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Farm Mechanization:

A New Challenge for Agriculture in Low and Middle Income Countries of Europe and Central Asia

Regional Review

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ACRONYMS

CAP	Common Agriculture Policy of the European Union
CEE	Central and Eastern Europe
CIS	Commonwealth of Independent States
EBRD	European Bank for Reconstruction and Development
ECA	Europe and Central Asia
EoDB	Ease of Doing Business Index
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign direct investment
GDP	Gross Domestic Product
IFC	International Corporation
ILO	International Labor Organization
IMF	International Monetary Fund
MTW	Minsk Tractor Works (Belarus)
OECD	Organization for Economic Co-operation and Development
VAT	Value added tax
WE	Western Europe
USDA	United States Department of Agriculture

COUNTRY ABBREVIATIONS

ALB	Albania
ARM	Armenia
AZE	Azerbaijan
BLR	Belarus
BGR	Bulgaria
CZE	Czech Republic
EST	Estonia
CRO	Croatia
GEO	Georgia
HUN	Hungary
KAZ	Kazakhstan
KYR	Kyrgyzstan
LAT	Latvia
LIT	Lithuania
MOL	Moldova
POL	Poland
ROM	Romania
RUS	Russian Federation
SVK	Slovakia
SLO	Slovenia
TJK	Tajikistan
TUR	Turkey
UKR	Ukraine
UZB	Uzbekistan

EXECUTIVE SUMMARY

The economic transformation of Eastern and Central Europe and Central Asia (ECA) has significantly altered the resource endowments, opportunities and constraints of farmers in the region. Small and medium-scale private farms have replaced large-scale collective farms as the major constituency for agriculture development, the prices of labor and capital have changed substantially in both absolute and relative terms, and price liberalization and more open trade regimes have created new market opportunities. Associated changes in factor ratios are required if farmers are to respond fully to these changes in farm size, factor prices and market opportunities.

But low and middle-income ECA farmers have struggled to adjust their resource base, particularly with respect to farm mechanization. The transformation and modernization of agriculture has been slowed as a result. Small and medium-scale private farmers have limited access to farm machinery, with many still heavily oriented towards subsistence production. Larger farms continue to depend heavily on an ageing, and often declining stock of soviet-era farm equipment. This study examines the causes and implications of this new challenge for agriculture in the region and provides recommendations on how to address it.

Trends in Agricultural Mechanization – The Impact of Reform

We draw on the diversity of agriculture in the ECA region to show that trends in farm mechanization are attributable to differing approaches to reform and differing agricultural resource endowments. The level of reform determines the pattern and extent to which labor and capital change, with land reform and commodity market liberalization as the underlying forces for change. These reforms substantially raise the incentives to invest as a means to increase productivity and incomes. In countries where this initial "threshold" of reform has not been attained agricultural incomes grow more slowly and there is less incentive to invest. Where the incentives to invest are high we argue that a second round of reform is necessary to facilitate investment – reforms which deepen and strengthen financial markets and improve the business environment.

To demonstrate these effects we analyze and compare farm mechanization in three groups of countries: the European accession countries, which have attained both thresholds; "transition" countries, actively pursuing reform, which have attained the first threshold but not the second; and "truncated reform" countries where governments have chosen to limit land reform and market liberalization and retain high levels of government intervention in factor and commodity markets. Further disaggregation of these groups according to the intensity of labor use allows us to consider the role of agriculture resource endowments.

Where reform is advanced, countries with more labor-intensive production systems have evolved towards small-scale agriculture, with more farms, more tractors and horses, and higher consequent capital-labor ratios. Labor extensive production systems have retained their orientation towards large-scale farms. Capital-labor ratios have also increased in these countries, but more as the result of labor shedding and labor out-migration than increased farm mechanization. These trends are apparent in the accession countries, where farmers have both the incentive and the means to invest in farm mechanization. The use of tractors and combines is high and increasing, with a 27% increase in tractor use in the labor-intensive countries from 1995–2005. More farms, as a result of land reform, have led to more tractors. Investment in tractors and combines, as measured by imports[1], exhibit high corresponding growth rates. Farm wages also rose in these countries and farm labor use fell.

In the labor-intensive transition countries active reform and a significant increase in farm wages also appear to have created the incentive for farmers to increase mechanization (inadequate data precluded analysis of labor

[1] Imports are a close proxy for investment as they were the major source of supply for most countries during the period of analysis (except for Belarus, which was omitted).

extensive transition countries). Yet mechanization levels are low. Tractor use is static, combine numbers are falling and the use of horses is increasing. Investment in tractors and combines is low. Farmers are seeking to mechanize, but they are investing in horses rather than tractors. This behavior is attributed to the low farm wage rate, despite a marked overall increase in farm wages. Horses are a lower cost form of capital, relative to wages, and so a more rational investment. Farmers in these countries are also constrained by limited access to finance, and a business environment that is not always conducive to the distribution and sale of farm machinery.

Where reform is weak or partial, capital-labor ratios are likely to fall. Capital stocks age and decline because there is less incentive to invest and poor access to finance. Reform is initially oriented towards the retention of farm labor, but continued low returns to farming eventually result in strong outmigration of labor as rural people leave to seek their living elsewhere. As a result of these trends the resource base for agriculture is contracting in many of the truncated reform countries. The use of tractors fell by around 40% from 1995–2005, and the use of combines by 30%. Low investment rates, well below normal replacement rates, have also resulted in a substantial ageing of the machinery fleet. This contraction and deterioration of the machinery fleet has been accentuated in the labor extensive countries by a 20% fall in farm labor supply since 2000 and increasing farm wages. In labor-intensive countries the decline in farm mechanization has been offset by a 24% increase in the use of horses and farm labor supply has remained stable. Farm wages have increased nevertheless, although they are still very low. As in the transition countries, these low wages appear to be an important influence on the level of mechanization.

In labor-extensive truncated reform countries such as Russia and Ukraine the combination of declining labor and declining capital has become a serious constraint to agricultural growth. These countries are trying to arrest the de-mechanization of agriculture by using subsidized finance to boost investment in farm machinery – but with limited success. De-mechanization is not the fundamental constraint to agriculture sector growth. Where the combination of partial reform and low wages prevails, measures to boost farm mechanization will inevitably have a more limited impact on growth than fundamental reform. Increased mechanization does not resolve the problems caused by inadequate reform of factor and product markets, weak financial systems and poor business environments. In truncated reform countries with a substantial manufacturing sector for farm machinery, industrial policies that favor domestic production and inhibit imports are a further constraint to mechanization. The study shows that policy measures to facilitate imports and encourage foreign direct investment in the manufacture of farm machinery are a more effective means to reduce the cost of capital than subsidized finance.

Farm Mechanization, Agricultural Productivity and Rural Poverty

The study indicates that farm mechanization is an adjunct to more fundamental influences on agricultural production and productivity in the ECA region, rather than a means to directly increase output. Across all ECA countries, regression analysis shows that the impact of mechanization on productivity is modest. A 10% increase in tractor investment is associated with a 2% increase in agriculture value-added/hectare of arable land (statistically significant at 5%). This suggests that mechanization enhances the impact of more fundamental changes such as technological innovation, changes in factor costs and changes in institutions such as land use rights. Hence, farm mechanization will have the strongest impact on agricultural productivity where reform is advanced and farm wages are high, as in the more advanced accession countries.

There is no evidence that mechanization compromises rural poverty reduction in low-income ECA countries, by driving down rural wages or reducing rural employment. Machinery does eventually substitute for labor, but only in more advanced countries where rural poverty is low. At the same time, there is no evidence that mechanization contributes to poverty reduction – at least with existing types of farm machinery.

Low-income farmers seek to mechanize their operations nevertheless, as evidenced by the increased use of horses among small-scale farmers. The growing use of farm machinery in Asian countries also shows that there are

low-cost alternatives to animal power, and that the benefits of mechanization can be extended to low-income farmers. This machinery enhances the capacity to mechanize farm operations at a much lower cost of capital, both in absolute terms and relative to farm labor. In the ECA region, improved access to such machinery could facilitate increased mechanization in countries with cautious approach to reform, especially where labor-intensive production systems and small-scale farms predominate. The study also shows that the ability of small-scale farmers to invest in farm machinery is constrained by limited access to credit, leasing and insurance.

Policy and Labor Costs Drive the Demand for Farm Machinery

There is reasonable evidence that policy reform influences investment in farm machinery. In all ECA countries, tractor investment did not exceed $10/ha of arable land until land reform, privatization and market liberalization were all at an advanced stage. Beyond this threshold, successively higher levels of investment were associated with reform of the banking sector and improved access to rural finance. Competition policy appears to become a more important determinant of investment once access to finance improves.

Regression analysis of the demand for investment shows that labor costs are generally a more important determinant of demand than the cost of capital, consistent with the observed pattern of low levels of mechanization in low wage countries. Across all ECA countries, a 10% increase in farm wages elicits a 10% increase in tractor investment, while a 10% fall in nominal interest rates results in a 4% increase in tractor investment (statistically significant at 1% and 5% respectively). Interest rates and access to finance are more important determinants of investment for higher priced combines. The level of road infrastructure also emerges as a marked influence on the demand for investment. Better infrastructure results in better access to fields and local markets and increases the role of farm machinery as a form of transport.

These results suggest that where reform is advanced and wage rates are high, as in the accession countries, policies that improve access to finance and create a business environment conducive to the supply of farm machinery are essential. In transition countries, where reform is active and labor costs are rising towards the levels observed in accession countries, policy should also be directed to strengthening the financial sector and the business environment, and reducing the cost of imports. Farmers will then be in a position to increase their mechanization of agriculture, as it becomes appropriate. Fundamental reform of factor and commodity markets offers the best means to increase the demand for farm machinery in the low wage truncated reform countries. Reduced import protection will also help to reduce the cost of farm machinery, along with policies to encourage competition and foreign investment in countries with an established sector for the manufacture of farm machinery.

A Greater Role for Low-Cost, Small-Scale Farm Machinery

Most of the new farm machinery sold in the ECA is unsuitable for small-scale, low-income farmers. The markets are dominated by medium and large-scale machinery sold by western multi-national manufacturers and large corporations in Belarus, Russia and Ukraine. These enterprises view this segment of the market as their most profitable focus for the foreseeable future. They have limited interest in designing and building simple, low-cost, small-scale machinery suited to low income farmers.

There are manufacturers with the capacity to design, manufacture and distribute farm machinery suited to low income farmers, however, and they are doing so on a very large scale. Indeed the limited presence of farm machinery manufacturers from China, India and Brazil in the ECA region is due in part to surging demand in their own domestic markets. This is beginning to change. The larger and more international of these corporations are now establishing manufacturing and distribution operations in the more advanced ECA countries where small-scale agriculture is predominant, as noted above. The opportunities for growth in the ECA region in this segment of the market have clearly been recognized.

The next step is to further this expansion into the transition countries. There is scope for donors to facilitate this expansion through the use of political risk guarantees coupled with support for national programs to improve business environments and improve access to financial services. Governments can also do much more to encourage foreign direct investment by these manufacturers, and to facilitate imports.

Promoting Farm Mechanization – What can be done?

The study identifies numerous ways to promote farm mechanization in low and middle-income countries, by addressing both demand and supply side constraints. Much can be done indirectly, without distorting factor markets or factor prices, but there is also scope for direct government or donor support.

Truncated Reform Countries

Under pressure to address the de-mechanization of agriculture, the governments of most truncated reform countries have given high priority to policies and programs to increase investment in farm machinery. Public programs to reduce the cost of capital, based on subsidized leasing and credit, have been the major response. But most of this subsidized finance has been restricted to the purchase of domestically produced farm machinery, as a means to support domestic manufacturers of farm machinery. None of these programs have arrested the de-mechanization of agriculture. Low wages are a more important determinant of mechanization in these countries than high costs of capital.

The underlying policy stance in these countries precludes full land reform and market liberalization. There is scope to modify current policy nevertheless, as a means to improve farm mechanization – as suggested below.

- Rationalize the industrial policies designed to protect domestic farm machinery manufacturers by removing preferential access to subsidized finance, removing tax exemptions for domestic machinery, reducing import protection and removing the barriers to foreign investment.
- Remove inappropriate restrictions to the import and sale of new and second-hand farm machinery, including the preferential trade agreements with CIS countries.
- Terminate the centralized procurement of farm machinery through state organizations and the state managed allocation of this machinery to farmers.
- Privatize state owned farm machinery stations and servicing stations.
- Reform of the business environment should focus on reducing start-up costs, reducing taxation and removing the differential taxation of local and foreign firms, streamlining import procedures, improving contract enforcement, improving access to insurance, improving leasing legislation, and ensuring that farm machinery distribution and sales outlets can be established and operated.
- Where state subsidized leasing and credit programs are operated as the basis for support to farm mechanization the emphasis should be on making these programs open to both imported and domestically produced farm machinery. A cap should also be placed on the amount of subsidized leasing or credit received by any single farmer to limit the high transfers to large corporate farms.
- A sunset clause should be placed on the operation of state leasing agencies, after which they should be privatized. Private leasing agencies should be allowed to operate in parallel with public leasing agencies.

Transition Countries

The transition countries should focus on: reducing barriers to imports (the main source of farm machinery), increasing access to finance, improving the business environment, and increasing foreign investment in manufacturing and distribution – especially for small-scale, low-cost farm machinery. Particular areas of activity include:

- Reform of the business environment should focus on reducing start-up costs, reducing taxation and removing the differential taxation of local and foreign firms, streamlining import procedures, improving contract enforcement, improving access to insurance, and ensuring that farm machinery distribution and sales outlets can be established and operated.
- Promote the establishment and expansion of machinery distributors and dealerships through training and profit sharing systems.
- Encourage foreign direct investment by farm machinery manufacturers and distributors able to supply low-cost appropriately scaled farm machinery, and ongoing servicing and parts supply.
- Support measures to strengthen and deepen financial markets, including the development of leasing and associated legislation. Care should be taken not to place undue emphasis on leasing as opposed to normal commercial credit. It has fewer advantages for low-income farmers who are unlikely to benefit from the tax savings conferred by leasing.
- Broaden the coverage of medium-term donor credit lines for agriculture to include investment in farm machinery.

I INTRODUCTION

I.1 RATIONALE AND OBJECTIVES

The underlying rationale of this study is that expressed in the seminal World Bank analysis of farm mechanization by Binswanger and Donovan[2].

> "The central economic policy question for mechanization is not whether to mechanize, but how to do so in a cost-effective manner that advances a country's economic and development objectives (growth, poverty reduction, political and economic stability etc). Mechanization is a means to achieve these objectives – not an objective in and of itself."

The economic transformation of Eastern and Central Europe and Central Asia (ECA) has significantly altered the resource endowments, opportunities and constraints of farmers in the region. Small and medium-scale private farms have replaced large-scale collective farms as the major constituency for agriculture development, and the prices of labor and capital have changed substantially in both absolute and relative terms. Price liberalization and more open trade regimes have created new market opportunities, and the mono-crop production systems of large-scale collective farms are being replaced by more diverse crop and livestock production systems.

Associated changes in factor ratios are required if farmers are to respond fully to these changes in farm size, factor prices and market opportunities. But low and middle-income ECA farmers have struggled to adjust their resource base, particularly with respect to farm mechanization. The transformation and modernization of agriculture has been slowed as a result. Small and medium-scale private farmers have limited access to farm machinery with many still heavily oriented towards subsistence production, and larger farms continue to depend heavily on an ageing, declining stock of soviet-era farm equipment. Sales and support services for farm machinery, a legitimate component of the agri-business sector, have also been slow to develop.

To date, the international community has focused on land reform and the liberalization of agriculture commodity markets as the basis for agriculture sector growth. Substantial progress has been made with these reforms in many ECA countries, however, and new challenges such as farm mechanization are emerging. Although the governments of low and middle-income ECA countries have long stressed the need to raise investment in farm mechanization, well-informed guidance on whether and how to address this issue is lacking. This study will assist both national governments and donor organizations to discern the constraints to farm mechanization, and decide how best to enhance its contribution to sustainable agriculture sector growth.

In this context, the objectives of the study are to:

- Review post-reform trends in farm mechanization in the ECA region and discern the impact of reform;
- Examine the influence of farm mechanization on agricultural productivity;
- Discern the level and determinants of investment in farm machinery in the ECA region, and the extent to which it is influenced by economic reform;
- Develop recommendations for enhancing the contribution of farm mechanization to agriculture development.

[2] Binswanger, Hans. P and G. Donovan. "Agriculture Mechanization: Issues and Options." World Bank Policy Study. 1987

The diversity within the ECA region provides a rich platform for comparative analysis. Numerous approaches to economic reform have been followed since 1990, with widely different outcomes. The reform programs of the more advanced European Union (EU) "accession" countries[3] provide valuable lessons for the low and middle-income countries in this respect, and this insight is used wherever possible to inform the study. Agricultural production systems also vary widely, from small-scale private farms in Central Europe and the former Yugoslavia to the huge former collective farms in Russia and the Commonwealth of Independent States (CIS). This diversity is used to show how differing resource endowments further influence the role and impact of farm mechanization.

I.2 SCOPE AND ORGANIZATION OF THE STUDY

The study covers 24 of the 28 countries in the ECA region, for the period 1990–2006. Particular attention is paid to the post-reform recovery period from 1998–2005.

Countries included: Albania, Armenia, Azerbaijan, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Slovakia, Slovenia, Tajikistan, Turkey, Ukraine, and Uzbekistan.
Countries omitted (due to inadequate data): Bosnia and Herzegovina, The Former Yugoslav Republic of Macedonia, Serbia and Montenegro, Turkmenistan.

Farm mechanization refers to the use of tractors, harvesters and equipment for cultivation, planting and feed conservation. Machinery and equipment used for irrigation, livestock production, grain drying and storage, and transport are not included. Data for the study were drawn from: the Word Bank Development Indicators, the World Bank Ease of Doing Business Index, the FAOSTAT data base of the Food and Agriculture Organization (FAO), the International Labor Organization (ILO), the International Monetary Fund (IMF), the European Bank for Reconstruction and Development (EBRD), the United Nations Commodity Trade Statistics database (COMTRADE), the United Nations Industrial Commodity Statistics Yearbook 2005, the United States Department of Agriculture (USDA) and national statistics of the various countries.

Chapter II sets the stage for the study with an overview of the implications of economic reform for agriculture and farm mechanization. A conceptual and analytical framework is outlined in chapter III, followed by analysis of the main trends in farm machinery use and investment, and farm labor supply in chapter IV. Trends in factor prices and factor ratios are presented in chapter V, plus an empirical analysis of the influence of farm mechanization on agricultural productivity and discussion of the link between farm mechanization and rural poverty. The determinants of farm machinery investment are analyzed in chapter VI, including the impact of policy reform. Broader, economy-wide influences are examined in chapter VII, including industrial policy. Supply side aspects of farm mechanization are then reviewed in chapter VIII, based on recent information on the manufacturing and distribution activities of major farm machinery companies operating in the region. The study concludes with a summary of the main conclusions, in chapter IX, and an outline of ways to enhance the impact of farm mechanization.

