for 2008-2012. Technical efficiency scores are measured with respect to the individual years' frontiers. Different from the technical efficiency measures presented in the previous section, super efficiency scores[14] are considered as this represents a more normally distributed dependent variable and allows to apply Ordinary Least Square (OLS) estimation method.

[14] Technical efficiency measures take on values between 0 and 1 with 1 representing fully technically efficient farms. The super-efficiency measure allows values larger than 1. It measures the maximal radial change in outputs for an observation to remain efficient, i.e. how much can the outputs be decreased and remain technically efficient.

Table 21: Description of explanatory variables in regression analyses of technical efficiency and profitability determinants

Variable	Description
log_totalprodvalue	Log of total production (mil UAH) (farm size proxy)
animprod_dv	Animal production dummy (production specialization proxy)
shareanimprod_totprod	Share of animal production in total production (production specialization proxy)
milkprod_dv	Milk production dummy (production specialization proxy)
sharemilkprod_animprod	Share of milk production in animal production (production specialization proxy)
subsidies_totcost	Share of subsidies in total costs
vat_totprod	Share of VAT in total production value
log_landrent	Log of land rent paid for ha (tsd UAH) (proxy for input quality)
log_unitlaborcost	Log of labor cost per employed person (tsd UAH/employee) (proxy for input quality)
log_depreciation_ha	Log of depreciations per hectare (capital intensity proxy) (tsd UAH/ha)
log_services_ha	Log of services (from external parties) per hectare (tsd UAH/ha)
log_material_ha	Log of material cost per hectare (variable input use intensity proxy) (tsd UAH/ha)
td2009	Time dummy - 2009, year 2009 = 1, otherwise 0
td2010	Time dummy - 2010, year 2010 = 1, otherwise 0
td2011	Time dummy - 2011, year 2011 = 1, otherwise 0
td2012	Time dummy - 2012, year 2012 = 1, otherwise 0, i.e. year 2008 represents the basis year
central_dv	Regional dummy - Central region = 1, otherwise 0
western_dv	Regional dummy - Western region = 1, otherwise 0
southern_dv	Regional dummy - Southern region = 1, otherwise 0
ah	Agroholding farm dummy, agroholding farms = 1, independent farms = 0.
mother_comp#	Agroholding mother company dummy (mother company nr. 15 represents the basis)

Note: Variables that are in absolute terms are log transformed as this increases the goodness-of-fit significantly.

The models presented below may suffer from endogeneity (selection bias related to agroholdings) and fixed effect biases, which refers to the fact that more than one observation (up to five) represent the same decision making unit, i.e. the observations are not independent from each other. The possible selection bias is difficult to control for with available data, particularly without any dynamics and information on decision for farms' integration to holding companies. The fixed effect is partially controlled for by incorporating dummy variables for groups of observations such as agroholding versus independent farms, agroholding farms' mother companies or regional dummies.

Results

The goodness-of-fit statistics in Table 22 imply that the parameters with respect to the chosen explanatory variables contribute jointly on a highly significant level to the explanation of both technical efficiency and profitability measures. As the R^2 statistics reveal, these regressors have a stronger explanatory power in explaining variation of technical efficiency than profitability. Hence, the variation of profitability remains to a larger share unexplained by the model than technical efficiency.

The parameter estimate with respect to farm size [log_totalprodvalue] has a positive impact on both performance indicators. This means that increasing farm size improves technical efficiency as well as it leads to higher profitability. The next four variables (animal production dummy [animprod_dv], share of animal production in total production [shareanimprod_totprod], milk production dummy [milkprod_dv] and share of milk production in animal production [sharemilkprod_animprod]) depict the effect of production specialization. The parameter estimates suggest that a higher share of animal production in total production value negatively affects farm profitability.[15] This closely corresponds to the previous section's finding that that animal production is much less profitable than crop production. In the technical efficiency model, the specialization variables have to be interpreted rather as control variables.[16] The farm group comparison, however, is not influenced by the specification of the multi-output specification of the production frontier. Therefore, an interesting result is that, with increasing share of animal production in total production value, agroholding farms are more profitable than independent farms. This observation may be explained in a way that agroholding farms are either more selective in their engagement in animal production ore that they are better able to manage animal production successfully.

Next three parameters in each model regard the effect of input-use intensity - concretely the intensity of capital, services and material use per hectare of land

[15] Analogical regressions for milk production profitability revealed that the share of milk production in animal production has a positive effect on milk production profitability. Also, farms with higher share of generated animal production value attain higher milk yields; this increases with the share of milk production in the animal production value. Regression analysis of winter wheat yield implied that the larger the share of animal production in total production value, the lower the winter wheat yield. In other words, farms specialized in crop production achieve higher crop productivity. These results thus suggest that specialization affects productivity.

[16] The reason for that is that technical efficiency is measured with respect to the share of each output. Therefore, the technical efficiency scores are not comparable between specializations.

[log_depreciations_ha, log_services_ha, log_material_ha]. The estimates imply that the higher the use of capital per hectare of land the higher technical efficiency as well as profitability. This suggests that investments in assets cause higher productivity as well as financial benefits. It indicates undercapitalization of Ukrainian farms which might be closely related to the state of the credit market which is characterized by high interest rates and constrained access to credit. The intensity of services use per hectare, on the other hand, has a negative effect on technical efficiency as well as on profitability. This, however, does not necessarily reflect the productive effect of services, but possibly the effect of service prices (which are not separable from service quantities[17]) or the fact that the production is based on services rather than on own investments. Furthermore, material use intensity has only an insignificant effect on technical efficiency. However, there is a significant difference in the material use effectiveness between independent and agroholding farms: agroholding farms use material more effectively. With regard to profitability, however, material use intensity has a significant negative effect. This negative profitability effect could be related to the high correlation between material use intensity and labor cost per hectare (over 0.60), i.e. it may be correlated to animal production.

[17] Noteworthy, third-party services are often provided untimely, which has a negative effect on productivity.

Table 22: Parameter estimates of regression model of farm technical efficiency and profitability determinants, 2008-2012 (unbalanced panel)

	Technical efficiency			Profitability		
	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
log_totalprodvalue	**0.155**	0.010	0.000	**0.232**	0.017	0.000
animprod_dv	-0.006	0.013	0.619	**-0.041**	0.022	0.062
shareanimprod_totprod	**0.621**	0.044	0.000	**-0.460**	0.075	0.000
milkprod_dv	**-0.081**	0.027	0.003	0.042	0.047	0.361
sharemilkprod_animprod	0.040	0.046	0.385	-0.078	0.079	0.321
log_depreciation_ha	**0.009**	0.005	0.061	**0.026**	0.008	0.002
log_services_ha	**-0.012**	0.005	0.010	**-0.023**	0.008	0.003
log_material_ha	-0.027	0.019	0.150	**-0.181**	0.032	0.000
log_material_ha*log_depreciation_ha	**0.010**	0.005	0.067	**-0.020**	0.009	0.024
log_material_ha*log_services_ha	**0.022**	0.006	0.000	0.002	0.010	0.853
log_unitlaborcost	0.005	0.011	0.619	**-0.080**	0.018	0.000
log_landrent	**-0.102**	0.009	0.000	**-0.172**	0.015	0.000
ah	0.005	0.110	0.964	-0.277	0.188	0.140
ah* animprod_dv	-0.013	0.029	0.657	0.005	0.050	0.916
ah* shareanimprod_totprod	-0.119	0.110	0.277	**0.363**	0.186	0.052
ah* milkprod_dv	0.010	0.066	0.883	-0.084	0.113	0.460
ah* sharemilkprod_animprod	-0.009	0.095	0.928	0.078	0.162	0.628
ah* log_totalprodvalue	0.018	0.020	0.366	-0.009	0.035	0.785
ah*log_depreciation_ha	-0.011	0.009	0.201	-0.007	0.015	0.629
ah*log_services_ha	-0.001	0.012	0.937	-0.023	0.020	0.238
ah*log_material_ha	**0.074**	0.027	0.005	0.063	0.045	0.165
ah*log_landrent	**-0.034**	0.019	0.078	-0.024	0.033	0.462
ah*log_unitlaborcost	0.014	0.017	0.438	**0.066**	0.030	0.027
subsidies_totcost	-1.009	0.758	0.183	-1.386	1.290	0.283
vat_totprod	-0.301	1.163	0.796	0.287	1.980	0.885
subsidies_totcost*animprod_dv	0.123	0.952	0.897	2.167	1.620	0.181
subsi-dies_totcost*shareanimprod_totprod	**7.902**	4.605	0.086	-3.515	7.839	0.654
vat_totprod*animprod_dv	3.407	2.509	0.175	5.881	4.271	0.169
vat_totprod*shareanimprod_totprod	-13.533	9.334	0.147	-14.587	15.888	0.359
Constant	**0.937**	0.051	0.000	**1.125**	0.087	0.000
Nr. Observations	1712			1712		
Prob > F	0.000			0.000		
R-squared	0.453			0.302		
Adjusted R-squared	0.430			0.274		

Note: For the lucidity of the table, time dummies, regional dummies and all their interaction terms (with the dummy variable for agroholding farms as well as between each other) are not displayed. Parameters with respect to both time dummies as well as regional dummy variables imply statistically significant differences in technical efficiency and profitability between years as

well as regions (see previous section for the discussion of these differences). Also parameters for the mother company dummies are not presented for the same reason. These are jointly highly (1 % significance level) statistically significant in both models. The number of obserations used in the regression analysis is lower than number of observation for the whole unbalanced panel since some of the explanatory variables contained missing values.

The next two parameters in the technical efficiency model address the interaction terms between material use and capital use intensity as well as material use and services use intensity [log_material_ha*log_depreciation_ha, log_material_ha*log_services_ha]. These parameters indicate that material cost intensity has a positive effect on technical efficiency when combined with increasing capital and services use intensity. This suggests that an increased material use needs simultaneously investments in better application technologies. In the profitability model, only the effect of the interaction term between material and capital use intensity is statistically significant, however, negative. It implies that increasing use of material per ha decreases the profitability of capital use intensity.