Lack of resources precluded study of the environmental implications of farm mechanization. This is a critical issue given the increasing pressure on land resources for food production, and the need for land use techniques that respect and preserve the environment. Research is needed on the influence of mechanization on soil compaction and carbon sequestration, and the role of low-tillage cultivation systems. The looming impact of climate change further increases the need for a wider understanding of these issues.

[3] Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

II THE IMPLICATIONS OF REFORM FOR AGRICULTURE AND FARM MECHANIZATION

This chapter provides the context for the analysis, with a brief overview of the impact of economic reform on agriculture in the ECA region and its implications for farm mechanization.

Under the Soviet Union, agriculture in the ECA region was dominated by large-scale, state and collectively owned farms, which were heavily supported by the state[4]. Mono-crop production systems prevailed (cereal or cotton based), and most agricultural operations were mechanized. Farm-owned machinery was augmented by state run machinery parks, and fuel and spare parts were heavily subsidized. Rural labor was generally abundant and cheap – due also to pervasive state intervention. The preference for mechanized production, despite the low cost of rural labor, reflected the desire to "modernize" agriculture, irrespective of its implications for economic efficiency. Collective ownership and management of farm machinery and high fuel subsidies also reduced the incentives to use this machinery in a cost-effective manner.

After the break-up of the Soviet Union in 1989–1990, the newly independent countries experienced a prolonged economic contraction. The extent of this collapse and the timing of the subsequent recovery varied by country, according to the nature and extent of the reforms they implemented. In most cases agricultural sector recovery was underway by 1996. A strong, sustained recovery occurred in the more advanced European Union Accession countries. Low and middle-income countries in the region have made a slower recovery and reform is incomplete.

The main implications of recovery and reform for agriculture and farm mechanization are summarized below.

II.1 A MORE DIVERSE STRUCTURE OF AGRICULTURE

New patterns of land use and farm ownership use have emerged in response to land reform and farm privatization (chapter III). In countries such as Albania and Georgia, where farm labor is abundant and reform has been active, small-scale, private farms have replaced large-scale, collective farms and have become the main source of agricultural sector output. Farm size has fallen less in countries where labor/land ratios are lower and where farm privatization and land reform are incomplete. In Russia, Belarus, Hungary and Ukraine the break-up of large collective farms was also restricted on the grounds that large-scale farms are needed to ensure economies of scale and to improve the competitiveness of agriculture. Between these two extremes a dual structure of agriculture has emerged in countries such as Poland, Bulgaria and the new states of the former Yugoslavia. Large corporate farms now operate in parallel with small-scale family farms, as in the modern agricultural economies of Western Europe.

II.2 PRICE LIBERALIZATION AND THE DIVERSIFICATION OF PRODUCTION

Farm product and input prices have been liberalized in most ECA countries, trade policy has become more open and foreign exchange controls have been removed. These changes have altered both absolute and relative prices and created new market opportunities, but have also increased price volatility. Where private sector markets are strong, as in the Accession countries, farmers have adjusted their product mix to

[4] Except for Poland and the former Yugoslavia where small-scale private farms operated in parallel to large socially owned farms.

benefit from these new conditions. In lower income countries where private sector markets remain weak, the combination of limited market outlets and increased price volatility has led many farmers to favor subsistence rather than commercial farming. Production systems have become more diverse in both cases, however, with a marked increase in livestock production. Mono-cropping has given way to more diversified systems of food and cash crop production, with cropping patterns driven by household food requirements and market prices rather than state production quotas. These changes are less evident in countries where reform has been truncated, and government has retained price controls and/or production quotas.

II.3 REDUCED ACCESS TO CAPITAL

The collapse of the Soviet Union had a profound impact on the cost and availability of capital. Low cost, publicly provided funds for seasonal credit, machinery, fuel and spare parts dried up and the public institutions responsible for delivery became dysfunctional. Where private institutions have been slow to fill this vacuum, the availability of capital has fallen and its cost has risen, relative to pre-independence conditions. Exchange rate liberalization has further raised the cost of (external) capital and reduced access to imported machinery and spare parts.

Without capital to replace and maintain existing machinery, the farm machinery fleet has deteriorated substantially in many ECA countries, resulting in a "de-mechanization" of agriculture (Chapter IV). Land reform has intensified the impact of reduced capital. As large farms typically have better access to available capital than small ones, the new generation of small-scale, private farmers are finding it difficult to obtain credit for seasonal finance (fuel, spare parts) and for capital investment in machinery (Chapter VI). Their ability to obtain new machinery, more suited to small-scale, mixed production systems is thus extremely limited. Farmers have also been deprived of the new mechanization technology developed during the last 15 years, particularly the new generation of minimum tillage equipment with its lower costs and environmentally friendly cropping practices.

These trends are less evident in the Accession countries, due to the emergence of a strong financial system and a more favorable environment for agri-business (Chapter VI). Access to finance remains difficult in many of the remaining countries and the farm machinery fleet continues to decline. Some of these countries have a substantial manufacturing capacity for farm machinery and have tried to boost demand for domestically produced farm machinery through subsidized leasing and credit. But these measures have had limited success. They have distorted the price and allocation of capital, constrained the development of private sector agri-business, and failed to arrest the de-mechanization of agriculture (Chapter V).

II.4 REDUCED FARM LABOR SUPPLY AND INCREASED FARM WAGES

In countries where reform was oriented towards the preservation of large-scale farms and/or farm employment, the impact of land reform and privatization on farm labor varied according to the extent and speed of labor shedding (Chapter IV). A rapid initial decline in farm labor occurred in many of the accession countries as they opted for rapid privatization and minimal restrictions on labor shedding. An increase in farm productivity resulted, although with high social costs. In contrast, the CIS countries opted for slower, partial privatization with limits on the degree of labor shedding and a smaller consequent fall in farm employment. Farm employment was preserved but farm incomes and farm productivity improved less. Farm incomes have remained low in these countries, however, causing many rural people to leave farm employment of their own volition for the higher income prospects in other sectors or other countries.

Where farm privatization and land reform resulted in a farm structure dominated by small-scale private farms, farm labor supply increased in the early stages of reform. The rural sector served as a safety net

for urban people who lost their jobs and livelihoods during the post-independence economic collapse. In countries such as Albania, Armenia and Kyrgyzstan where employment opportunities have increased in other sectors and in nearby countries farm labor supply has now begun to fall. In countries with cautious approach to reform such as Moldova and Azerbaijan it has changed little.

Farm labor supply has thus fallen in most countries, to one degree or another, except where the opportunities for employment in other sectors or other countries are poor. Farm wage rates have increased significantly as a result, although they remain very low in the low-income ECA countries (Chapter IV).

II.5 LESS GOVERNMENT SUPPORT FOR AGRICULTURE

The collapse of the Soviet Union halted the high levels of support that agriculture received prior to independence. Severe budget constraints meant that direct subsidies for farm inputs, fuel and credit were no longer available, and soft budget support for unprofitable farms was eventually halted. State run farm machinery parks collapsed and government purchases of farm machinery fell dramatically or stopped altogether. The indirect support afforded by artificially high exchange rates was also dismantled, and import protection was reduced. Public support was gradually reinstated in the accession countries, but in most other ECA countries direct and indirect support for agriculture has remained very low due to continued fiscal constraints.

III CONCEPTUAL AND ANALYTICAL FRAMEWORK

III.1 CONCEPTUAL MODEL

Drawing on a recent World Bank study of agricultural performance in the ECA region by Swinnen and Vranken[5] the conceptual basis for the study starts with the assumption that the effect of reform on farm mechanization is conditioned by two factors – the approach to reform and the agriculture resource endowment (land, labor and capital) at the beginning of reform. Land is regarded as fixed in the short term but labor and capital vary by country.

III.1.1 Reform Pathways – Accession, Transition and Truncation

After the break-up of the Soviet Union in 1989–1990, the newly independent countries in the ECA region chose among three broad pathways of economic reform:

- Among the more advanced "accession" countries of central and northern Europe an initial period of economic transition was followed by the alignment of agricultural policies and institutions with the Common Agriculture Policy (CAP) of the European Union (EU). These countries have all experienced sustained growth;
- "Transition" oriented countries such as Albania, Georgia and Kyrgyzstan implemented a wide range of reforms associated with land ownership and use, farm privatization, and price and market liberalization, together with on-going "structural adjustment" of fiscal and monetary policy. While significant growth has occurred, most of these countries remain poor and the full benefit of reform has yet to be realized;
- A more limited set of reforms was implemented in the CIS and other less reform oriented countries. Factor and product markets were partially liberalized but governments' chose to "truncate" the reform process and maintain high levels of state intervention. Agriculture sector growth has been weaker in these countries.

III.1.2 Beginning Resource Endowments

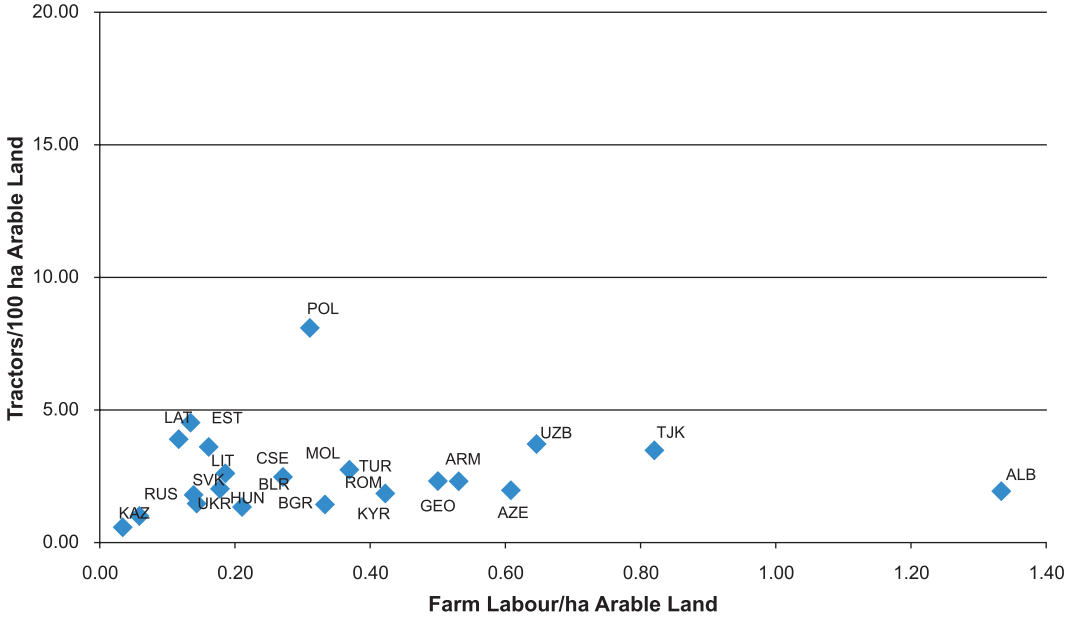
Land, labor and capital endowments are measured in terms of arable land, agricultural workers and the number of tractors respectively. Labor data are drawn from ILO using a broad definition of farm labor that includes paid employees, self-employed farmers and family workers. Tractor numbers are the only widely reported measure of mechanization, but are likely to under report mechanization levels for countries with fewer, larger tractors. Aggregate tractor horsepower would be a more accurate indicator but data are scarce. An analysis of available data suggests that this bias is modest, however (Chapter IV, section IV.3). In Hungary and the Czech Republic, where large-scale production systems predominate, large tractors (> 100 kw) accounted for only 8% and 14% of the total tractor fleet respectively.

Beginning labor/land and capital/land ratios are shown in Figure 1 below, for 1989–1991. Capital/land ratios (tractors/100 hectares arable land) are low even in the more advanced countries, with limited variation between countries. Of the 23 ECA countries for which data are available only two have more than 5 tractors/100 ha of arable land. Equivalent ratios in Western Europe (WE) for the same period were much higher and more varied, ranging from 4.7 tractors/100 ha arable land in Portugal to 24.1 in Austria. Twelve of the thirteen

[5] "Reforms and Agricultural Performance in ECA: 1989–2005." Johann Swinnen and Liesbet Vranken. LICOS Center for Institutions and Economic Performance. University of Leuven (KUL). March 2007.

WE countries examined[6] had capital/land ratios greater than 5 tractors/100 ha arable land. Labor/land ratios (agricultural workers/hectare of arable land) are more diverse, ranging from 0.03 in Kazakhstan to 1.33 in Albania. Corresponding ratios in Western Europe were all less than 0.4 farm workers/ha arable land.

Figure 1. Labor and Capital Endowments for ECA Agriculture: 1989–1991



Sources: FAOSTAT, ILO, USDA.

Beginning labor and capital resources in the ECA region are thus characterized by a relatively high and varied labor supply, versus a low and more uniform supply of capital. This suggests that differences in beginning labor/land ratios will have a bigger impact on reform outcomes than capital/land ratios. Hence, it is assumed that the outcome of economic reform will differ according to whether the underlying resource endowment results in labor intensive or labor extensive agriculture production, and on whether reform is fully or partially implemented. (The approach differs from Swinnen and Vranken in this respect, who contrast labor intensive and capital intensive production systems).

In 2005, fifteen years after reform began, the overall pattern of agricultural resource endowments in the ECA region had not changed dramatically. Labor/land ratios still varied widely between countries, from 0.04 workers/ha arable land to 1.46 workers/ha arable land. Relatively low levels of mechanization were still predominant. Only 6 out of 23 countries examined had more than 5 tractors/100 ha arable land in 2005, versus 2 out of 23 in 1990.

The different reform pathways pursued have influenced resource endowments nevertheless. Countries where labor intensive agriculture predominates have become more labor intensive, due to the movement of people into agriculture early in the reform process and the proliferation of small farms. Labor extensive agricultural economies have become more labor extensive. People have moved out of agriculture, even in countries where privatization policies were designed to keep them in. Mechanization increased in European accession countries, remained fairly stable in transition countries and fell in truncated reform countries.

III.1.3 Power versus Control Intensive Mechanization

The analysis of mechanization is usually based on types of agricultural operation, rather than on power sources. In this context, agricultural operations may be grouped into two categories:

[6] Austria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, UK.

- **Power intensive operations** that use relatively large amounts of energy (transport, milling, grinding, pumping, land preparation, threshing)
- **Control intensive operations** that need a higher input of human judgment (seeding, weeding, pest control, harvesting of fragile crops).

Within this framework the harvesting of grain crops and secondary tillage operations are intermediate in power and control intensity.

Farmers typically seek to mechanize power intensive operations first, especially where agricultural production systems are intensive. Hence, transport, tillage and power-intensive pumping and processing operations (especially milling and threshing) are usually mechanized long before wages rise to high levels. Moreover, as many pumping and processing operations can be performed by simple, low-cost stationary machines, mechanization of these operations typically advances much more rapidly than tractorization.

Power intensive operations are associated with more intensive agriculture because intensification raises the demand for labor or power, or both, above the level that the agricultural labor force is able to provide. As there are numerous ways to provide this additional power, the objective should be to develop a mix of power sources according to the supply and cost of labor, the availability and cost of capital and the costs of mechanized operations. For this reason production systems that draw on a combination of machine, animal and human power are often highly cost-effective. Even on large-scale farms in the United States, most farmers continued to use a combination of horses and tractors until farm wages began to increase in the 1950s[7].

In contrast, the higher the control intensity of the operation, the more expensive the machine required and the higher the labor costs must be to justify such a machine. Thus, seeding tends to be mechanized before harvesting because mechanical seeding can lead to better yields and row planting reduces weeding costs. Where labor is abundant the mechanization of harvesting is less profitable in low-wage countries because the cost-effectiveness of harvesting depends directly on saving labor costs. Mechanized harvesting becomes cost effective when the labor requirement is high, either because the crop is fragile or harvesting is highly time-bound.

III.2 THE ROLE OF FARM MECHANIZATION

Farm mechanization is viewed as an adjunct to more fundamental influences on agricultural production and productivity, rather than a means to directly increase output. Its role is to enhance the impact of more fundamental changes such as technological innovation, changes in factor costs and changes in institutions such as land use rights. But where farm mechanization is economically rational, a shortage of farm machinery constitutes a resource constraint and so an impediment to increased production and productivity. The extent of this constraint depends on the cost and availability of other sources of power, and the type of production system.

III.3 FARM MECHANIZATION WITH FULL REFORM[8]

Where labor-intensive producti on systems predominate, and reform is fully implemented, land reform and farm privatization will result in a shift from large-scale, collective faming to small-scale, individual farming (Figure 3). This form of organization minimizes the costs of labor supervision, which are typically large in agriculture, and allows the farmer to benefit directly from his increased labor effort in response to improved incentives. Moreover, losses in scale economies tend to be small for labor-intensive production systems

[7] Binswanger and Donovan. 1987 op cit.
[8] Adapted from Swinnen and Vranken. 2007. op cit.

as there are fewer fixed costs and large assets. There is little advantage in remaining as a large, collective farm under these circumstances and the tendency is for farms to split in order to achieve factor intensities that give higher returns to labor. Reform under these circumstances results in significant gains in technical efficiency, with relatively small losses in scale efficiency.

As land is usually the most limiting resource on smaller farms, farmers will seek to mechanize operations that increase returns to land. Given adequate resources, they will mechanize power intensive rather than control intensive operations and transport, but they will opt for a combination of power sources (mechanical and animal). Investment in tractors or horses will thus be a high priority, but they will also use hired machinery. The proliferation of small farms and the consequent increase in the number of farmers will significantly increase the overall use of mechanization because every farmer will want his own horse or tractor. Capital/labor ratios will increase as a result. But mechanization may have a lesser impact on productivity than other land enhancing inputs such as fertilizer and improved seed.

In countries or regions where labor extensive production systems predominate and reform is fully implemented, land privatization usually leads to some reduction in farm size in order to reduce labor supervision costs and raise labor productivity (Figure 2). But downsizing will stop when the benefits from labor-related cost-savings are exceeded by the costs of reduced scale economies. These scale economies can be significant for labor-extensive production systems, which require larger assets and incur higher fixed costs. Small farms have fewer advantages under these circumstances, and are likely to amalgamate to obtain scale economies. Labor shedding is the most important response to land privatization and results in an increased capital-labor ratio. But it is a one-off event to rationalize the farm labor complement and reduce supervision costs.