The variable unit labor cost [unitlaborcost] was included among the regressors to control for possible labor quality differences among farms as well as effect of wages as a motivational instrument. Its effect on technical efficiency is found to be statistically indifferent from zero, however, it is statistically significant and negative in the profitability model. This suggests that higher wages are not adequately mirrored in labor productivity – the result which requires further proof but which leads to a preliminary conclusion that labor motivation is a smaller problem than the lack of relevant skills of most employees. The negative profitability effect of higher wages is however not significant for agroholding farms [ah*log_unitlaborcost].[18]

Similarly to unit labor costs, land rent costs [log_landrent] is integrated into the models to control for land quality. The expected positive relationship between land rent value and technical efficiency, which would suggest a positive land quality effect on farm efficiency scores is not confirmed. On contrary, the respective parameter estimate shows a

[18] In additional analyses, unit labor costs are found to have a positive impact on milk yields. At the same time, higher unit labor cost results also in a decrease of milk production profitability, which jointly suggests that the wage increase exceeds the production value generated by the higher wage. The productivity and profitability effect results jointly suggest that either higher wages work as an incentive mechanism for higher labor productivity (but only in more labor intensive productions), however, wages are set disproportionately in relation to productivity or that relatively better workers are paid disproportionately higher wages.

significant negative effect of land rent price on technical efficiency. The negative parameter with respect to land rent value on technical efficiency is found even to be significantly larger for agroholding farms than independent farms. The land rent value has also a significant negative effect on farm-level profitability. One explanation for these counterintuitive results could be that high rental prices are driven by aggressive farm growth which is not resulting immediately in equivalent higher outputs. To some extent, this is not surprising because the high profitability of grains (in the analyzed period) caused high competition for land plots. This competition resulted in higher rent payments even for plots of lower quality.

The dummy variable for farm integration in an agroholding [ah] was included into the model not only as a variable depicting a linear shift in the performance levels. It also occurs in interaction with several other variables to inform about possible differences in the effect of these variables between independent and agroholding farms. All parameters for ah variable and its interaction terms are jointly significant (at 5 % significance level in the technical efficiency model and at 1 % significance level in the profitability model), which suggests that farm integration in a holding has a significant effect on its technical efficiency as well as profitability. The individual parameter with respect to ah variable is, however, statistically insignificant. This suggests that the technical efficiency and profitability differences are to a significant degree captured by the effect of variables that were in the previous section found to distinguish agroholding farms from independent farms (such as higher material cost intensity and use of services, lower capital intensity or higher land rent prices and paid wages). These are also included the models and found significant in the explanation of technical efficiency and profitability variability.

Parameters with respect to the mother company dummy variables [mother_comp#] provide estimates of the effect of belonging to the same mother (holding) company. The results suggest that some mother companies have a significant effect on technical efficiency levels as well as profitability of their farms (joint test of significance of all dummy variables depicting mother companies suggests that the mother company-related fixed effect is statistically significant). Some mother companies have a significantly higher while others significantly lower effect on technical efficiency and profitability.

The last two variables of interest share of subsidies in total costs [subsidies_totcost] and share of VAT in total production value [vat_totprod] are included to estimate farm technical efficiency and profitability effects of state support to farms. It is worthwhile to mention that the parameter estimates do not depict information about the sectorial effect of these supports but only their contribution to the explanation of farms' variability in the two target variables - technical efficiency and profitability. The results imply that neither the farm differences in the share of subsidies in total costs nor in the share of VAT in total production value have a statistically significant effect on farm-level technical efficiency or profitability. However, subsidies are found to have an increasing positive effect on technical efficiency with increasing animal production in the farm production structure. This result suggest that state support matters for farm performance particularly when market conditions are less favorable (i.e., animal production was over the analyzed period the least profitable production specialization).

5 KEY FINDINGS AND POLICY RECOMMENDATIONS

The previous analyses identify significant productivity and efficiency deficits as well as indications on potential causes. The findings do not allow to differentiate in a black and white world. Rather the results suggest on the one hand that Ukrainian agriculture is still far away from being efficient, though there are some positive trends. The determinants of efficiency deficits as well as mechanisms for improvements are quite complex.

One general trend is that absolute productivity increases. This is particularly, but not solely driven by the growth of agroholdings. In general, agroholding farms achieve significantly higher yields in terms of produced crop per ha or milk per cow. These yield advantages of agroholding farms increased over time and amounted to up to 20 % in recent years. However, these higher yields went along with a significant increase in intensities and thus with higher costs. The analyses show that these higher intensities neither reduced yet in general the per unit cost nor increased the relative profitability of production. Rather, the analyses show that higher material use has to be supported by appropriate investments in assets, services and human capital. A more intensified production which exploits the potentials of Ukrainian agriculture requires appropriate access to financial means for medium and long term investments. Also indicators like profits per ha or cow lead to an unclear picture. On the one hand, these profits are not generally higher for farms with a high intensity. This is particularly true for many farms which belong to agroholdings. On the other hand, in recent years agroholding farms increased profitability significantly. Partly, this can be attributed to high world-market prices, particularly for crops. High product prices favor high-cost production strategies. Thus, if the downstream and upstream sectors of the agricultural value chain would improve their efficiency, this could result in higher prices for the farms and thus in higher profitability of higher intensities. The same logic applies to an improved political and institutional environment. If the macroeconomic, political and institutional deficits which are addressed in section 2.4 can be overcome, this would create strong additional incentives for Ukrainian farms to extend production and to contribute even more than now to economic growth.

Agroholding farms can be seen as more productive than independent enterprises in terms of output per input unit such as per ha, labor unit or cow. Moreover, there is a tendency that they generate a higher value-added. Nevertheless, they do not exhibit a significantly higher or lower efficiency than independent enterprises. Similar, though

with a small advantage of independent farms, applies to profitability. More important than the organizational differences are farm-specific characteristics, such as farm size (with a significant positive effect), specialization and intensity. The effects of these determinants are however changing over time. Particularly the recently increasing profitability and efficiency of agroholding farms are driven by dynamic effects of increasing intensities. I.e., the real benefits of growth, investments and higher intensities are time-lagged. Reasons for such dynamic effects of increasing intensities are initial adjustment costs and learning. This argument is supported by the finding that farm-level increases in total factor productivity are positively correlated with higher intensities as well as with profitability. This argument is also supported by the finding that agroholding farms increased total factor productivity by reducing technical inefficiency rather than by technical change. This indicates that particularly underperforming agroholding farms moved over time towards the production frontier. Accordingly, the real returns of increasing intensities are rather to be expected in the medium- and long-term than immediate. This suggests that farms need economic and institutional conditions which allow stable planning. In the end – and this is relevant for agroholdings as well as independent enterprises – the farms need financial means which enable long-term development.

Aside of these general findings, there are several rather specific results. One result is that animal production has a positive efficiency effect while it has at the same time a negative profitability effect. This efficiency effect can be related to the higher disposition of crop production to weather risks. Particularly, crop farms need to develop production strategies which allow to cope better with weather uncertainties. These strategies should not only address financial risks (e.g. through insurances and diversification) but also the production risk by applying yield stabilizing measures.

The negative profitability effect of animal production may also be related to the fact that even large animal producers are confronted with low market power while large crop farms benefit from relatively low land prices. This argument is supported by the fact that the average farms' profit (particularly that of crop farms) is quite substantial. The profits from crop and animal production were in recent years higher than labor and land costs. Total profits on the enterprise level were even larger than the land and the labor costs together. These levels of profits can partly be explained by the fact that the

analysis does not account for the farms' costs of finance, i.e. of debts and equity capital, as well as costs related the management of corruption.

In the more recent years, agroholding farms generated an increasing share of their profit outside crop and animal production. An important role can be seen in infrastructure investments such as increasing storage capacities which allowed for additional value-added by enabling the farms to sell their produce at periods with better prices. Such investments should be addressed as a relevant policy issue as they create additional value added for rural areas.

Despite of the relatively low land prices, in recent years on a per ha basis, the level of payments for labor was lower than that for land rentals. This applies particularly to agroholding farms which exhibit steadily and significantly increasing land rental costs while their labor costs increased only moderately and are on a similar level than those of independent enterprises. The increasing land costs are very likely driven by aggressive growth strategies of agroholding farms. As the above presented regression analysis shows that high rental prices are correlated with lower efficiency and lower profits, these additional rentals are obviously not leading immediately to a higher payoff. Adjustment and learning costs prevent immediately higher profits. Growth does only pay off in the longer run.

Given the increasing land rental costs and the fact that most of the rented land is owned by rural inhabitants, rural income from renting out the land may in the future be seen as probably more important than the income from employment in agricultural enterprises. This may change over time as a substantial portion of land shares is already in the ownership of successors of rural inhabitants who died. A considerable number of these successors live now in urban areas and, therefore, rental payments are paid to them and go to urban areas. Nevertheless, the still existing land sales moratorium secures the opportunity of the rural population to benefit from increasing agricultural productivity and value-added. Introducing the land sales market could have two problematic effects on rural income: the first issue is that particularly individuals under financial stress might sell their land under its real value. Most likely, a significant share of the land would be bought by either wealthy individuals and investment funds or by large farms and agroholdings with access to financial means. As a result, the potential benefits of a more prospering agricultural sector which most likely would be translated into increasing benefits from landownership may be lost for rural areas. The second

critical issue is that the opportunity to buy land at rather low prices would create strong incentives for agricultural enterprises to invest available financial means in land rather than to invest it into productivity enhancing measures. This effect becomes the more critical given the high interest rates and short lending terms within the Ukrainan financial system and the recently increased difficulties of even large enterprises and agroholdings to raise funds on the international financial market. However, further land reform is still unclear because the new government has not yet announced its policies in this regard. Most probably, legal persons, i.e. agricultural enterprises will be banned from buying farm land at the first stage of the reform. This might limit the abovementioned second effect to a certain extent.