Once the labor complement of larger farms has been rationalized, further increases in productivity will rely heavily on mechanization. Rather than hire more labor farmers will seek to mechanize both power and control intensive operations in order to increase labor productivity. Increased farm mechanization is thus essential for these farms, and will further increase capital-labor ratios. It will also have a strong impact on labor productivity.

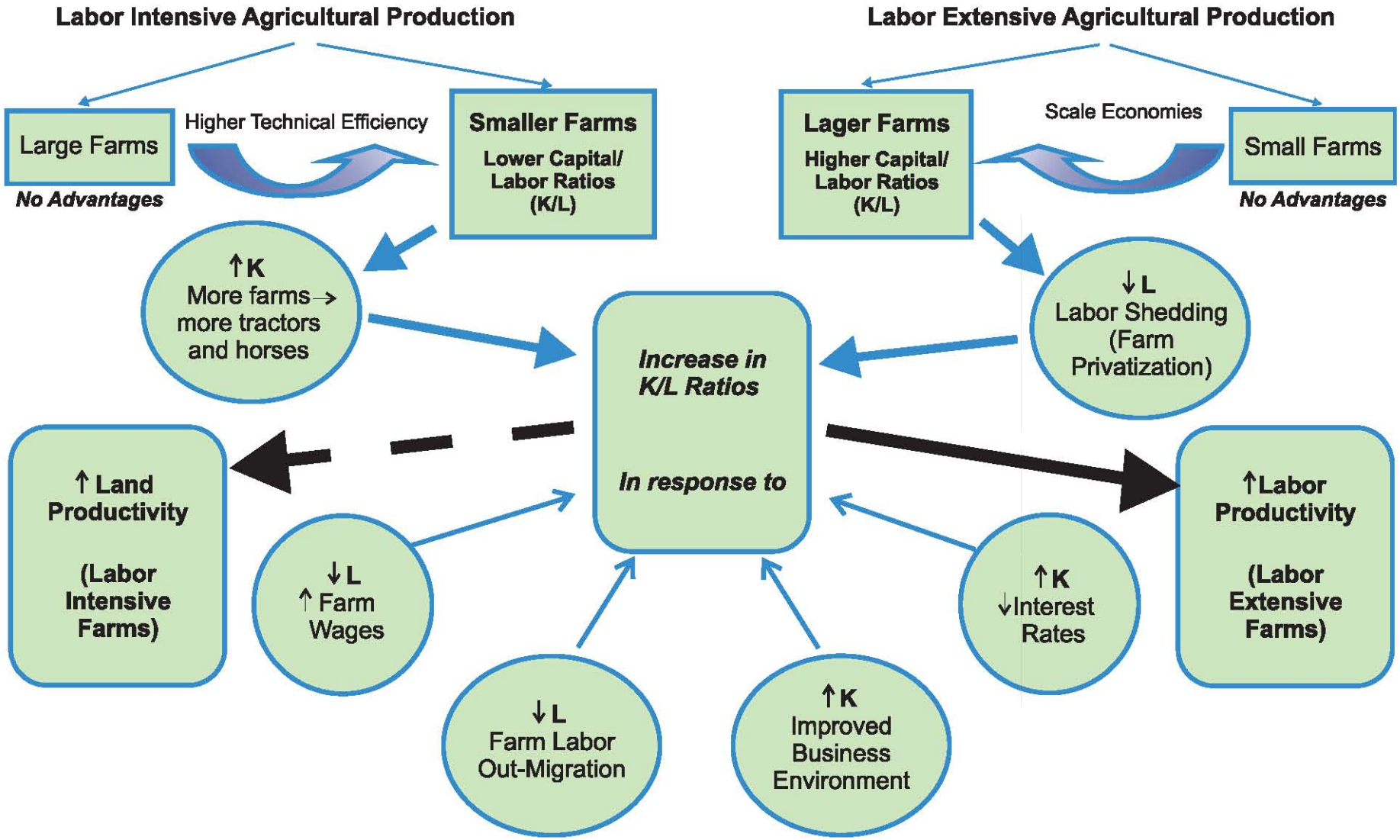
More general, economy-wide outcomes of reform will lead to a further increase in capital-labor ratios on both labor intensive and labor extensive farms. Investment in farm machinery will increase in response to financial deepening and lower interest rates; and a stronger business environment will result in a wider array of machinery options at more competitive prices. The supply of farm labor will decline as alternative employment opportunities emerge in other sectors. Out-migration of farm labor will also increase in response to improved access to employment opportunities in other countries and the strengthening of social safety nets. The consequent increase in farm wages will become an increasingly important influence on farmer decisions to substitute capital for labor.

III.4 FARM MECHANIZATION WITH PARTIAL REFORM

For labor-intensive production systems, policies that inhibit an improvement in farmer incentives are the most immediate constraint to economic transition and agriculture growth. Incomplete land reform and/or incomplete market liberalization reduce the ability and incentives for farmers to establish small, private farms, restricting the emergence of a proven engine for agriculture sector growth and rural poverty reduction. For labor extensive production systems, policies that inhibit land reform, farm privatization and labor shedding are the immediate constraints to transition and growth. Large-scale farms are unable to rationalize their size and resource base in order to improve efficiency and income.

In both cases capital-labor ratios will eventually decline. Weak financial markets and minimal government support for agriculture will preclude investment in farm machinery, and the farm machinery park will

Figure 2. Determinants and Outcomes of Farm Mechanization in the ECA Region



deteriorate. Under these conditions measures by governments and donors to increase investment in farm machinery and arrest this deterioration merely preserve the status quo. An increase in farm mechanization does not resolve the underlying constraints to increased farm productivity.

Market liberalization, land reform and farm privatization are not the only barriers to more efficient factor ratios and increased farm productivity. A further set of economy-wide constraints, associated with incomplete transition, is observed in countries where these reforms have been implemented. These constraints reside in weak or absent financial markets for credit, leasing and insurance, and in poor business environments'. While farmers may have the capacity and incentives to adjust factor ratios in these circumstances, they may not have the means or the opportunity to invest in farm mechanization. Inappropriate policies associated with government incentives to invest in farm machinery and government support for domestic manufacturers of farm machinery will also distort the cost and use of capital.

On small-scale, labor-intensive farms, weak or absent markets for credit, leasing and insurance severely limit the ability of farmers to obtain productivity enhancing machinery and equipment. This is a major barrier to modernization and continued, sustainable growth. On larger, labor-extensive farms these constraints preclude the replacement and modernization of farm machinery and equipment, and lead to a steady deterioration of the existing machinery park. In both cases a poor business environment discourages the establishment and operation of machinery sales and service outlets by both domestic and foreign enterprises. Policies to support the domestic manufacture of farm machinery, through direct incentives (subsidized credit or leasing) and/or import protection create a further disincentive by limiting farmer choice, distorting incentives for investment, and raising machinery prices. Tax regimes that discourage leasing and fail to provide for accelerated depreciation also inhibit mechanization.

Where these problems are not resolved farmers will eventually face a broad-based decline of their resource base. In addition to deterioration of their machinery resources, they may also experience a loss of farm labor and increased farm wages as a result of changes elsewhere in the economy. Inadequate mechanization becomes a constraint to production but it is symptomatic of more fundamental distortions and constraints.

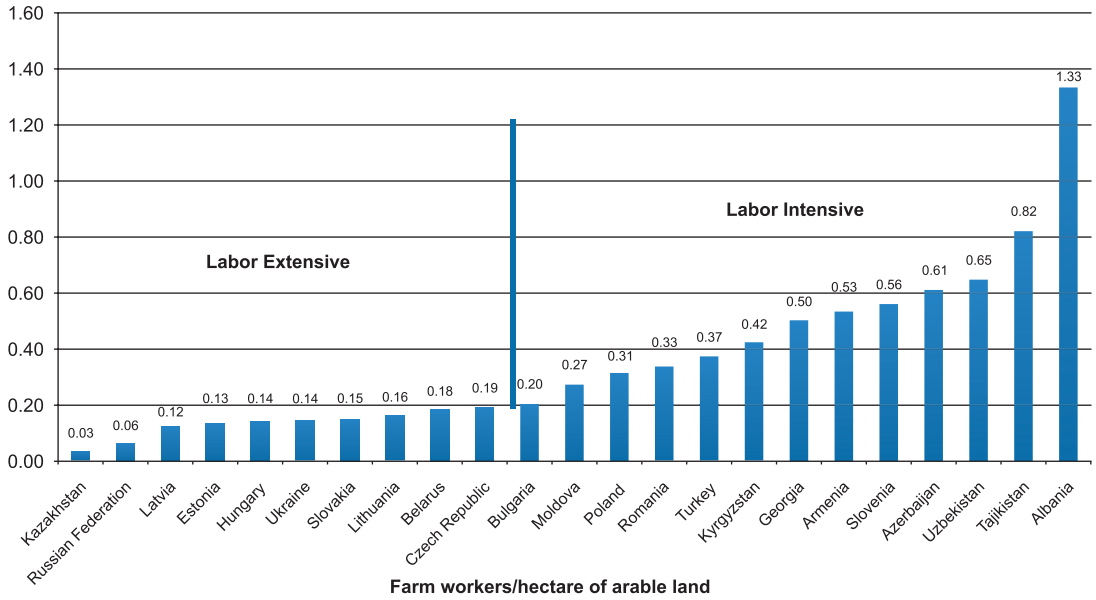
III.5 ANALYTICAL FRAMEWORK

This conceptual framework leads readily to analysis. The study countries are grouped first according to whether their labor-land resources at the start of reform are labor intensive or labor extensive. As there is no objective cut-off point for this distinction, a natural break in the labor/land ratios for 1989–1991 is used – as shown in Figure 3.

With the exception of Bulgaria, countries with labor/land ratios of 0.2 workers/ha arable land or less are categorized as labor extensive and the remainder as labor intensive. Although arbitrary, this cut-off point is broadly consistent with systems of agriculture production in these countries. Accession countries close to the cut-off point such as Bulgaria, Poland and Romania tend to have a dual structure of agriculture, with large and small farms operating in parallel. Additional analysis showed that the labor/land ratio for Bulgaria had risen to 0.24 by 1998 and that it behaved like the labor-intensive countries. For this reason it was also included in the labor-intensive category.

Policy indices developed by the World Bank for assessing the status of economic reform were used to categorize the study countries by reform pathway. These indices have been ascribed annually since 1997 according to pre-defined indicators of progress, on a scale of 1–10. A full description of these policy indices and their scaling criteria is presented in Appendix I. An average of the indices for land reform and market liberalization as of 2005 is used as the basis for classification, as these are the two key areas of reform relevant to farm mechanization and agricultural productivity.

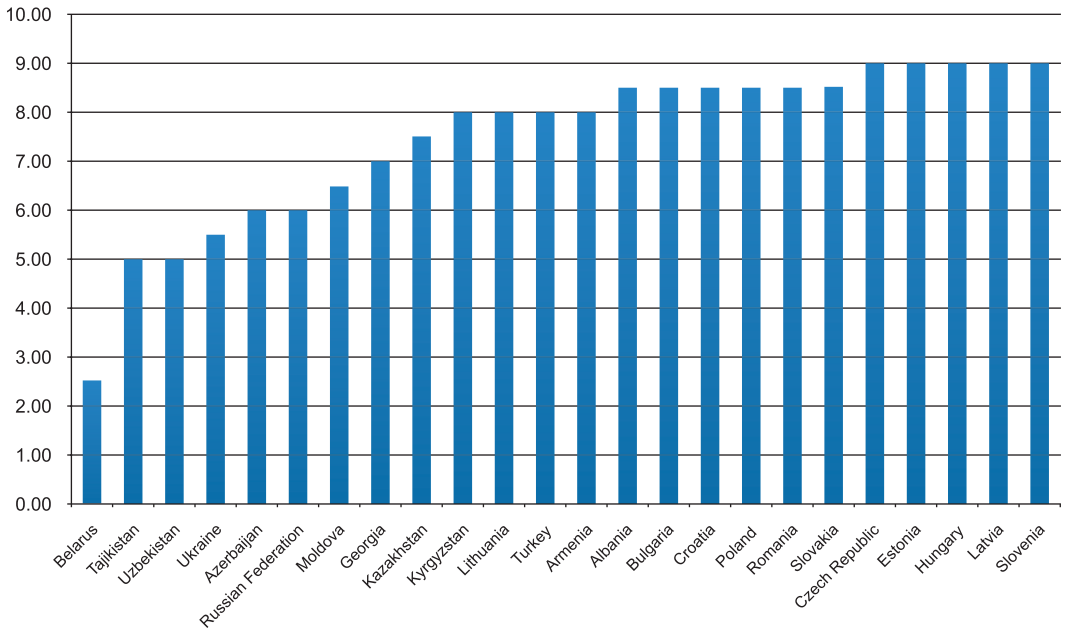
Figure 3. Labor-Land Ratios for ECA Countries (1989–1991)



Sources: ILO, FAOSTAT, USDA.

Cut-off points are assigned to distinguish between different levels of reform, as for labor-land ratios (Figure 4). A cut-off point of 7.0 is used to distinguish between countries that have actively pursued reform and transition and those that have chosen to delay or truncate reform. Among the countries that have actively pursued reform a further distinction is made between those that are members of the EU ("accession" countries) and those that are not ("transition" countries). Accession countries are characterized by an advanced level of reform and a high level of support for agriculture. Hence Turkey is included in the accession group, even though it is not a member of the EU. The transition countries differ from the accession countries in that although they have actively implemented economic reform, they are poorer and have yet to reap the full benefits of economic transformation. Countries below the reform cut-off point are referred to as the "truncated" reform countries.

Figure 4. Reform Status: Average of Land and Market Reform Indices 2005



Source: World Bank.

Based on these criteria the following categorization of countries is used for purposes of analysis (Table 1). The labor extensive transition category (LETRA) includes only one country, Kazakhstan, which limits its value for analysis. Results for this category are presented for the sake of completion but don't allow for any meaningful conclusions.

Table 1. Country Groupings According to Labor Resource Base and Reform Pathways

Reform	Labor Intensive			Labor Extensive		
	Accession	Transition	Truncation	Accession	Transition	Truncation
Acronym	LIEA	LITRA	LITRU	LEEA	LETRA	LETRU
Countries	Bulgaria Croatia Poland Romania Slovenia Turkey	Albania Armenia Georgia Kyrgyzstan	Azerbaijan Moldova Tajikistan Uzbekistan	Czech Rep Estonia Hungary Latvia Lithuania Slovakia	Kazakhstan	Belarus Russian Federation Ukraine
Labor/ha	0.31	0.70	0.59	0.15	0.03	0.13
Land Reform Index	8.83	7.75	5.75	8.50	8.00	4.33
Market Reform Index	8.67	8.00	5.50	8.50	7.00	5.00

Sources: World Bank, FAOSTAT.

IV TRENDS IN MACHINERY USE AND INVESTMENT AND FARM LABOR

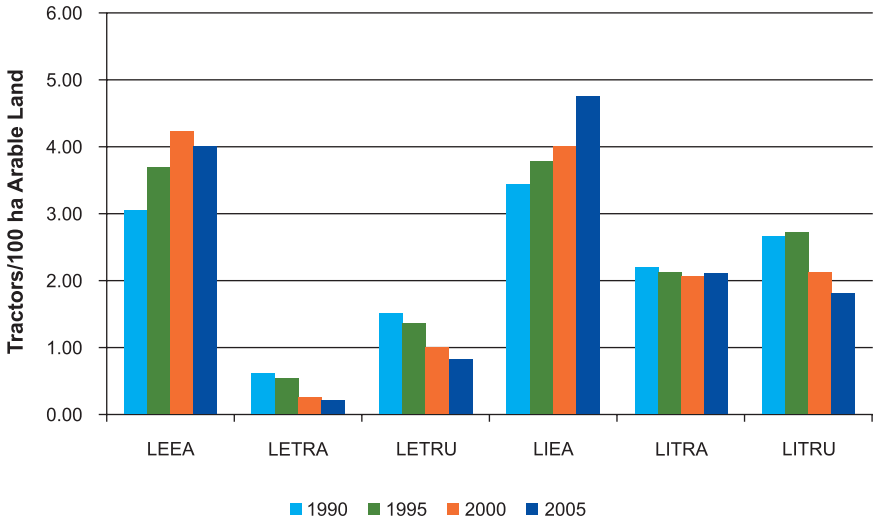
Broad trends in farm machinery use and investment are examined in this chapter, together with corresponding trends in farm labor supply. The use of tractors, horses and combines, measured as the number of units per 100 hectares of arable land, is examined for the period 1990–2005. With the caveats noted in chapter III, tractor numbers rather than tractor horsepower is used as the measure of tractorization. Horses are included in the analysis to indicate the role of alternative sources of power for mechanization. The country groupings used are as described in Table 1, but Croatia and Slovenia are omitted from the LIEA countries and Uzbekistan is omitted from the LITRU countries due to inadequate data. Trends in the import of tractors and combines are reviewed for the period 1996–2005, as an indicator of investment in farm mechanization. Analysis is based on the $US dollar value of imports per hectare of arable land, in constant (2000) dollars. The use of ploughs and seeders is also reviewed, albeit with a more limited data set.

IV.1 TRACTORS, HORSES AND COMBINES

Farm labor endowments have a strong influence on tractor numbers, with higher overall levels of tractorization observed in countries with more labor-intensive agriculture (Figure 5). Reform pathways are also pertinent, with high and increasing tractor numbers in the accession countries, stable tractor numbers in the (labor-intensive) transition countries and declining tractor numbers in the truncated reform countries. These trends provide strong support for the conceptual framework outlined in chapter III.

Tractor numbers are highest and have increased most rapidly, in the labor-intensive European accession countries (LIEA). Land reform resulted in the proliferation of small farms in these countries, and as every farmer wants his own tractor, numbers increased by 38% from 1990–2005. Tractor numbers are slightly lower and have increased more slowly among the labor extensive European accession countries (LEEA), as would be expected. Much larger farms have emerged from land reform in these countries, with fewer, but more powerful tractors as the preferred option. Horses are of limited importance in the LEEA countries, as would be expected, and their use has declined in LIEA countries as tractor use has increased (Figure 6).

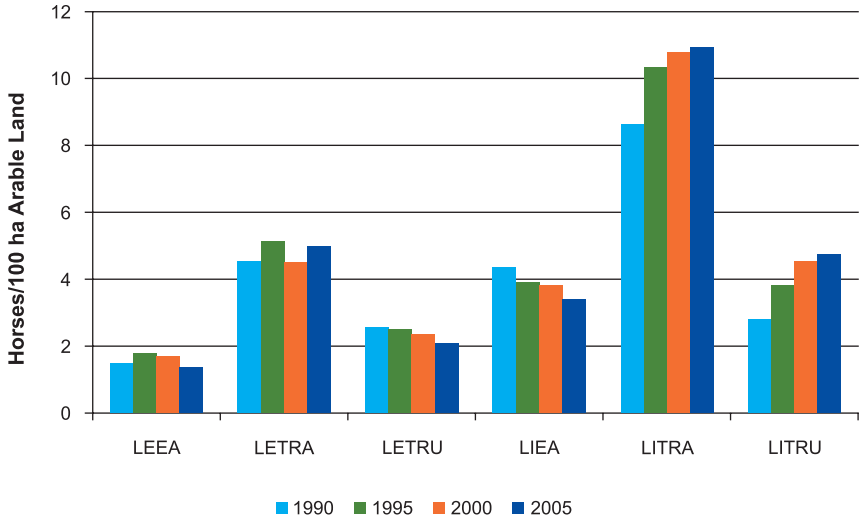
Figure 5. Tractor Use in the ECA Region (1990–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries;TRA – Transition Countries; TRU – Truncated Reform Countries.

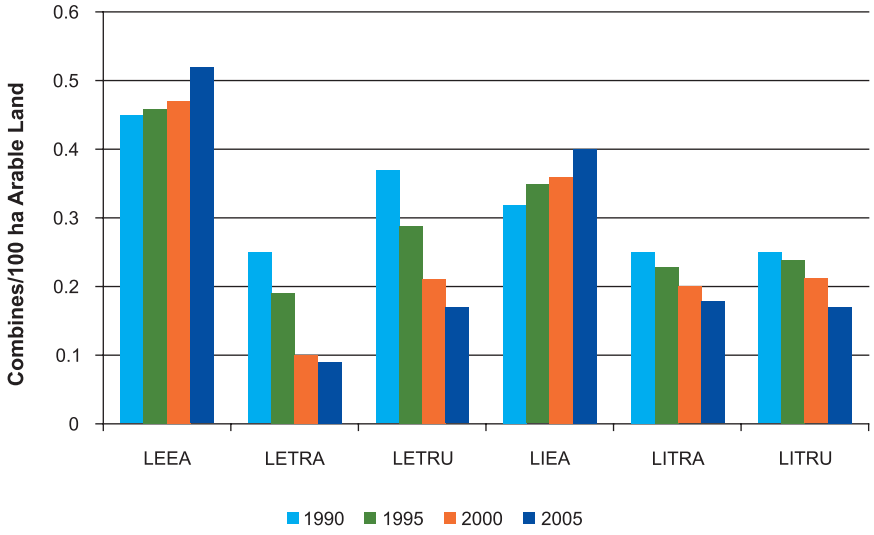
Tractor numbers remained static in the labor-intensive transition countries (LITRA), despite good progress with land reform, but horse numbers have increased. The new generation of small-scale farmers is using horses rather than tractors as their energy source for mechanization. Tractor numbers have declined significantly where reform has been truncated, by 32% in labor intensive countries and 45% in labor extensive countries. This has been offset by increased use of horses in the labor intensive countries (LITRU), but not in the labor extensive countries (LETRU). The combination of falling tractor numbers, falling horse use and low labor endowments suggests that the LETRU countries are facing increasing resource constraints for agriculture.

Figure 6. Horse Use in the ECA Region (1990–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries;TRA – Transition Countries; TRU – Truncated Reform Countries.

Figure 7. Combine Use in the ECA Region (1990–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries;TRA – Transition Countries; TRU – Truncated Reform Countries.

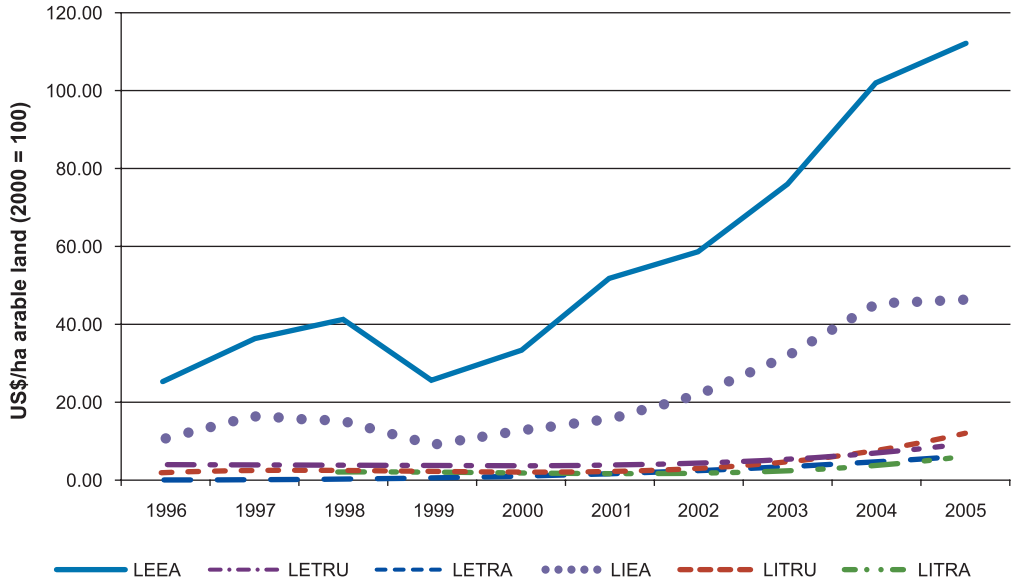
As cereals account for more than 80% of the area cultivated in the ECA region[9], the capacity to ensure timely, efficient harvesting is important for agriculture. Reform pathways have a marked influence on the use of combines (Figure 7), with increased combine numbers in the accession countries, especially since

[9] Cereal production accounted for 82.2% of arable land in 2005. FAOSTAT

2000, and declining combine numbers in the transition and truncated reform countries. As with tractors, this fall is most pronounced in the labor extensive countries (LETRU) where labor supply is low. Differences in labor endowments have limited influence on the use of combines, as they are typically owned by contractors and/or large farms. Overall rates of use are thus similar in both situations.

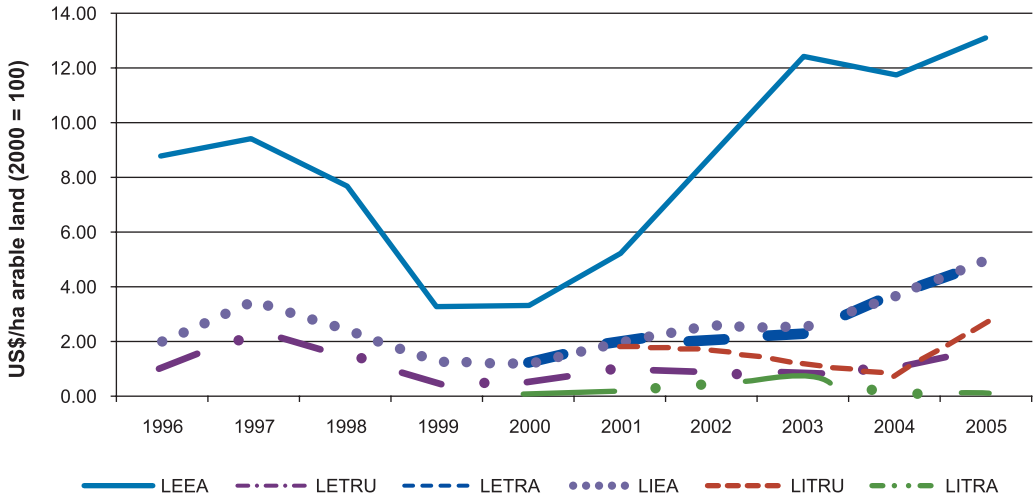
With the exception of Belarus, the ECA countries rely on imports for most or all of their new machinery. Trends in imports thus provide a useful indicator of levels of investment, and add further insight to the analysis of farm mechanization. For both tractors and combines, all of the ECA countries exhibit similar trends in imports: with an initial increase from 1996–1998 as the benefits of reform began to accrue, a sharp contraction from 1998–1999 following the collapse of the ruble, and increasing investment thereafter (Figures 8, 9).

Figure 8. Tractor Imports – ECA Region (1996–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries;TRA – Transition Countries; TRU – Truncated Reform Countries.

Figure 9. Combine Imports – ECA Region (1996–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Sources: COMTRADE, FAOSTAT.

Significant differences occur in both the levels of investment after 2000 and the rate at which investment increases. For tractors, the strongest investment is observed in the European accession countries, particularly in the LEEA countries. These higher rates of investment are consistent with the increase in tractor numbers in these countries from 1995–2005 (Figure 5).

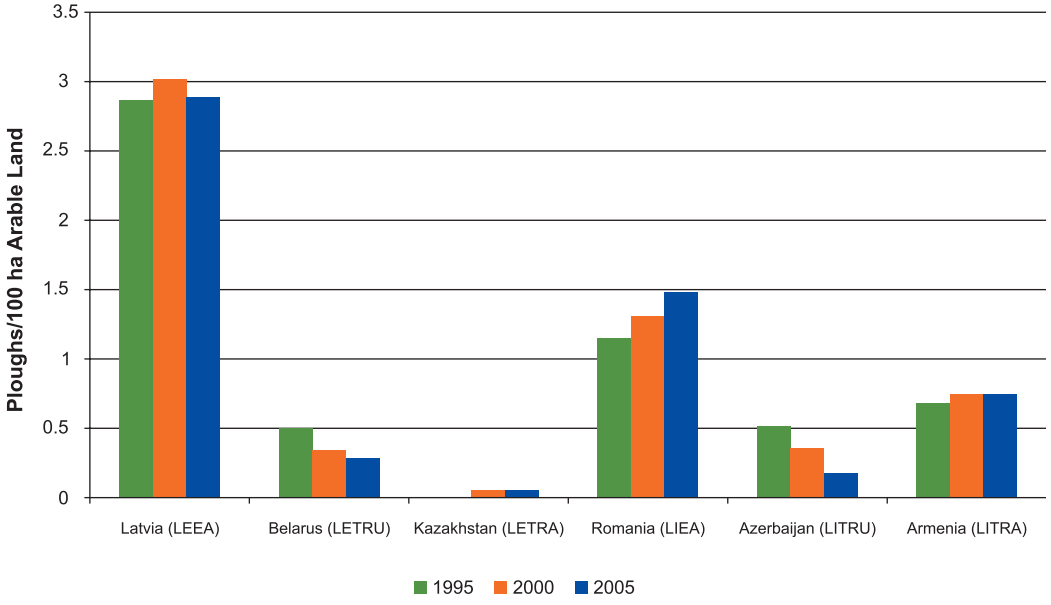
Tractor investment rates were low in the transition and truncated reform countries, both before and after 2000. In the transition countries these investment rates appear to have been sufficient to replace existing stock, and thus retain overall tractor numbers at a constant level. But in the truncated reform countries investment rates appear to be too low to prevent de-mechanization. As noted above, this trend is of particular concern for the truncated reform countries where labor extensive agriculture prevails. Of these countries, only Belarus has a domestic manufacturing capacity for tractors sufficient to offset this trend.

For combines, the level of investment also appears to be highest in the labor extensive European accession countries (LEEA). The marked increase in imports is also consistent with the increased in combine numbers in these countries since 2000 (Figure 7). Import levels are much lower in the labor-intensive European accession (LIEA) countries, but they seem to be high enough to allow for an increase in combine numbers, particularly since 2000. Among the transition and truncated reform countries, it appears that the increase in imports since 2000 has not been high enough to ensure the replacement of existing machinery – hence the observed decline in combine numbers (Figure 7).

IV.2 PLOUGHS AND SEEDERS

Due to limited data, analysis of the use of ploughs' and seeders' was done for one country from each of the respective country groupings (Figures 10 and 11). Ploughs are examined as they are the most widely used cultivation implement, and seeders are examined as an example of control intensive mechanization.

Figure 10. Plough Use in Selected ECA Countries (1995–2005)

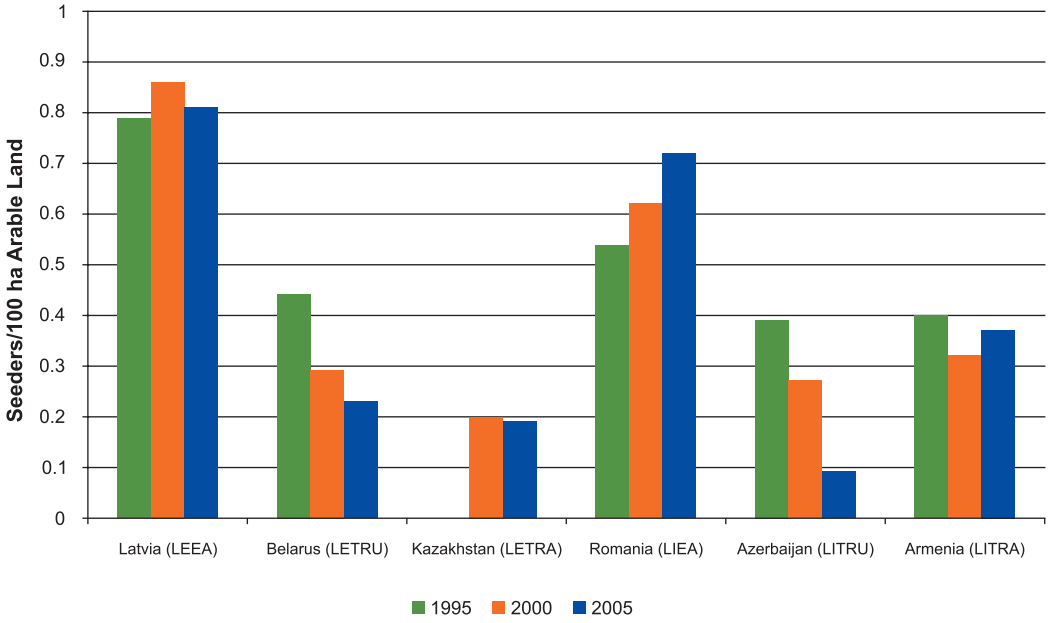


LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Sources: FAOSTAT.

The general trends observed are similar to those observed for tractors and combines. The more advanced European accession countries, Latvia and Romania, show high and increasing numbers for both implements,

with a rapid increase observed in labor intensive Romania. A somewhat higher rate of increase is observed for seeders relative to ploughs, consistent with the view that control intensive activities will be mechanized more rapidly in more advanced, intensive production systems where farm wages are high. The differences are not strong however. As with tractors and combines, the number of ploughs and seeders remained fairly static in the transition countries (Armenia and Kazakhstan) and declined for the truncated reform countries (Azerbaijan and Belarus).

Figure 11. Seeder Use in Selected ECA Countries (1995–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Source: FAOSTAT.

IV.3 SCALING UP AND WEARING DOWN

The divergent trends in tractor use and investment between the accession countries and other ECA countries have further implications for farm mechanization. In the accession countries, larger more powerful tractors are becoming an increasing proportion of the tractor fleet. Conversely, low investment rates and declining tractor numbers in the other ECA countries are causing a significant ageing of the tractor fleet. Available country evidence is reviewed below to examine the extent of these influences.

Changes in the composition of tractor fleets in Hungary, the Czech Republic and Slovenia indicate that there has been some scaling up but that it is modest (Table 2). This scaling up is strongest in the labor extensive countries. In both Hungary and the Czech Republic the proportion of small (<40 kw) and medium sized (40–60 kw) tractors declined from 2000–2005, with a corresponding increase in the proportion of 60–100 kw tractors. The proportion of tractors >100 kw also increased but it remained a small part of the fleet. In neither case was there a dramatic shift to super-tractors. Small and medium-sized tractors still account for 60–70% of the total fleet, and most of the increase has occurred in tractors of 60–100 kw.

Comparable trends in Slovenia suggest that any scaling up of tractor power among the labor-intensive accession countries has also been moderate. Small tractors (<40 kw) declined as a proportion of the total from 2000–2005, with a corresponding increase in tractors of 40–100 kw. But small tractors still account for about 70% of the total tractor fleet and tractors of >100 kw for less than 1%.

The low rate of investment in farm machinery before 2000, even in the accession countries, has resulted in a significant ageing of the farm machinery fleet. Among the countries for which data is available, 70–90% of tractors and combines are more than 10 years old (Table 3). In Central Asia, 56–92% are more than 15 years old. Assuming a useful life of 12 years, no more than 17% of a machinery fleet should be over 10 years old if replacement investment is adequate.

Table 2. Changing Composition of Tractor Power, Selected Countries

Country	Number of Tractors		Percent of Total	
	2000	2005	2000	2005
Hungary	123,537	128,251	100%	100%
> 40 kw	59,558	49,282	48.2%	38.4%
40–59 kw	44,467	41,677	36.0%	32.5%
60–100 kw	11,435	27,255	9.3%	21.3%
> 100 kw	8,047	10,037	6.5%	7.8%
Czech Republic	94,607	87,039	100%	100%
> 40 kw	24,440	14,685	25.8%	20.2%
40–59 kw	45,058	10,464	47.6%	38.0%
60–100 kw	15,970	4,311	16.9%	27.9%
> 100 kw	9,139	1,697	9.7%	13.8%
Slovenia	108,166	103,756	100%	100%
> 38 kw	81,022	70,708	74.9%	68.1%
38–59 kw	24,425	27,366	22.6%	26.4%
60–90 kw	2,431	5,199	2.2%	5.0%
> 90 kw	288	483	0.3%	0.5%

Sources: Statistical Yearbooks: Hungary, Czech Republic, Slovenia. 2006.

The predominance of older farm machinery raises maintenance costs due to the need for more frequent repairs, and operating costs due to the lower fuel efficiency of older tractors and combines. Tractors and combines are also non-operational for longer periods, with associated losses in productivity and profits due to late planting, late weeding and late harvesting.

Table 3. Ageing of the Farm Machinery Fleet, Selected Countries

Country	> 10 Years Old (%)	> 15 Years Old (%)
Kyrgyzstan (2003)		
Tractors	na*	92%
Combines	na	86%
Tajikistan (2006)		
Tractors	80%	na
Uzbekistan (2004)		
Tractors	na	60%
Combines	na	56%
Kazakhstan (2006)		
Tractors	80%	na
Russia (2006)		
Tractors	83%	na
Combines	73%	na
Czech Republic (2007)		
Tractors	84%	na
Combines	78%	na

*na – not data.

Sources: Kyrgyzstan: Agricultural Census 2003. Goscomstat; Tajikistan, Ministry of Agriculture estimates, 2006; Uzbekistan: World Bank Report, 2007; Russia, Kazakhstan FAO, 2008; Czech Republic, Statistical Year Book, 2008.

These problems will not be resolved quickly or easily. Tractors and combines are typically replaced gradually, even where investment conditions are favorable. In countries such as Kyrgyzstan and Tajikistan, where private markets for tractors and combines are extremely thin and public resources for farm machinery acquisition are minimal there is no immediate prospect of improved investment. The farm machinery fleet in these countries will thus continue to age, decline and deteriorate for the foreseeable future.