Summarizing the findings of the above analyses, a further insight is that agroholdings may not be seen as a general solution to overcome the deficits of Ukrainian agriculture. Their current particular recent strength has rather to be seen in a better ability to deal with the existing deficits in the macroeconomic political and institutional environment of Ukrainian agriculture. In this environment, agroholdings contribute currently to the development of Ukrainian agriculture and thus of the Ukrainian economy. This contribution may even significantly increase in the future, particularly if agroholdings are able to further exploit their productivity and economic potentials. From the side of their shareholders and other stakeholders (particularly international lenders), there is a huge pressure to do so. Those, which are not performing are likely to fail. This creates certain societal risks. Until now, these risks are limited for at least two reasons. The first is that the above results indicate an increasing awareness within the agroholdings that economic performance is not just a question of size but rather a question of productivity. A second is that agroholdings which are in financial trouble are acquired by other holdings. As long as there are expectations by investors that agroholdings have positive prospects within Ukrainian agriculture and access to financial means, this kind of insurance continues to exist.

Repeatedly, political debates emerge whether the growth of agroholdings needs a stronger regulation such as the introduction of size limits. The key problem of such propositions is however that they do not provide alternatives for independent enterprises to overcome the existing deficits in the macroeconomic, institutional and political environment. As it is unlikely that these conditions will change soon and significantly, it

is more recommendable not to intervene in the structural developments. Rather, policy makers should focus on improving the agricultural business environment.

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Appendix

General distribution of land by type of land users is presented in Table below.

Table A - 1: Distribution of land by type of land users (as of 01.01.201*)

Type of land users	Amount of cultivated lands, thou ha
Agricultural enterprises/legal entities (total of lands being owned and used including agroholdings and agricultural enterprises) incl.	17,003,000
Non-state agricultural enterprises	15,936,500
State agricultural enterprises	1,064,900
Citizens who were granted the right of land ownership and use incl.	19,600,800
Family farms (also a type of legal entity but included into this section because the right of land ownership and use is granted to individual members of the farmer's family and the farmer oneself who are obviously citizens)	4,016,300
Land for agricultural commodity production	9,091,100
Subsistence farms	3,469,700
Lands for construction and maintenance of residential homes and commercial buildings (household plots)	1,376,000
Lands for gardening	182,100
Lands for horticulture	196,500
Land for haying and cattle grazing	1,261,900
Reserve lands and lands not granted for ownership and permanent use within settlements (which are not provided for temporary use)	4,340,500
Total lands	41,625,800

Source: State Agency for Land Resources of Ukraine

Note: The table does not contain some minor users, for example agricultural lands used by industrial, defense, housing maintenance and other enterprises.

Table A - 2: Overview of ratio indicators for data cleaning procedure and data exclusion threshold values

	2008			2009		2010		2011		2012	
	Thresh-hold based on histo-gram 2008-12	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold
Value of total production/total costs	4.00	2.47	3.00	2.40	3.00	2.47	3.00	2.59	3.00	2.47	3.00
Total costs/value of total production	3.00	2.12	2.20	2.18	2.20	2.13	2.20	2.05	2.20	2.12	2.20
Value of crop production/crop production costs	4.00	2.48	3.00	2.39	3.00	2.48	3.00	2.62	3.00	2.47	3.00
Crop prod costs/crop prod value	3.00	2.31	2.50	2.36	2.50	2.30	2.50	2.22	2.50	2.31	2.50
Value of animal production per animal pro-duction costs	2.50	2.13	2.50	2.12	2.50	2.10	2.50	2.18	2.50	2.11	2.50
Animal prod costs/anim prod value	3.00	2.73	2.80	2.75	2.80	2.77	2.80	2.68	2.80	2.76	2.80
Value of milk production per milk production costs	2.50	1.93	2.50	1.86	2.50	2.04	2.50	2.09	2.50	1.91	2.50
Milk prod costs/milk prod value	3.00	1.82	2.00	1.88	2.00	1.73	2.00	1.70	2.00	1.83	2.00
Yield of milk	80.00	68.77	70.00	74.24	75.00	75.59	76.00	76.60	77.00	80.91	81.00
cropprod/arable land	15.00	24.23	25.00	24.05	25.00	24.87	25.00	26.48	27.00	26.66	27.00
arable land/cropprod	2.50	2.04	2.50	2.07	2.50	1.95	2.00	1.84	2.00	1.83	2.00
total land/labor units	300.00	455.40	470.00	462.07	470.00	464.49	470.00	463.05	470.00	465.25	470.00
labor units/total land	0.20	0.27	0.45	0.27	0.45	0.27	0.45	0.27	0.45	0.27	0.45
arable land/labor units in crop prod	300.00	462.87	470.00	471.48	470.00	472.37	470.00	470.51	470.00	472.81	470.00
labor units in crop prod/arable land	0.10	0.44	0.45	0.44	0.45	0.44	0.45	0.44	0.45	0.44	0.45
total prod/total labor units	1000.00	1699.24	1700.00	1708.22	1750.00	1745.65	1800.00	1822.23	1850.00	1848.97	1900.00
total labor units/total prod	0.05	0.08	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.07	0.08
crop prod/labor in crop prod	700.00	1692.27	1500.00	1697.58	1600.00	1735.06	1700.00	1819.17	1800.00	1828.03	1900.00