IV.4 TRENDS IN FARM LABOR

The extent to which mechanization replaces labor and so reduces a source of rural employment, and the extent to which mechanization enhances the returns to labor are both key issues for the analysis of farm mechanization. Farm labor data are drawn from the ILOSTAT series reported by the ILO, supplemented where necessary by national statistics. As noted in chapter III, a broad ILO definition of farm labor is used, which includes salaried staff on commercial farms', self-employed farmers and unpaid family labor.

Widely divergent trends in farm labor supply have occurred since 1990, with a marked decline in some countries and equally marked increases in others (Table 4).

Table 4. Changes in Farm Labor Supply 1990–2005

	Countries	1990–1995	1995–2000	2000–2005	1990–2005
LEEA	CZE, EST, HUN, SVK	–52.0%	–23.5%	–22.9%	–71.7%
LETRA	KAZ	na*	na	na	na
LETRU	UKR	6.2%	–6.7%	–19.5%	–20.3%
LIEA	BGR, POL, ROM, SLO, TUR	–2.6%	–7.9%	–20.0%	–28.3%
LITRA	ALB, ARM, KYR	31.2%	8.1%	–12.3%	24.4%
LITRU	AZE, MOL, TJK, UZB	13.1%	1.7%	0.0%	15.0%

*na – not data.
LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Source: ILO (ILOSTAT).

Farm labor supply has fallen to varying degrees in all of the European accession countries. The significant decline in labor extensive accession countries is due largely to the widespread labor shedding that occurred in the early stages of reform (1990–1995), although farm labor has continued to leave agriculture since then. In contrast, most of the fall in farm labor in the labor-intensive accession countries has occurred since 2000, suggesting that it reflects a voluntary outmigration of labor. In labor-intensive transition countries most of the increase in farm labor occurred during the early stages of reform (1990–1995) in response to economic collapse in other sectors. The decline in farm labor since 2000 suggests that these countries are now also experiencing an outmigration of farm labor due to the growth of alternative employment opportunities in other sectors and in other countries.

Labor shedding was minimal among the truncated reform countries and farm labor supply increased during the early stages of reform. Most of these countries opted for slower farm privatization and minimal labor shedding. In the labor extensive countries (LETRU) there has been an overall fall in farm labor nevertheless, due to accelerating labor outmigration since 2000. This recent trend is less evident in the labor-intensive countries (LITRU), where the farm labor supply has been relatively stable since 1995.

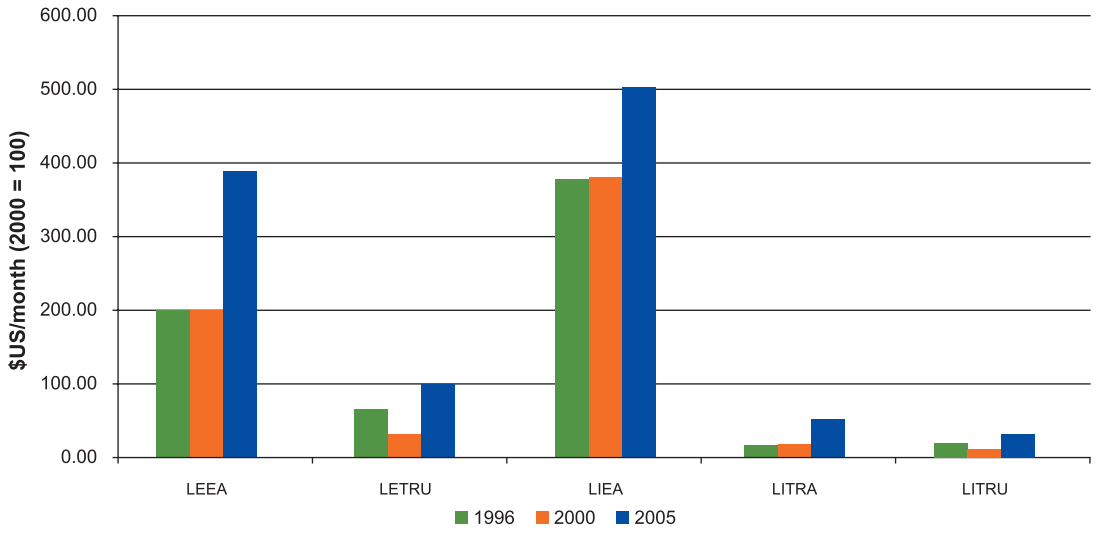
V FACTOR PRICES, FACTOR RATIOS AND PRODUCTIVITY

This chapter examines the relationship between factor prices and factor use, and the impact of farm mechanization on agricultural productivity. The focus shifts to labor-capital ratios rather than specific factors of production as productivity is driven by the joint use of land, labor and capital. Farm wages are defined as the gross monthly wage in constant $US (2000 = 100), with data drawn from ILO. The impact of both nominal and real interest rates is examined using data from the World Bank Development Indicators. Analysis focuses on the period after economic recovery began, from 1996–2005. The chapter ends with a discussion of the implications of farm mechanization for rural poverty.

V.1 FARM WAGES AND INTEREST RATES

Real farm wages have increased in all ECA countries since 1996, with a strong increase from 2000–2005 following recovery from the ruble collapse in 1998 (Figure 12). The highest wage levels occur in the European accession countries, as would be expected, particularly where labor-intensive agriculture prevails. The LIEA countries have experienced the lowest overall increase in real farm wages (33%), however, suggesting a weakening demand for farm labor. Real farm wages remain low in the transition and truncated reform countries, despite a significant increase. This increase is most pronounced in the labor-intensive transition countries, where real wages increased by 287% from 1996–2005. For the truncated reform countries farm wages increased by 115% in the labor extensive countries (LETRU) and 83% in the labor-intensive countries (LITRU). The truncated reform countries experienced a very sharp increase in wages from 2000–2005 (204% and 162%, respectively). These increases are high because they are from a very low base, but they indicate that the underlying demand for labor remains high. This is consistent with the declining availability of both farm labor and farm machinery – particularly in the labor extensive countries (LETRU).

Figure 12. Farm Wage Rates ECA Region (1996–2005)

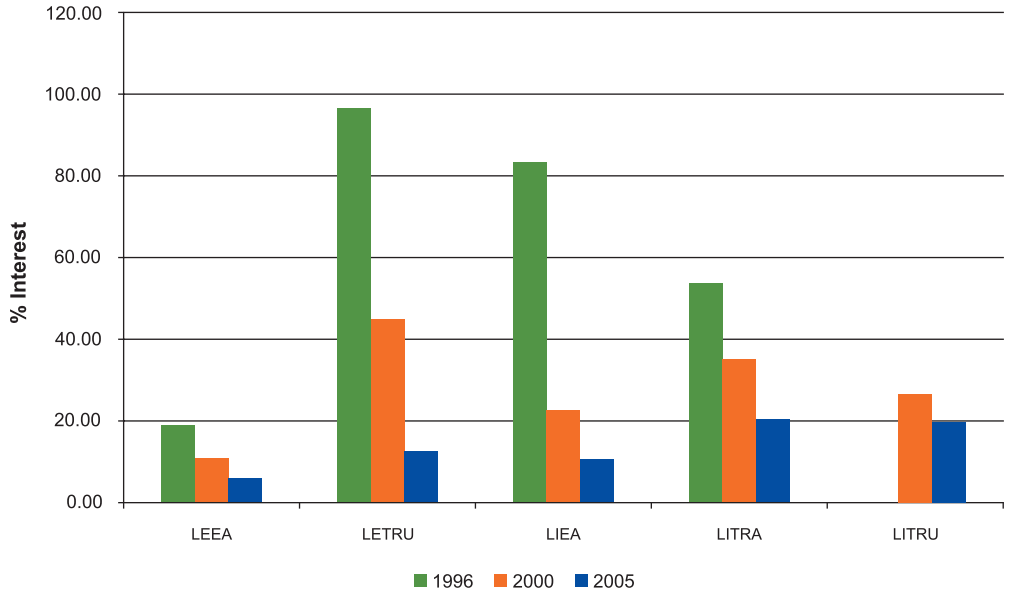


LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Source: ILO.

Nominal interest rates have fallen significantly in all ECA countries (Figure 13), converging towards a band of 6%–20% by 2005. Equivalent trends in real interest rates (Figure 14) show that finance is more costly in

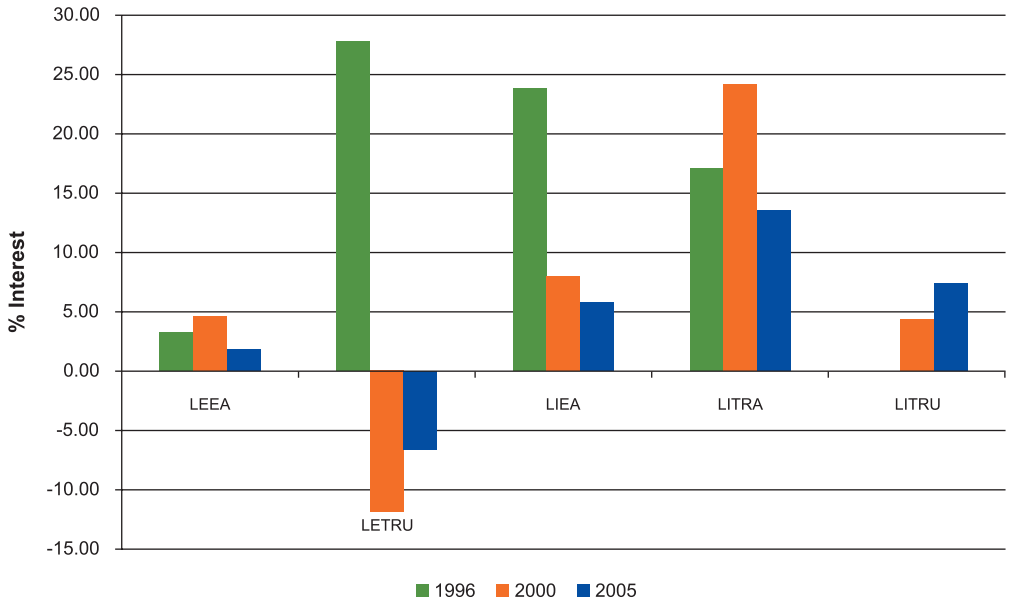
real terms in labor-intensive countries – particularly in the transition countries. Among the labor-intensive truncated reform countries, real interest rates increased from 2000–2005. In comparison, real interest rates are very low in labor extensive accession countries and negative in labor extensive truncated reform countries.

Figure 13. Nominal Interest Rates ECA Region (1996–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.

Figure 14. Real Interest Rates ECA Region (1996–2005)



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Source: World Bank Development Indicators.

The overall pattern has thus been an increase in farm wage rates and a decrease in interest rates. If factor markets are working, farm mechanization should gradually increase in response to these trends. Yet the pattern of farm mechanization has varied widely in response to differences in resource endowments and reform pathways, as shown in chapter IV.

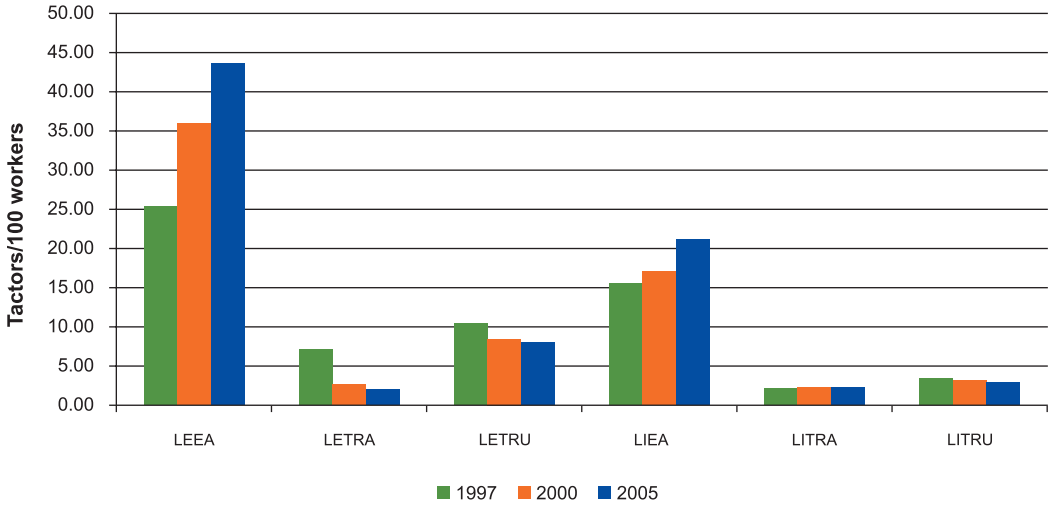
In the accession countries the combination of high wages and low interest rates has clearly facilitated the significant increase in farm mechanization. And this influence is strongest among the labor extensive accession countries, where interest rates are lowest. Among the labor-intensive transition countries, lower wages and higher interest rates appear to have reduced the incentive to mechanize – at least with tractors and combines. Tractor and combine use has remained stable while the use of horses has increased. Horses appear to provide a lower cost source of power for mechanized operations.

A similar pattern is observed among labor-intensive truncated reform countries, which also exhibit low farm wages and higher interest rates. But in this case the increased use of horses occurs together with a decline in the use of tractors and combines. Factor markets appear to be even weaker in the labor extensive truncated reform countries. Farm mechanization has declined rather than increased in response to low interest rates and high farm wages, with no offsetting increase in the use of horses. It thus appears that strong changes in factor prices have not elicited a corresponding change in factor use in the truncated reform countries, with less machinery and an ageing machinery fleet as a result.

V.2 THE INFLUENCE OF FACTOR PRICES ON FACTOR RATIOS

The trends described above are reflected in the changing pattern of capital/labor ratios (Figure 15), as measured by the number of tractors/100 farm workers. Capital-labor ratios are higher in the labor extensive agricultural economies, as would be expected. An increase in capital/labor ratios is only observed in the European accession countries, reflecting their gradual integration and alignment with the OECD countries. Elsewhere, capital-labor ratios are flat in the labor-intensive transition and truncated reform countries, and declining in the labor extensive transition and truncated reform countries.

Figure 15. Capital/Labor Ratios – ECA Region

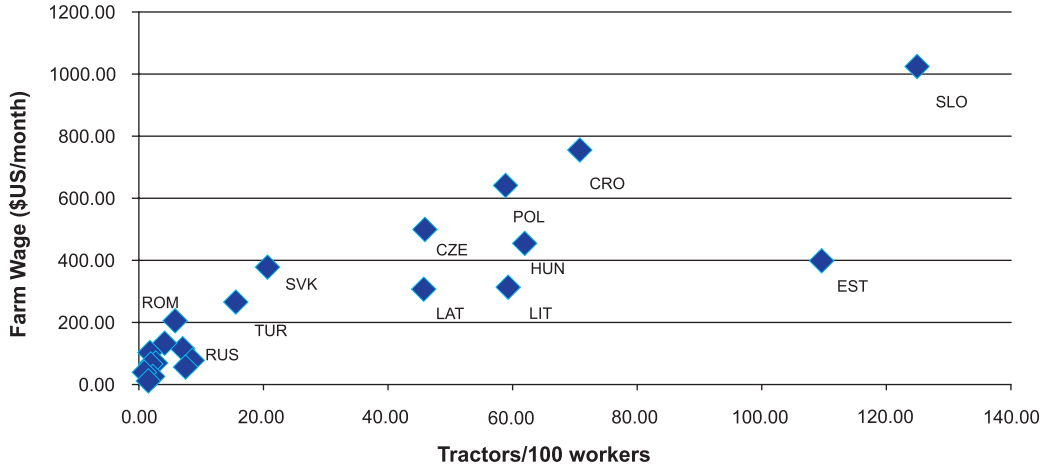


LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Sources: FAOSTAT, ILO.

Both wages and interest rates are strongly associated with factor ratios. Higher wages exert a strong positive influence on capital-labor ratios (Figure 16), with capital being substituted for labor as wages increase – as expected. Only accession countries exhibit this relationship, however. The lowest capital-labor ratios are all observed among the low wage transition and truncated reform countries. Lower interest rates exert a positive influence on capital-labor ratios (Figure 17), but the impact levels off when nominal interest rates fall to a range of 5%–10%. Once interest rates fall to this level, wage rates appear to have a greater influence on

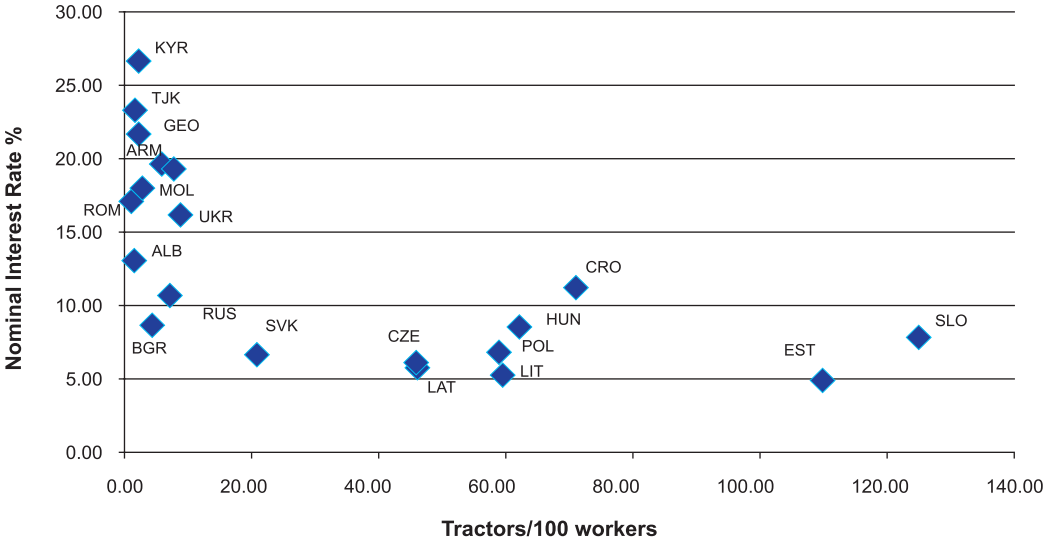
capital-labor ratios. These results suggest that changes in wage rates and labor supply are a more powerful influence on capital-labor ratios than changes in interest rates and levels of capital investment.

Figure 16. Capital-Labor Ratio versus Farm Wage (2005)



Sources: FAOSTAT, ILO.

Figure 17. Capital-Labor Ratio versus Nominal Interest Rate (2005)



Sources: FAOSTAT, World Bank.

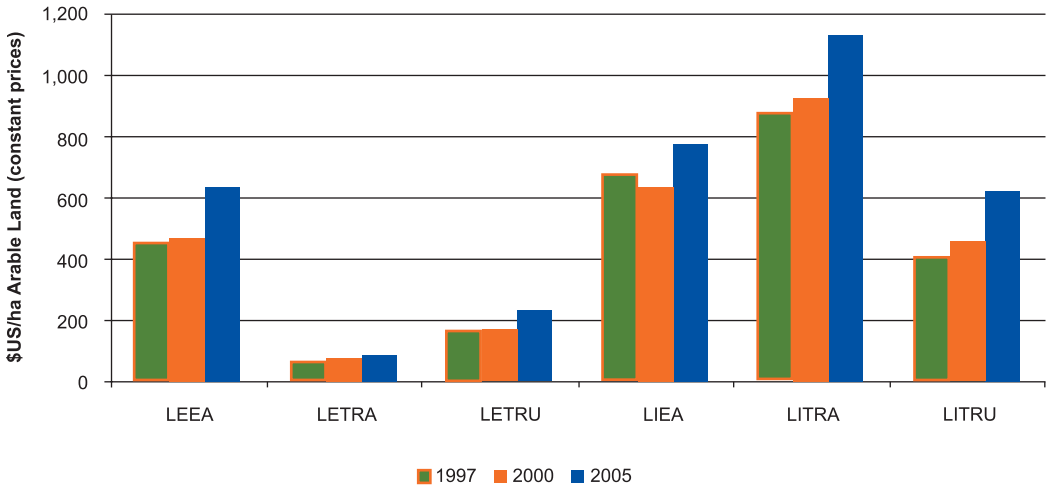
The countries with the highest capital-labor ratios exhibit both high wages and low interest rates, and all are European accession countries. Not all of the accession countries follow this trend however, with Romania, Bulgaria and Slovakia still facing higher interest rates, lower wages and lower corresponding capital-labor ratios' in 2005. The transition and truncated reform countries are also characterized by higher interest rates, lower wages and lower capital-labor ratios'. Labor intensity has no discernable impact on this trend among the transition and truncated reform countries.

V.3 FARM MECHANIZATION AND AGRICULTURAL PRODUCTIVITY

Agricultural productivity increased significantly in all of the ECA countries from 1997–2005, both per hectare and per farm worker (measured as agriculture valued-added at constant (2000) prices in $US). Overall, productivity/ha was highest in the labor-intensive agriculture economies (Figure 18) and productivity/farm

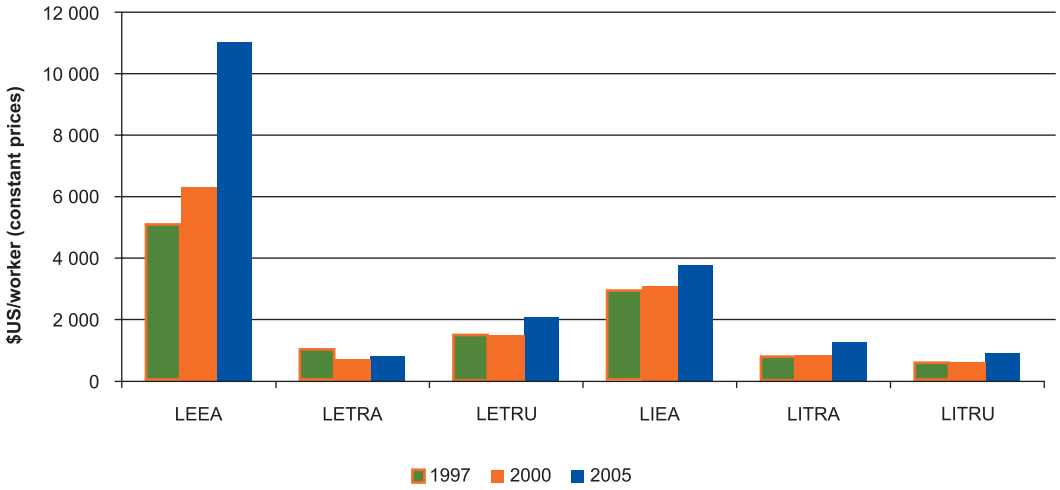
worker was highest in the labor extensive agriculture economies (Figure 19). In each case farmers appear to be maximizing returns to the most limiting resource.

Figure 18. Trends in Agriculture Value-Added/ha – ECA Region



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.

Figure 19. Trends in Agricultural Value-Added/farm worker – ECA Region



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Sources: ILO, World Bank Development Indicators.

As agricultural productivity is influenced by numerous factors, regression analysis is used to determine the extent to which it is influenced by farm mechanization. The underlying model is based on a system of simultaneous equations (as specified below) in order to account for the joint endogeneity of labor and capital in the production function.

(1) Agricultural VA/ha = f(farm labor$_t$/ha, tractor number$_{t-1}$/ha, tractor investment$_t$/ha, horses$_t$/ha, fertilizer use$_t$/ha, wheat price$_t$, reform pathway dummy, labor intensity dummy, trend variable).

(2) Farm labor$_t$/ha = f (farm wages$_t$, wheat price$_t$, tractor number$_{t-1}$/ha, tractor investment$_t$/ha, horses$_t$/ha, reform pathway dummy, labor intensity dummy, trend variable).

(3) Tractor investment$_t$/ha = f(farm wages$_t$, wheat price$_t$, tractor number$_{t-1}$/ha, tractor investment$_t$/ha, horses$_t$/ha, nominal interest rates$_t$, reform pathway dummy, labor intensity dummy, trend variable).

Capital inputs are disaggregated into tractor stocks at time (*t–1*) plus tractor investment at time *t*, in order to examine the influence of both past and current investment in mechanization.

These relationships were analyzed with panel data (16 countries for 1998–2005) in logarithmic form, using a random effects model estimated by generalized least squares (GLS) in STATA. As STATA does not have an estimation procedure that handles both panel data and simultaneous equations, the estimated values of farm labor and tractor investment from equations (2) and (3) were manually substituted into equation (1) to remove endogeneity.

The model was estimated separately for: all countries, accession countries, transition and truncated reform countries, labor-intensive countries and labor extensive countries. The response elasticities for the main parameters of the production function are reported in Table 5 below. Full results for all three equations are reported in Appendix II.

Table 5. Determinants of Agricultural Value Added/ha – Response Elasticities

Parameter	Response Elasticity				
	All Countries	Accession Countries	Transition and Trunc. Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Labor/100 ha	ns*	ns	ns	1.53***	0.81***
Tractors/100 ha (t–1)	ns	0.23***	ns	ns	–0.76***
Tractor Investment/ha	0.19***	0.16***	ns	0.42***	ns
Horses/100 ha	ns	ns	ns	–0.33**	–0.25***
Fertilizer Use/ha	0.05***	0.08***	ns	ns	ns
No. of Observations	126	72	54	70	56

*ns – not statistically significant.
** Statistically significant at 1%.
*** Statistically significant at 5%.
(A response elasticity of +0.60 for tractor use indicates that a 10% increase in the number of tractors will lead to a 6% increase in agricultural productivity).

Tractor investment has a positive impact on agricultural productivity for all countries together, accession countries and labor-intensive countries. The level of tractor stocks has a positive impact on productivity in accession countries and a negative impact in labor extensive countries. This negative coefficient is consistent with the trend towards fewer, larger tractors on large-scale farms as a means to improve efficiency – as suggested by the decline in tractor numbers on large-scale accession farms in Figure 5. Five of the seven countries included in this regression are accession countries. The non-significant results for transition and truncated reform countries are attributed to the combined effects of the small sample size and limited change in the parameters of interest. Of the other variables, fertilizer use has a small positive impact on productivity for all countries and accession countries. The significant coefficients for labor use and horse use in the labor intensive and labor extensive country regressions are difficult to explain, but are included for the sake of completion.

These results suggest that mechanization does contribute to agricultural productivity, and that its impact is conditioned by the level of reform and the labor intensity of production. The overall impact is modest, however, consistent with the view that mechanization is an adjunct to more fundamental changes rather than a major vector for change in itself. Mechanization appears to have a stronger impact on productivity where reform is well advanced. Its impact in countries with modest progress in implementing reform is unclear. Ultimately, however, it is the combination of capital and labor that influences productivity rather than one or the other individually. Mechanization is more likely to be a significant influence in accession countries where the cost of labor is high and less likely to be influential in transition and truncated reform countries where wages are low. Its importance will thus increase as countries modernize and wages increase.

In labor-extensive truncated reform countries such as Russia and Ukraine the influence of a declining, ageing machinery fleet on agricultural productivity is more difficult to discern against a background of agricultural growth. It is present nevertheless, as evidenced by the annual production losses associated with the lack of combines in Ukraine and the declining area cultivated in Russia. These trends are an impediment to growth.

V.4 FARM MECHANIZATION AND RURAL POVERTY

Mechanization is increasingly accessible to the small-scale farmers who account for most of the rural poor (chapter VIII). A wide range of low-cost, small-scale farm machinery is now manufactured, suited to most conditions, crops, and farm operations. Larger machines still retain some unit cost advantages, but these advantages are less important in low wage economies as they usually derive from savings of operator labor. The cost of smaller farm machines has been further reduced by the growth of manufacturing in developing countries such as China, India and Brazil. Low income, small-scale farmers are the major market for these manufacturers and their products are scaled and priced accordingly. This low-cost, small-scale machinery reduces the bottlenecks associated with time-bound cultivation operations, and provides transport for farmers to their fields and to rural markets. Private rental markets create further opportunities for small-scale farmers to mechanize their operations in a cost-effective manner. These increasingly active rental markets allow small-scale farmers to engage in more power intensive cropping systems, with higher potential returns, which would otherwise be beyond their means.

Farm mechanization can affect the welfare of rural people in two ways, by influencing farm productivity and so incomes, and/or by substituting capital for farm labor – to the detriment of income. There is no evidence that increased farm mechanization raises the incomes of low-income famers, and reduces rural poverty. The preceding analysis suggests that, where reform is advanced, farm mechanization may have a positive impact on rural incomes by raising agricultural productivity. Its impact on poverty in less reform-minded countries is unclear.

The study shows that farm mechanization has not compromised poverty reduction, however, by reducing farm employment in the low and middle-income non-accession countries, or by reducing rural wages. Farm labor either increased or remained stable during the early period of reform from 1990–1995 (Table 4). The economic recovery since 1995 has been associated with **stable** mechanization and **stable** farm labor among the labor intensive transition countries, **declining** mechanization and **stable** farm labor in the labor intensive truncated countries, and **declining** mechanization and **declining** farm labor among the labor extensive truncated reform countries (Table 6). There is no evidence of increasing mechanization and declining farm labor during this period, and real farm wages have increased significantly.

Table 6. Changes in Tractor Use, Farm Labor and Farm Wages (1995–2005)

Country Group	Tractor Use	Farm Labor	Farm Wages
Labor Extensive/European Accession (LEEA)	↑ (9%)	↓ (–21%)	↑ (103%)
Labor Intensive/European Accession (LIEA)	↑ (27%)	↓ (–28%)	↑ (30%)
Labor Extensive/Transition (LETRA)	na*	na	na
Labor Intensive/Transition (LITRA)	↔ (0%)	↔ (–5%)	↑↑ (287%)
Labor Extensive/Truncated Reform (LETRU)	↓ (–40%)	↓ (–25%)	↑ (115%)
Labor Intensive/Truncated Reform (LITRU)	↓ (–37%)	↔ (2%)	↑ (83%)

*na – not data.

In contrast, increased farm mechanization in the higher income European accession countries since 1995 is associated with reduced farm employment. This pattern is consistent with the conclusion of Binswanger and Donovan (1987, *op cit*) that the substitution of capital for labor usually occurs in more advanced economies where farm wages are driven up in response to increased demand for labor in non-agricultural sectors.

VI DETERMINANTS OF DEMAND FOR FARM MECHANIZATION

The determinants of demand for farm mechanization are examined in this chapter, with particular emphasis on the impact of policy reform and access to finance. Further insight into the relative importance of labor and capital for farm mechanization is obtained from an empirical analysis of the demand for investment in tractors and combines.

VI.1 THE POLICY ENVIRONMENT

The conceptual framework for this study argues that land reform and market liberalization are the basis for economic transition in agriculture. These reforms create the incentive for farmers to increase capital-labor ratios, by reducing farm labor and/or increasing farm mechanization. Once this reform "threshold" is attained investment in farm machinery will be influenced by the reform and development of financial markets, and economy-wide reform of the policies that influence trade, foreign exchange, competition and the business environment. More advanced reforms facilitate higher levels of investment. If these postulates hold, investment in farm machinery will remain low until land reform and market liberalization are well advanced; and will then grow as economy-wide reforms are implemented.

To test this framework we compare trends in tractor imports (as a proxy for investment) from 1993–2006, with parallel trends in policy reform indices compiled annually for each country by the World Bank and the European Bank for Reconstruction and Development (EBRD). The level and pattern of tractor imports varies widely among countries, with a general upward trend since 2000 (chapter IV). The timing, speed and extent of reform also differ widely among countries, as indicated by the patterns of change in the policy reform indices. The influence of reform can thus be gauged from the level of reform extant at successively higher levels of imports.

For countries that had tractor import levels of more than $10/ha arable land in 2005, the relevant reform indices were noted for the year in which tractor imports were close to $10, $20, $50 and $100/ha of arable land in constant $US (2000 = 100). The World Bank indices for land reform, price and market liberalization and rural finance are based on a scale of 1–10. For these indices, reform was deemed to be at an advanced stage once the reform index reached 7. The EBRD indices for privatization, bank reform and interest rate liberalization, non-bank financial institutions and securities markets, competition policy and trade and foreign exchange policy are based on a scale of 1–4+. For these indices, reform was deemed to be at an advanced stage once the reform index reached 3.67. A full description of these indices is presented in Appendix I.

VI.1.1 Policy Incentives to Mechanize

There is strong support for the hypothesis that land reform, market liberalization and farm privatization need to be well advanced to create adequate incentives for investment in farm machinery (Table 7). In most of the reform-oriented countries, even low tractor import levels of $10–15/ha arable land were not achieved until the World Bank indices of land reform and market liberalization had reached at least 7, and the EBRD indices of privatization had reached at least 3. These reform thresholds were reached earlier among the labor extensive agricultural economies (Estonia, Latvia, Lithuania, and Slovakia) as compared to the labor intensive agricultural economies.

Table 7. Policy Reform Levels for Low Level Tractor Investment

Country	Year	Imports $US/ha	Land Reform	Market Liberalization	Small-Scale Privatization	Large-Scale Privatization
			Scale 1–10		Scale 1–4+	
Reform Thresholds for Imports > $10/ha Arable Land						
Albania	2005	9.65	9	8	4	3
Bulgaria	2001	10.82	8	9	3.67	3.67
Estonia	1995	8.04	na*	na	4	4
Hungary	1993	12.73	na	na	3	3
Latvia	1997	12.73	9	7	4	3
Lithuania	1995	9.93	na	na	4	3
Moldova	2004	10.14	7	6	3.67	3.33
Poland	1998	13.14	8	8	4.33	3
Romania	2000	9.71	8	7	3.67	3
Slovakia	1994	14.38	na	na	4	3
Turkey	1996	12.13	8	5	na	na
Average			8.14	7.14	3.83	3.20

*na – not data.
Sources: World Bank, EBRD, Comtrade.

VI.1.2 Policies that Facilitate Investment

Once this initial policy threshold is obtained, the reform of policies that facilitate investment become more important (Table 8). Access to finance is clearly important. Tractor imports do not reach $100/ha arable land until banking reform is consistently ranked at or above 3.67, and the World Bank Rural Finance Index is consistently ranked at 9.

The slower reform of competition policy and non-bank financial institutions and securities markets suggests that these policies may inhibit investment in farm machinery once access to finance improves. Weak competition policy may protect inefficient domestic farm machinery manufacturers to the detriment of farmers (Chapter VII). Slow development of non-bank financial institutions and securities markets will reduce the supply of finance and slow the emergence of alternative sources of finance such as leasing (Chapter VII). Weak financial markets and competition policy are apparent in all of the less reform-oriented countries.

The broad policy base for trade and foreign exchange was reformed early in the transition process and so does not appear to be a constraint to investment. The EBRD trade and foreign exchange policy index was at or above 4 for all countries at all levels of tractor imports.

Table 8. Policy Reform versus Rates of Tractor Investment

Country	Year	Imports $US/ha	Rural Finance	Banking and Interest Rates	Non-Bank Institutions	Competition Policy
			Scale 1–10	Scale 1–4+		
Imports < $10/ha Arable Land						
Armenia	2005	2.97	7	2.67	2	2.33
Azerbaijan	2005	6.83	6	2.33	1.67	2
Georgia	2005	5.81	6	2.67	1.67	2
Kazakhstan	2005	6.07	5	3	2.67	2
Kyrgyzstan	2005	1.25	7	2.33	2	2
Russian Federation	2005	4.88	7	2.67	3	2.33
Ukraine	2005	5.32	7	3	2.33	2.33
Average			6.43	2.67	2.19	2.14

Continued Table 8

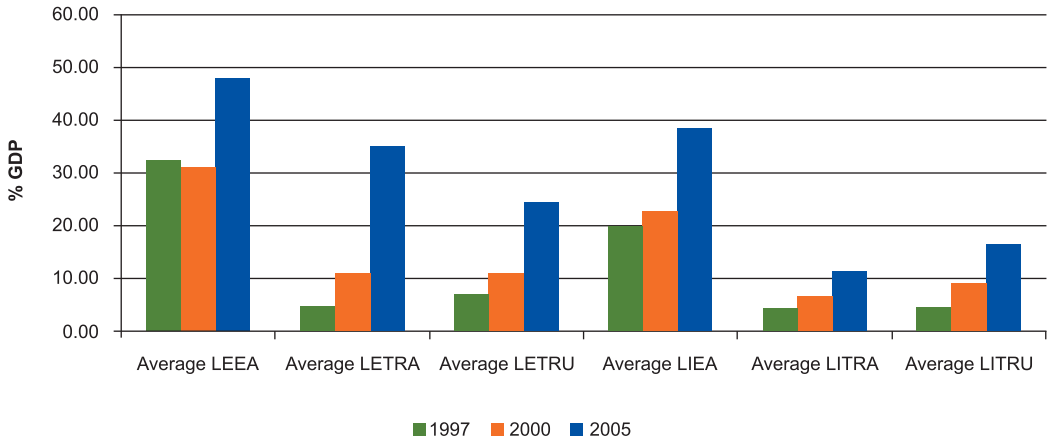
Country	Year	Imports $US/ha	Rural Finance	Banking and Interest Rates	Non-Bank Institutions	Competition Policy
			Scale 1–10	Scale 1–4+		
Imports > $10/ha Arable Land						
Albania	2005	9.65	7	2.67	1.67	2
Bulgaria	2001	10.82	7	3	2	2.33
Estonia	1995	8.04	na*	3	1.67	2
Hungary	1993	12.73	na	3	2	2
Latvia	1997	12.73	7	3	2.33	2.33
Lithuania	1995	9.93	na	3	2	2
Moldova	2004	10.14	7	2.67	2	2
Poland	1998	13.14	7	3.33	3.33	2.67
Romania	2000	9.71	6	2.67	2	2.33
Slovakia	1994	14.38	na	2.67	2.67	3
Turkey	1996	12.13	7	Na	na	na
Average			6.86	2.90	2.17	2.27
Imports > $20/ha Arable Land						
Bulgaria	2003	22.43	7	3.33	2.33	2.33
Czech Rep.	1994	30.84	na	3	2.67	2.67
Estonia	1997	32.16	7	3.33	3	2
Hungary	1997	27.50	8	4	3.33	3
Latvia	1998	30.37	8	2.67	2.33	2.33
Lithuania	1997	39.40	6	3	2.33	2.33
Poland	2002	26.47	7	3.33	3.67	3
Romania	2004	28.57	8	3	2.33	2.33
Slovakia	1995	29.36	na	2.67	2.67	3
Average			6.71	3.15	2.74	3.14
Imports > $50/ha Arable Land						
Czech Rep.	1996	52.98	na	3	2.67	2.67
Estonia	2001	51.30	9	3.67	3	3
Hungary	2003	59.40	9	4	3.67	3
Latvia	2002	48.95	9	3.67	3	2.33
Lithuania	2001	55.63	7	3	3	3
Poland	2004	66.05	7	3.33	3.67	3
Slovakia	1996	51.68	na	2.67	2.67	3
Average			8.2	3.33	3.10	2.86
Imports > $100/ha Arable Land						
Czech Rep.	2004	126.43	9	3.67	3.33	3
Estonia	2003	109.14	9	3.67	3.33	3
Latvia	2006	101.50	9	3.67	3	3
Lithuania	2005	104.76	7	3.67	3	3.33
Slovakia	2004	122.50	9	3.67	2.67	3.33
Average			8.6	3.67	3.07	3.13

*na – not data.
Sources: World Bank, EBRD, Comtrade.