	2008			2009		2010		2011		2012	
	Thresh-hold based on histo-gram 2008-12	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold
labor in crop prod/crop prod	0.06	0.21	0.20	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20
anim prod/labor in anim prod	400.00	260.71	280.00	270.62	300.00	281.75	320.00	301.15	340.00	314.12	360.00
labor in anim prod/anim prod	0.20	0.19	0.20	0.19	0.20	0.18	0.20	0.18	0.20	0.18	0.20

Table A - 3: Overview of ratio indicators for data cleaning procedure and data exclusion threshold values (continued)

	2008			2009		2010		2011		2012	
	Thresh-hold based on histo-gram 2008-12	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold
value of crop production/labor cost (in crop production) per value of crop production	100.00	150.80	150.00	149.07	150.00	152.26	150.00	155.44	160.00	154.46	160.00
labor cost (in crop production) per value of crop production	0.50	0.29	0.30	0.30	0.30	0.28	0.30	0.27	0.30	0.27	0.30
value of animal production/labor cost (in animal production) per	40.00	31.21	35.00	31.13	35.00	31.48	35.00	31.98	35.00	31.66	35.00
labor cost (in animal production) per value of animal production	1.00	0.86	1.00	0.86	1.00	0.85	1.00	0.83	1.00	0.84	1.00
milk prod/labor cost in milk prod	25.00	18.10	20.00	18.07	20.00	19.69	20.00	19.77	20.00	19.19	20.00
labor cost in milk prod/milk prod	1.00	0.57	0.60	0.57	0.60	0.51	0.60	0.50	0.60	0.52	0.60
Labor cost in milk production per cow head	5.00	3.12	3.20	3.33	3.40	3.58	3.60	3.91	3.80	4.04	4.00
cow heads/ Labor cost in milk production	5.00	3.36	3.40	3.16	3.20	3.00	3.00	2.86	2.90	2.81	2.80
total matcap/total value	2.00	1.45	1.60	1.46	1.60	1.41	1.60	1.38	1.60	1.43	1.60
total value/total matcap	5.00	3.82	4.00	3.79	4.00	3.92	4.00	4.03	4.00	3.89	4.00
matcapcrop/cropvalue	2.00	1.45	1.60	1.47	1.60	1.42	1.60	1.39	1.60	1.44	1.60
cropvalue/matcap in crop prod	6.00	4.00	5.00	3.95	5.00	4.10	5.00	4.21	5.00	4.04	5.00
matcapanim/animvalue	2.50	2.03	2.50	2.02	2.50	2.07	2.50	2.01	2.50	2.05	2.50
animvalue/matcap in anim prod	4.00	4.76	5.00	4.77	5.00	4.69	5.00	4.80	5.00	4.72	5.00
matcapamilk/milkvalue	2.00	1.31	1.35	1.35	1.35	1.24	1.35	1.22	1.35	1.33	1.35
milkvalue/matcap in milk prod	5.00	3.17	3.50	3.06	3.50	3.37	3.50	3.45	3.50	3.12	3.50
matcapcrop/arableland	7.00	9.00	9.00	8.92	9.00	9.17	9.20	9.95	10.00	10.20	10.20

		2008		2009		2010		2011		2012	
	Thresh-hold based on histo-gram 2008-12	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold	Thresh-hold (Median +3*std. dev)	Final threshold
arableland/matcap crop prod	3.50	6.66	6.70	6.70	6.70	6.57	6.60	6.35	6.40	6.31	6.30
matcapcrop/laborcrop	500.00	720.14	720.00	723.58	730.00	737.15	740.00	786.35	790.00	806.71	950.00
labor in crop prod/matcap crop prod	0.07	0.09	0.12	0.09	0.12	0.09	0.11	0.09	0.10	0.09	0.09
matcapanim/laboranim	250.00	211.35	210.00	217.12	220.00	228.55	230.00	240.17	240.00	253.22	280.00
labor in anim prod/matcap in anim prod	0.20	0.45	0.45	0.44	0.44	0.43	0.44	0.43	0.43	0.43	0.43

Table A - 4: Result of cleaning procedure: number of outliers in selected ratio indicators, 2008 2012