VI.2 ACCESS TO FINANCE

The cost and availability of finance are obvious determinants of farm machinery use and investment. Tractors, combines, draft animals and farm equipment are all costly, lumpy inputs – difficult to finance with cash alone and so usually purchased with credit. Both nominal and real interest rates have fallen throughout the ECA region, as shown in chapter V (Figures 13 and 14). The supply of credit has also increased as seen in Figure 20 below, which shows trends in the level of domestic credit extended to the private sector as a percent of GDP.

Figure 20. Domestic Credit to Private Sector – ECA Region



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.
Source: World Development Indicators.

The supply of credit is highest in the European accession countries where banking and financial systems are more highly developed. But even in these countries credit supply did not increase dramatically until after 2002 when the conditions for both lending and borrowing had improved. Financial sector reform is far from complete in the other ECA countries (Table 8). The recent increase in credit supply in the labor extensive agricultural economies is largely the result of increased oil revenues (Russia and Kazakhstan) and increased foreign investment (Ukraine), although some reform has been implemented – especially in Kazakhstan. The banking and financial systems in the low and middle income labor intensive agricultural economies remain small and weak – with a low corresponding supply of credit to the private sector. Farmers in these countries face much greater credit constraints.

A small proportion of domestic credit to the private sector is allocated to agriculture in most countries, although in general this allocation is proportional to the share of agriculture in GDP (Table 9). Measured as a percent of agriculture value-added, the supply of agricultural credit varies more widely, with much better access to credit in labor extensive agricultural economies. Small-scale farming appears to reduce access to agricultural credit, except in Bulgaria, Poland and Moldova that have a dual structure of agriculture with a significant proportion of large-scale farms; and/or where there are large, subsidized agricultural credit programs. Elsewhere, a combination of small farm size, limited collateral, weak financial markets and low public support for rural finance restrict the supply of credit to agriculture.

Access to credit is also influenced by the willingness and capacity of financial institutions to lend in rural areas. Farmers are perceived as risky clients by many financial institutions, especially small-scale farmers, due to their inability to offer land as collateral, the long production cycle on which they rely for income and the climatic and market risks they face. There is ample evidence that farmers are viable lending propositions however, provided that lenders' improve their capacity for farm loan appraisal, find suitable alternative forms of collateral and develop appropriate loan products.

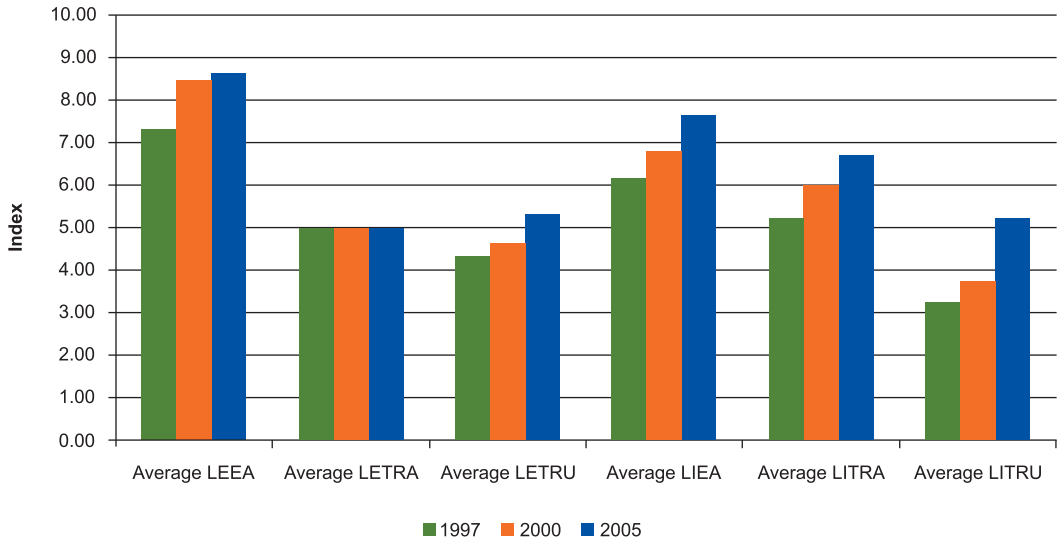
Table 9. Domestic Credit for the Economy and for Agriculture by Country, 2005

Country	Domestic Credit to Private Sector as % GDP	Agricultural GDP as % Total GDP	Agricultural Credit as % Total Credit	Agricultural Credit as % Agricultural Value Added
Labor Extensive European Accession Countries				
Czech Republic**	40.9	2.9	1.6	29.1
Estonia	56.4	3.7	4.0	74.5
Hungary**	55.4	4.3	0.8	12.9
Latvia**	87.5	4.0	2.9	77.3
Lithuania	41.3	5.6	2.1	19.3
Slovakia	35.5	3.9	2.9	27.8
Labor Extensive Transition Countries				
Kazakhstan	35.7	6.8	5.0	27.6
Labor Extensive Truncated Reform Countries				
Belarus	15.9	9.8	13.0	24.8
Russian Fed	25.7	5.6	na*	na
Ukraine	32.2	10.4	6.5	22.9
Labor Intensive European Accession Countries				
Bulgaria**	47.1	9.4	2.5	17.0
Croatia	60.6	7.6	na	na
Poland**	33.3	4.6	5.3	44.2
Romania	20.0	10.1	0.5	1.1
Slovenia	57.3	2.5	na	na
Turkey	21.6	10.8	3.0	6.7
Labor Intensive Transition Countries				
Albania	14.9	22.8	9.9	7.6
Armenia***	7.0	20.8	25.7	8.5
Georgia	14.8	16.7	1.6	1.6
Kyrgyzstan	8.0	31.9	4.4	1.2
Labor Intensive Truncated Reform Countries				
Azerbaijan	9.5	9.9	4.4	4.6
Moldova	23.6	19.5	23.0	33.8
Tajikistan	17.2	24.0	na	na
Uzbekistan**	20.7	28.0	15.3	13.4

*na – not data.
**2006.
***2004.
Sources: GDP, Agricultural Value Added, Domestic Credit to Private Sector from World Development Indicators. Agricultural credit calculated from information in World Bank ECA Profiles, Profiles on Agricultural Finance and Risk Management and national statistics

The extent to which suitable rural financial institutions have evolved is summarized in Figure 21 below, based on the World Bank Rural Finance index. Although this index has improved in most ECA countries since 1997, only in the European accession countries is it consistently at or above 7.0 – which indicates the emergence of financial institutions with the capacity to serve agriculture. Six of the twelve European accession countries had a score of 9.0 in 2005, and two others had a score of 8.0 All of the labor intensive transition economies are at or approaching the threshold of 7.0, together with the truncated reform countries Azerbaijan, Moldova, Russia and Ukraine. Among the remaining truncated reform countries (Belarus, Tajikistan, Uzbekistan) the rural finance index ranged from 2–4 in 2005, which is very low. Most of the truncated reform countries continue to rely on state-owned or state run credit programs to finance agriculture and show little interest in departing from this approach. While state-owned or state funded credit programs appear to result in a strong supply of credit for agriculture in these countries, parallel trends in agricultural productivity and machinery use suggest that this credit is not being used effectively.

Figure 21. Rural Finance Index ECA Countries



LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.

Rural Finance Index Category			
3–4	**5–6**	**7–8**	**9–10**
New banking regulations are introduced; little or no commercial banking.	Restructuring of existing banking system, emergence of commercial banks.	Emergence of financial institutions serving agriculture.	Efficient financial system for agriculture, agro-industries, and services.

Source: World Bank.

VI.3 EMPIRICAL ANALYSIS OF INVESTMENT DEMAND

Regression analysis of the determinants of demand for tractors and combines adds further insight. The underlying model is derived from the unconstrained maximization of a profit function, with demand as a function of input and output prices[10]. We extend this model by adding variables to capture access to credit (credit to private sector as a % of GDP), and road density (km of roads/100 km^2) to reflect the demand for farm machinery as a means of transport. Investment is represented by the value of imports/ha arable land in $US (2000 = 100). The basic model is thus:

Investment = f (farm wages, nominal interest rates, access to credit, wheat prices, road density, reform pathway dummies, trend variable).

As for the production function, these relationships were analyzed with panel data (17 countries for 1998–2005) in logarithmic form, using a random effects model estimated by generalized least squares (GLS) in STATA. The model was estimated separately for: all countries, accession countries, transition and truncated reform countries, labor-intensive countries and labor extensive countries. The response elasticities for the main parameters are reported in Table 10 below. Full results for all equations are reported in Appendix III.

Wage rates emerge as the main determinants of investment in tractors, with statistically significant coefficients in most versions of the model and high response elasticities. Higher labor costs are a powerful incentive to substitute capital for labor, as would be expected. Lower interest rates also increase the demand for

[10] Substituting a production function into the revenue component of the profit function, input demand equations can be derived from the first order conditions for unconstrained profit maximization such that $x_1 = f(r_1,r_2,p)$; where r_1 and r_2 are factor prices and p is product price

investment in tractors, by lowering the cost of capital, but this impact is less powerful than wages. Access to credit is not significant. Of the other variables, road density also emerges as a consistently positive influence on tractor investment. More roads increase the advantages of owning a means of transport for travel from house to farm and to local markets.

Table 10. Determinants of Demand for Farm Machinery – Response Elasticities

Parameter	Response Elasticity				
	All Countries	Accession Countries	Transition and Trunc. Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Tractors					
Wages	0.98**	ns*	1.58**	0.91**	0.56**
Interest rate	–0.39***	–0.76**	ns	ns	ns
Access to Credit	ns	ns	ns	ns	ns
Wheat Price	ns	0.78**	–0.61***	ns	0.64***
Road Density	0.49***	0.97**	0.69**	ns	0.38**
No. of Observations	135	88	47	71	64
Combines					
Wages	ns	–0.55***	–	ns	ns
Interest rate	–0.58**	–0.69**	–	s	ns
Access to Credit	0.78**	0.88**	–	ns	0.72**
Wheat Price	ns	0.90***	–	ns	1.00***
Road Density	0.30***	0.61***	–	0.69***	0.25***
No. of Observations	111	88	23	47	64

*ns – not statistically significant.
** Statistically significant at 1%.
*** Statistically significant at 5%.
(A response elasticity of +0.60 for tractor use indicates that a 10% increase in the number of tractors will lead to a 6% increase in agricultural productivity).

Unlike tractors, interest rates and access to credit are the main determinants of investment in combines, consistent with the much higher cost of this form of mechanization. The ability to finance an expensive combine is of greater concern than the cost of labor. Wheat prices are a further positive influence on investment, as would be expected, and road density again emerges as a consistently positive influence. The influence of road density in this case is probably due to the increased ability to drive combines to different locations, thus expanding the range of activity.

The ability to discern the impact of differing levels of reform on this overall pattern of response was limited by inadequate data. Wages appear to have a more powerful impact on tractor investment in the transition and truncated reform countries, while interest rates appear to be more important in the accession countries – but the overall results for tractor investment for transition and truncated reform countries were weak. For combine investment, there were too few transition and truncated reform countries with adequate data to allow for any meaningful results.

Data limitations also precluded inclusion of the policy indices in the regression analysis of investment demand. As reform has followed a broadly consistent pattern in most of the ECA countries, the various indices were all highly correlated and so could not be used together due to collinearity. Adding each index to the underlying model individually, in succession, elicited no meaningful results. Hence, the relative importance of different elements of the reform process to farm mechanization could not be ascertained.

Despite the limitations of this analysis, the results highlight the powerful impact of farm labor costs on the demand for mechanization[11]*. As shown by the wage elasticity of demand for tractors (Table 10), an increase in wage rates is likely to have a much greater impact on the demand for mechanization than a fall in the*

[11] This issue was investigated further to determine whether a low wage "trap" exists in some countries, which blocks mechanization. But no evidence was found to support this hypothesis

price of capital. Only for more expensive equipment such as combines does the cost of capital appear to be a more important issue.

In contrast, policy makers typically focus on measures to reduce the cost of capital as their primary vehicle for influencing mechanization, by reducing interest rates. Where labor costs are low, as in most of the transition and truncated reform countries, such interventions are unlikely to have a significant impact – except for costly equipment such as combines and large tractors. A much more substantive reduction of capital costs is needed to influence the demand for mechanization in low wage countries, by facilitating access to low cost farm machinery – as produced by manufacturers in India, Turkey and Brazil.

VI.4 FARM MACHINERY STATIONS AND PRIVATE HIRE SERVICES

Machinery hire offers an affordable and cost-effective means to obtain the use of farm machinery and equipment, especially for farmers without the means to purchase it. For owners, machinery hire also offers a way to reduce the costs of ownership. These advantages account for the widespread use of machinery hire, particularly for power intensive operations such as land preparation and harvesting. A range of hiring systems occurs, including state owned machinery stations', commercial contractors and informal hiring among neighboring farmers. Payment mechanisms also vary from fixed fees per hectare or per hour, paid in cash or in-kind, to crop sharing payments.

State-owned machinery stations were common in the centrally planned economies prior to 1990, especially in Central Asia and the CIS countries. Set up to make farm machinery more accessible to farmers, they offered machinery hire and repair services at district and regional level. They invariably incurred heavy losses, however (Binswanger and Donovan, *op cit*), and most ceased to operate after 1990. The economies of scale associated with large-scale purchase of farm machinery were offset by the much higher diseconomies of operating large tractor and harvester fleets. During peak seasons it is more difficult to motivate salaried drivers and mechanics to work long hours and to maintain machinery in top condition, as compared to private-sector owner-operators. Moreover, where agricultural operations are highly time bound, machinery use can only be maximized by transporting machinery to other agro-climatic zones – at further expense. For operations that are not highly time bound, private rental markets usually emerge because these operations can be scheduled without too much conflict among neighboring farmers. Where private markets can emerge, public service services are not needed. And where private entrepreneurs cannot operate profitably, public tractor stations will incur even larger losses.

Currently, machinery stations operate only in Belarus, Kazakhstan, Uzbekistan and Ukraine. In Belarus they remain state owned and state operated and continue to depend on state support. Kazakhstan has recently re-introduced farm machinery stations, with 25 state owned farm machinery stations established since 2003 under a broader program to improve farmer access to machinery. These stations lease farm machinery on highly subsidized terms from the state-owned leasing company, KazAgroFinance, for hire to farmers. Uzbekistan and Ukraine have privatized most of their farm machinery stations. They still rely heavily on state-owned leasing companies to finance machinery purchase, however, on highly concessional terms.

The continued heavy reliance on state support suggests that these machinery stations have not overcome the underlying constraints to viability – even where they have been privatized. More importantly, state support inhibits farm machinery hire by private sector operators. High crop losses due to a shortage of combines are an annual complaint in the Ukraine, despite the operation of more than 850 mainly private farm machinery stations. In Russia, where farm machinery stations are no longer a major presence, both domestic and foreign[12] enterprises are now an important source of custom farming services for crop cultivation and

[12] Turkish harvesting enterprises are now an important presence in Russia, moving from south to north as the crop ripens, with payment on a crop-share basis (FAO, 2008)

harvesting, and large-scale farms provide these services to household farms (FAO, 2008). Crop losses due to late harvest are much lower in Russia than the Ukraine.

There is no systematic information on the role of private sector machinery hire in the ECA countries, although its use is widely observed. The most direct way to expand commercial machinery hire is simply to increase investment in farm machinery by private sector owners. More farm machinery results in more competition among potential suppliers of machinery hire services, and reduces the waiting time for time-bound activities.

VII ECONOMY-WIDE INFLUENCES ON FARM MECHANIZATION

Broad, economy-wide influences on farm mechanization are reviewed in this chapter, including trade, tax and industrial policies, the business environment, leasing and insurance.

VII.1 TARIFFS AND TAXES

Tariffs and taxes constrain demand and supply when they are too high, and/or when used to limit competition by exempting some market participants and not others. Taxation is also important for farm mechanization because of its implications for leasing[13] and the influence of accelerated depreciation on capital investment.