	Number of outliers				
	2008	2009	2010	2011	2012
Value of total production/total costs	7	4	8	10	6
Total costs/value of total production	15	7	10	9	13
Value of crop production/crop production costs	11	2	8	8	4
Crop prod costs/crop prod value	11	6	9	5	7
Value of animal production per animal production costs	0	5	4	7	6
Animal prod costs/anim prod value	14	5	12	16	16
Value of milk production per milk production costs	1	0	3	2	0
Milk prod costs/milk prod value	8	5	1	1	3
Yield of milk	3	0	3	2	2
Cropprod/arable land	8	6	5	10	6
Arable land/cropprod	9	10	18	7	6
Total land/labor units	4	10	11	9	8
Labor units/total land	13	17	17	16	12
Arable land/labor units in crop prod	8	9	11	7	8
Labor units in crop prod/arable land	6	8	6	6	7
Total prod/total labor units	4	5	7	9	11
Total labor units/total prod	10	7	11	10	3
Crop prod/labor in crop prod	4	5	7	8	11
Labor in crop prod/crop prod	6	10	9	5	5
Anim prod/labor in anim prod	13	16	16	20	19
Labor in anim prod/anim prod	16	7	4	6	6
Value of crop production/labor cost (in crop production) per value of crop production	6	11	11	12	14
Labor cost (in crop production) per value of crop production	16	19	13	9	12
Value of animal production/labor cost (in animal production) per	8	9	10	10	9
Labor cost (in animal production) per value of animal production	10	5	4	5	10
Milk prod/labor cost in milk prod	4	6	7	5	5
Labor cost in milk prod/milk prod	7	10	3	2	4
Labor cost in milk production per cow head	3	3	5	6	7
Cow heads/ Laborcost in milk production	12	13	13	8	5
Total matcap/total value	13	6	8	9	12
Total value/total matcap	12	12	15	12	8
Matcapcrop/cropvalue	16	8	5	6	11
Cropvalue/matcap in crop prod	6	5	11	7	4
Matcapanim/animvalue	6	2	6	10	9

	Number of outliers				
	2008	2009	2010	2011	2012
Animvalue/matcap in anim prod	7	11	8	9	7
Matcapamilk/milkvalue	8	6	2	1	4
Milkvalue/matcap in milk prod	6	3	11	6	1
Matcapcrop/arableland	11	9	6	12	17
Arableland/matcap crop prod	5	7	6	3	3
Matcapcrop/laborcrop	9	10	14	17	18
Labor in crop prod/matcap crop prod	13	12	17	9	5
Matcapanim/laboranim	13	12	16	17	18
Labor in anim prod/matcap in anim prod	16	15	7	8	4

Table A - 5: Summary statistics of variables for DEA model for main geographic regions, 2008-2012

DEA model variables - unbalanced panel	Central region			Eastern region			Southern region			Western region		
	Obs	**Mean**	Std. Dev.	Obs	**Mean**	Std. Dev.	Obs	**Mean**	Std. Dev.	Obs	**Mean**	Std. Dev.
Crop production value (tsd UAH) *)	902	**29415**	97583	455	**17232**	47946	416	**9429**	13620	283	**17960**	37870
Milk production value (tsd UAH) *)	316	**6071**	15198	105	**10992**	25082	99	**2294**	3601	133	**2227**	4198
Value of other animal production (tsd UAH) *)	483	**2835**	7494	215	**7281**	26674	174	**3013**	12500	181	**1652**	3961
Labor unit (persons)	902	**150**	425	457	**160**	652	416	**87**	189	283	**98**	151
Total land (ha)	902	**5623**	15531	457	**5773**	17444	416	**3225**	3769	283	**3863**	5641
Material cost and depreciations (tsd UAH)	902	**18571**	61494	457	**14901**	53687	416	**6539**	12042	283	**12681**	23811
From that - depreciation	902	**834**	2843	457	**1024**	3849	416	**529**	972	283	**756**	2138
- material cost (without services)	902	**13406**	44580	457	**11406**	42341	416	**4886**	9671	283	**8909**	16198
- services	902	**4331**	17739	457	**2471**	10103	416	**1123**	2126	283	**3016**	7559
DEA model variables - balanced panel												
Crop production value (tsd UAH) *)	535	**29547**	94478	295	**19546**	56091	200	**10654**	15202	140	**17369**	38128
Milk production value (tsd UAH) *)	179	**7730**	17298	60	**16389**	32031	60	**2626**	4082	64	**2613**	3121
Value of other animal production (tsd UAH) *)	264	**3329**	7598	104	**12958**	37469	78	**2363**	3420	84	**1526**	1874
Labor unit (persons)	535	**154**	416	295	**198**	803	200	**95**	203	140	**87**	96
Total land (ha)	535	**4732**	10849	295	**6586**	20784	200	**3549**	4351	140	**3311**	4497
Material cost and depreciations (tsd UAH)	535	**17659**	54855	295	**18030**	65548	200	**7117**	11401	140	**12505**	23436
From that - depreciation	535	**731**	1987	295	**1319**	4744	200	**616**	1099	140	**694**	1486
- material cost (without services)	535	**13066**	42233	295	**14066**	51852	200	**5188**	8212	140	**8212**	13587
- services	535	**3863**	14316	295	**2645**	11514	200	**1312**	2693	140	**3600**	9655

Note: *) The number of observations and statistics in the table refers to observations with non-zero values. For the derivation of technical efficiency scores, these were replaced with zeros.

Table A - 6: Comparison of mean values in technical efficiency, profitability and partial productivity indicators between independent farms and agroholding farms, averages 2008-2012 (balanced panel)

	Number of observations		**Mean value**		Two-group mean comparison test	
	Independ. farms	Agrohold. members	**Independ. farms**	**Agrohold. farms**	t-value	Prob.
Technical efficiency	930	240	**0.672**	**0.680**	-0.611	0.271
Profitability (farm level)	930	240	**0.240**	**0.078**	7.489	0.000
Profitability of crop production	930	240	**0.305**	**0.109**	8.455	0.000
Profitability of animal production	422	113	**-0.089**	**-0.085**	-0.136	0.446
Profitability of milk production	265	98	**0.024**	**0.009**	0.529	0.299
Milk yield (dt/cow)	269	98	**35.483**	**43.095**	-4.812	0.000
Winter wheat yield (dt/ha)	905	236	**31.385**	**39.283**	-8.976	0.000
Summer wheat yield (dt/ha)	183	31	**23.314**	**26.560**	-1.765	0.040
Winter barley yield (dt/ha)	406	78	**27.742**	**32.559**	-3.509	0.000
Summer barley yield (dt/ha)	777	184	**24.418**	**28.897**	-5.213	0.000
Crop production yield (dt/ha)	927	240	**3.595**	**4.997**	-8.730	0.000
Arable land/labor in crop production	1561	486	**68.989**	**71.793**	-1.072	0.142
Total production value/labor (tsd. UAH/employee)	930	240	**198.072**	**259.680**	-5.212	0.000
Crop prod. value/labor in crop prod. (tsd. UAH/employee)	886	232	**190.433**	**509.517**	-4.910	0.000
Animal prod. value/labor in animal prod. (tsd. UAH/employee)	419	110	**73.097**	**98.017**	-4.923	0.000
Milk prod. value/labor cost in milk prod. (tsd. UAH/employee)	265	98	**5.662**	**6.540**	-2.781	0.003
Total prod. value/(material cost + deprec.)	930	240	**1.903**	**1.732**	4.664	0.000
Crop prod. value/(material cost + deprec. in crop prod.)	930	240	**2.001**	**1.781**	5.212	0.000
Animal prod. value/(material cost + deprec. in animal prod.)	420	112	**1.432**	**1.511**	-1.777	0.038
Milk prod. value/(material cost + deprec. in milk prod.)	265	98	**1.728**	**1.811**	-1.425	0.078

Table A - 7: Agroholding mother companies' representation in the unbalanced panel data sample, total of 2008 2012

Agroholding mother company identif. number	Independent farms	Agroholding farms	Total
	1571	0	1571
1	0	101	101
2	0	31	31
3	0	4	4
4	0	10	10
5	0	32	32
6	0	45	45
7	0	44	44
8	0	1	1
9	0	63	63
10	0	20	20
11	0	5	5
12	0	67	67
13	0	4	4
14	0	3	3
15	0	57	57
Total	**1571**	**487**	**2058**

Table A - 8: Regional differences (ANOVA) in winter wheat yields (dt/ha), 2008-2012 (balanced panel).

Region			Central		Western		Southern	
2008-2012	**Mean**	**Nr. obs.**	**Mean diff.**	***p-value***	**Mean diff.**	***p-value***	**Mean diff.**	***p-value***
Central	36.865	521						
Western	32.652	135	-4.213	*0.001*				
Southern	27.299	196	-9.567	*0.000*	-5.353	*0.000*		
Eastern	30.133	289	-6.733	*0.000*	-2.519	*0.252*	2.834	*0.060*
ANOVA: F = 39.15, Prob > F = 0.000								
2008								
Central	42.993	106						
Western	35.290	28	-7.703	*0.006*				
Southern	33.914	40	-9.079	*0.000*	-1.376	*1.000*		
Eastern	42.494	59	-0.498	*1.000*	7.205	*0.025*	8.580	*0.001*
ANOVA: F = 9.59, Prob > F = 0.000								
2009								
Central	40.344	103						
Western	32.845	27	-7.499	*0.018*				
Southern	25.913	40	-14.431	*0.000*	-6.933	*0.100*		
Eastern	30.597	59	-9.747	*0.000*	-2.249	*1.000*	4.684	*0.292*
ANOVA: F = 18.62, Prob > F = 0.000								
2010								
Central	28.847	104						
Western	23.630	26	-5.218	*0.063*				
Southern	26.347	38	-2.500	*0.924*	2.718	*1.000*		
Eastern	23.766	55	-5.081	*0.007*	0.137	*1.000*	-2.581	*1.000*
ANOVA: F = 4.70, Prob > F = 0.003								
2011								
Central	36.363	106						
Western	37.131	27	0.767	*1.000*				
Southern	31.282	40	-5.082	*0.067*	-5.849	*0.176*		
Eastern	30.215	59	-6.148	*0.003*	-6.916	*0.036*	-1.066	*1.000*
ANOVA: F = 5.80, Prob > F = 0.001								
2012								
Central	35.682	102						
Western	33.933	27	-1.749	*1.000*				
Southern	18.553	38	-17.129	*0.000*	-15.380	*0.000*		
Eastern	22.915	57	-12.767	*0.000*	-11.018	*0.000*	4.362	*0.282*
ANOVA: F = 35.11, Prob > F = 0.000								