Table 11. Tax Rates and Farm Machinery Tariffs for ECA Countries (2008)

Country	Total Tax Rate (as % Profit)	Tariffs on Farm Machinery (Average Ad Valorem Equivalent %)			
		Tractors	Combines	Seeders and Haymakers	Spare Parts
Labor Extensive European Accession Countries					
Czech Republic	49.6	0.9	0	0	0–3.7
Estonia	51.1	0.9	0	0	0–3.7
Hungary	56.6	0.9	0	0	0–3.7
Latvia	32.6	0.9	0	0	0–3.7
Lithuania	52.2	0.9	0	0	0–3.7
Slovakia	49.7	0.9	0	0	0–3.7
Labor Extensive Transition Countries					
Kazakhstan	39.5	5	0	0	na*
Labor Extensive Truncated Reform Countries					
Belarus	137.5	na	na	na	na
Russian Federation	60.0	5–15	5	5	5
Ukraine	59.5	10	0	0–10	na
Labor Intensive European Accession Countries					
Bulgaria	46.0	0.9	0	0	0–3.7
Croatia	32.5	2.6	2.5	0	0–6.7
Poland	38.1	0.9	0	0	0–3.7
Romania	57.2	0.9	0	0	0–3.7
Slovenia	40.0	0.9	0	0	0–3.7
Turkey	53.0	0.9	0	0	0
Labor Intensive Transition Countries					
Albania	58.2	0	0	0	0
Armenia	34.0	0	0	0	0
Georgia	57.0	0	0	0	0
Kyrgyzstan	68.2	0	0	0–10	5–10
Labor Intensive Truncated Reform Countries					
Azerbaijan	46.3	0.5	0.5	0.5	0.5–5
Moldova	48.2	na	na	na	na
Tajikistan	82.1	0	0	0	0
Uzbekistan	96.7	10	10	10	na

*na – not data.

Sources: World Trade Organization; World Bank Ease of Doing Business Index; FAO 2008.

[13] Leasing is not competitive with lending as a source of finance unless tax laws ensure that there is no double taxation

Tariffs on imported farm machinery are generally moderate in the ECA region (Table 11). They range from 0–5% in most countries; and from 5–15% in Russia, Ukraine, Uzbekistan and Kazakhstan (data for Belarus and Moldova are unavailable). New and second-hand machinery are both taxed at the same rate. The higher levels of protection in the CIS countries are partially offset by trade agreements between Russia, Ukraine and Belarus that exempt farm machinery from import tariffs. Trade is "displaced" towards machinery produced in the CIS region as a result, to the detriment of the more sophisticated and expensive farm machinery from western manufacturers. As low cost farm machinery manufacturers in China and India increase their exports, these regional trade agreements will also limit farmer access to more competitively priced imports from these countries. In Kazakhstan, domestic distributors are also exempt from VAT on imported farm machinery while foreign owned distributors pay full VAT. This combination of higher and more discriminatory import protection is most apparent among the CIS countries, particularly those with truncated reform.

Tax levels vary widely, as measured by the composite tax indicator[14] reported in the World Bank "Ease of Doing Business Index" (EoDB). The highest levels of taxation are observed in the truncated reform agricultural economies although low levels of correlation between tax rates and farm machinery imports suggest that the general influence of taxation on farm machinery investment is small (Table 13). Double taxation is most frequently cited as a constraint to leasing among the labor intensive lower and middle income countries (Table 15). There is no systematic information on the use of accelerated depreciation. This facility is unlikely to influence investment decisions among low-income farmers, for whom minimizing income or profit taxes is a minor issue.

VII.2 SUPPORT FOR DOMESTIC MANUFACTURING

More than half of the ECA countries operated large-scale, state-owned farm machinery manufacturing enterprises in 1990, producing for both domestic and export markets in the former Soviet Union. All of these enterprises faced a massive drop in demand during the early stages of reform and many went out of business. Some of the survivors remain as state-owned enterprises but most were privatized and re-organized or consolidated; and all now operate at much lower levels of output. Governments' have used various forms of support for these enterprises, with differing consequences for farm mechanization.

This section examines these support programs in six ECA countries that have a large capacity for tractor production. In Russia and Ukraine public support is based on the use of subsidized leasing for domestically produced tractors. In Romania and the Czech Republic the emphasis has been on promoting foreign direct investment (FDI). Belarus and Turkey are both major exporters of agricultural machinery. They differ, however, in that the sector is state-owned and state controlled in Belarus and privately owned in Turkey. The analysis and conclusions are based on trends from 2000–2005, a period of growing investment in farm machinery (Chapter IV). Changes since 2005 are discussed where data are available.

Russia and Ukraine

Together with Belarus, Russia and Ukraine were the largest producers and exporters of agricultural machinery in the former Soviet Union. Most of the main manufacturers were privatized early in the reform process but struggled for survival until the late 1990s when rising farm incomes increased the demand for farm machinery. Demand was further increased during this period by the emergence of large vertically integrated agricultural holding companies with the means and the incentive to invest in new machinery. But Russian and Ukrainian tractor manufacturers were ill-equipped to respond to this increase in demand. Outmoded production technology, older models and limited product lines reduced their ability to compete with imports from Belarus and western manufacturers. Output grew slowly as a result and remained small

[14] Calculated as the total taxes and mandatory contributions payable, as a share of commercial profits

relative to underlying demand, particularly in Russia. Imported tractors continue to dominate the markets of both countries.

Both countries set up subsidized leasing programs in 1999–2000 to promote investment in farm machinery, but restricted the use of these programs to domestically produced machinery (Table 12). Initially, this finance was distributed solely through state-owned leasing and credit agencies but private leasing agencies are now active (see Section VII.4). In 2002 Ukraine also began giving a grant of 30% to farmers purchasing domestically produced farm machinery. Both countries also subsidize interest on commercial loans for farm machinery, with no restrictions on where the machinery is from, but the shortage of medium-term credit has limited the use and impact of this support. Foreign direct investment was minimal during this period (for combines only) despite strong interest, as international companies encountered considerable start-up problems. Import protection is moderate in Russia, but higher in Ukraine. The import tariffs for tractors in Ukraine were reduced after 2005.

While these programs undoubtedly contributed to the increase in farm machinery investment from 2000–2005, they did not arrest the de-mechanization of agriculture – and in Russia they had a limited impact on domestic tractor output. Domestic manufacturers used this support to their advantage nevertheless. Sales income generated by the preferential leasing and grant programs' allowed them to upgrade their plants and product lines, and to consolidate the agricultural machinery industry. In Russia the main manufacturers merged into three large holding companies during this period, reducing internal competition. Weak government support for foreign direct investment also helped domestic manufacturers to withstand external competition. The Russian agricultural machinery sector has consolidated further since 2005 (two of the three main holding companies merged in 2006), and is now actively building foreign partnerships in both domestic and export markets. But FDI is being used to reinforce the position of the current duopoly in the Russian domestic market rather than to increase competition.

Romania and the Czech Republic

Agriculture machinery production operated on a smaller scale in central Europe before 1990, although tractor companies such as Zetor (Czechoslovakia), Ursus (Poland) and Tractorul (Romania) were well known on both domestic and export markets. Output fell sharply after 1990, as in other ECA regions, but governments' have sought foreign direct investment as the basis for recovery rather than using direct subsidies to stimulate demand. In both Romania and the Czech Republic (headquarters of Zetor) this has been a prolonged and difficult process. By 2000, production had stopped completely at Zetor. It was privatized in 2002 and bought by a Slovak Holding company, which has since engineered a strong recovery. Production reached 5750 tractors in 2005, of which 95% were exported – mostly to Poland where Zetor is the market leader. The Romanian government tried to sell its 80% share in Tractorul, the maker of Universal tractors from 2000–2008. Following unsuccessful bids by Italian and Indian agricultural machinery companies (Landini in 2003, Mahindra and Mahindra in 2008) Tractorul will now be wound down through bankruptcy. However a Chinese agricultural machinery company will establish a tractor assembly company in Brasov, the location of Tractorul, in order to take advantage of the skilled labor force in the city and Romania's ready access to markets in Europe and the CIS countries.

The lack of direct support for domestic tractor manufacturers in both countries does not appear to have prejudiced either tractor use or tractor investment (Table 12). Farmer access to tractors has improved significantly, as indicated by the growth in tractor imports, but this is the result of increased farm incomes, improved access to finance and improved access to new and second-hand imported tractors. The tractor factories have been treated as any other industrial enterprise. Viable enterprises eventually attracted investors with the human and financial resources to affect a recovery, and those that were unviable were closed down. Where recovery of tractor production was achieved it was not at the expense of agriculture in general and farmers in particular.

Table 12. Support Measures for Domestic Manufacture of Tractors 2000–2005: Selected Countries

Country	Support Measures						Responses					
	FDI	Subsidized Leasing	Subsidized Credit	Import Protection	Purchase Grants	R & D Grants	Tractors in Use 2005	% Change 2000–05	Tractor Production 2005	% Change 2000–05	Tractor Imports $US/ha** 2005	% Change 2000–05
Russian Federation		++ (Domestic Production)	+ (Domestic Production)	+ (5%)			480,000	–35.7%	4,200	–2.3%	4.88	495.1%
Ukraine		++ (Domestic Production)	+ (Domestic Production)	+ (10–25%)	++ (Domestic Production)	+	53,581	–26.5%	5,543	37.4%	5.32	197.2%
Romania	++			+ (7%)			173,043	8.1%	3,510	–35.0%	31.90	228.5%
Czech Republic	++			+ (7%)			87,039	–10.0%	5,750	na	139.66	132.4%
Belarus		++ (Domestic Production)	+ (Domestic Production)	na*			53,851	–26.1%	41,546	84.9%	8.26	1.3%
Turkey	+		Since 2004	(0%)			1,022,365	8.6%	38,800	8.1%	23.13	178.0%

*na – not data.
**Constant dollars (2000 = 100), per hectare of arable land.
Sources: FAOSTAT (Tractor Use); COMTRADE (Tractor Imports); UN Commodity Statistical Yearbook (Production); FAO, 2008 (Support Measures).

Belarus and Turkey

Agriculture is highly subsidized in both Belarus and Turkey, through widespread use of input subsidies, price subsidies and credit subsidies (in Belarus). But the agriculture sector is dominated by small-scale private farms in Turkey versus large-scale collective farms in Belarus. There are also marked differences in the state's role in tractor production. The Minsk Tractor Works (MTW) in Belarus is a state-owned monopoly, which supplies most of the tractors on the domestic market and is also a major international exporter. It benefits from strong government support, through subsidized credit and leasing programs for MTW tractors purchased by collective farms and state-owned machinery farm service centers. The five privately owned tractor manufacturers in Turkey also dominate the domestic market, but compete with one another and receive minimal direct support from government[15]. Foreign direct investment is actively encouraged however, as in Romania and the Czech Republic.

As in Russia and Ukraine, public support for MTW in Belarus has helped support domestic investment in tractors, but it has not arrested the de-mechanization of agriculture (Table 12). This public support has also contributed to MTW's increasing output and aggressive expansion of exports – notably in the CIS countries but also in other parts of the world. In Turkey, both domestic tractor use and tractor output have increased, despite the lack of direct support and tractor imports are increasing. Turkish tractor producers are also forming strategic partnerships with other international tractor producers as the base for expanding production and sales – both inside and outside Turkey.

The differing responses observed in these countries suggest that agriculture and farmers benefit most from government policies that encourage investment and competition in domestic tractor manufacturing. Support based on subsidized leasing and credit, and grants for domestically produced machinery has more benefit for manufacturers than farmers. It is also an inadequate response to the de-mechanization of agriculture.

VII.3 BUSINESS ENVIRONMENT

The business environment influences the supply side of farm mechanization – the importers, sales and service centers and spare parts suppliers who procure, sell and service farm machinery. Where a country's business environment favors the establishment and operation of these enterprises, farmers will have a wider choice of farm machinery and after-sales service. By facilitating new entries to the market a favorable business environment also encourages competition, which lowers prices and improves service. An unfavorable business environment constrains the development of private business activity. Manufacturing and commerce is dominated either by the public sector or by private sector monopolies, which weakens economic growth and employment creation.

This section uses information from the World Bank "Ease of Doing Business Index" (Box 1) to examine the influence of the business environment on imports of tractors and combines in 2005. The Ease of Doing Business Index (EoDB) is calculated annually for each country for a hypothetical medium-sized commercial or manufacturing enterprise. Numerous parameters are used to derive ten main indicators, which are averaged for each country. The country values are then ranked to create the index. The lower the index, the more business friendly the country. Imports are a useful indicator of supply as most ECA countries imported the bulk of their farm machinery in 2005.

There is a strong association between farm machinery imports and the EoDB, as indicated in figures 22 and 23 below. Domestic manufacture reduces the need for imports[16] in Belarus (tractors), Turkey (tractors) and Ukraine (combines) but the overall relationship still holds. The European accession countries exhibit a more

[15] Interest subsidies were introduced in 2004 but the shortage of medium-term credit has limited their impact.

[16] Domestic manufacture of farm machinery is also growing in Russia, but it was modest in 2005 – both absolutely and relative to imports.

favorable business environment and correspondingly higher imports, as expected. Less favorable business environments, and lower levels of imports characterize the transition and truncated reform countries. The relationship is quite robust, with correlation coefficients of –0.65 and –0.74 for tractor imports and combine imports, respectively. The most severe supply-side constraints to farm mechanization appear to occur in small, low and middle-income countries such as Kyrgyzstan, Azerbaijan, Albania, Georgia and Tajikistan where there is both a weak business environment and no domestic manufacture.

Box 1. The Ease of Doing Business Index

The Ease of Doing Business Index is based on the following indicators:

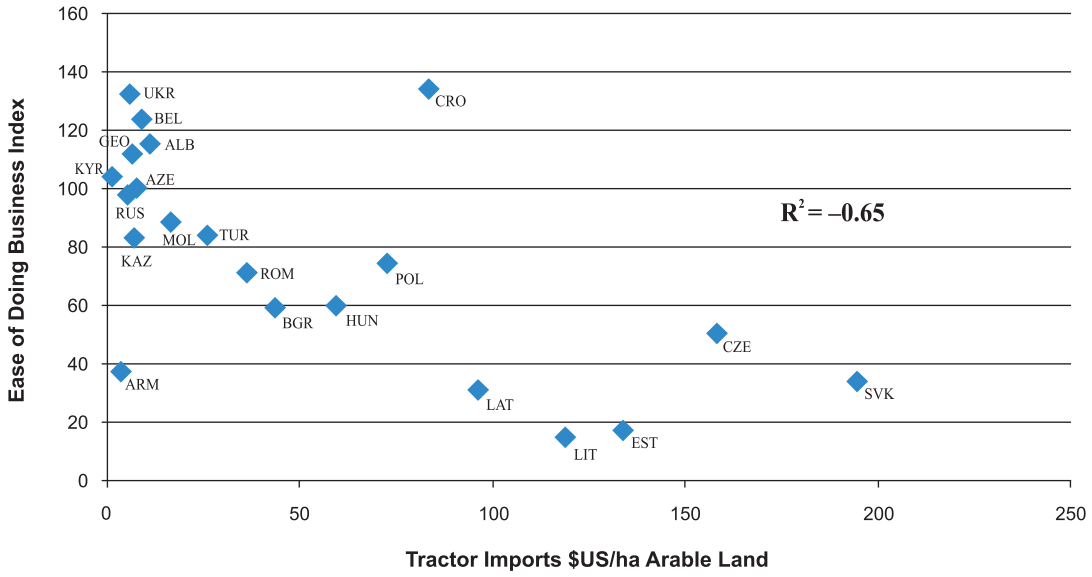
- Starting a business
- Construction permits (to build a warehouse)
- Employing workers (hiring and firing)
- Registering property (transfer of commercial real estate)
- Getting credit (legal rights and credit information)
- Protecting investors'
- Paying taxes (amounts and procedures)
- Trading across borders (imports and exports)
- Enforcing contracts (commercial disputes)
- Closing a business (bankruptcy)

These indicators are compiled annually for more than 180 countries.

Source: World Bank.

Two exceptions to this general relationship show that the quality of the business environment is not always a major influence on the supply of farm machinery. Armenia has a favorable business environment but low import levels, while Croatia has high imports despite a low EoDB ranking. In both cases demand side factors such as access to credit are probably more important influences on imports and the overall supply of farm machinery.

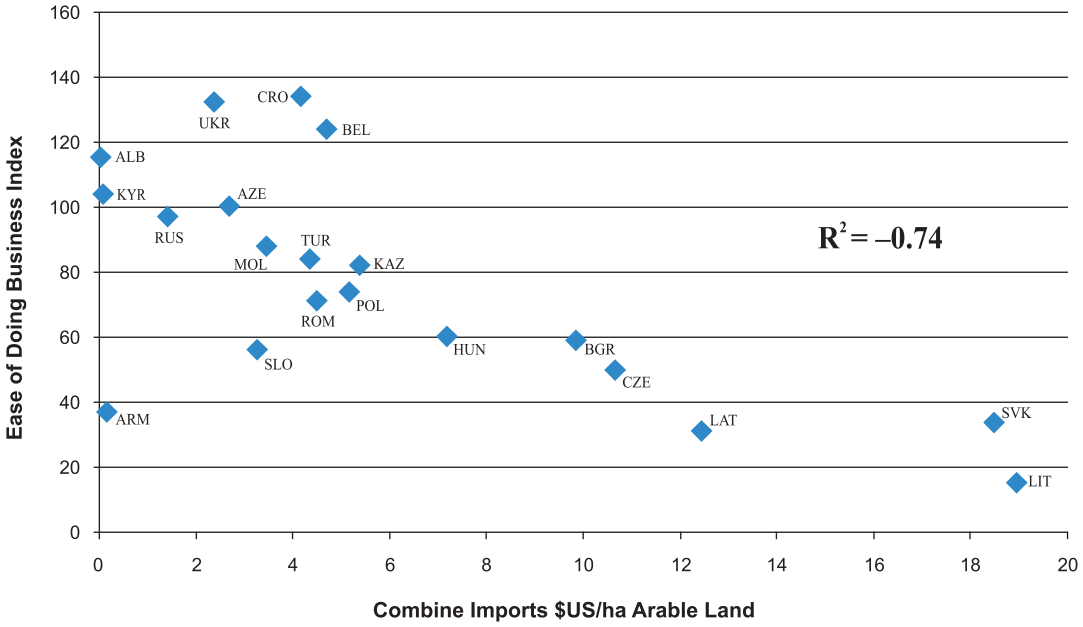
Figure 22. Tractor Imports vs Ease of Doing Business Index – ECA Region 2005



Correlation coefficients between the imports of tractors and combines and individual components of the EoDB show the influence of particular characteristics of the business environment (Table 13). Efficient

import procedures, strong incentives for lenders to provide credit and the ease of obtaining building permits for warehouse construction, are all strongly associated with the import of farm machinery. These are all issues faced by importers and sales and distribution centers for farm machinery. Particular aspects of business start-up, property registration, contract enforcement and bankruptcy also influence farm machinery imports although these probably constrain all business activity not just farm machinery. It also seems that the number of procedures involved in business activities is a bigger constraint than the time needed to implement these activities, although the reason for this is not apparent.

Figure 23. Combine Imports vs. Ease of Doing Business Index-ECA Region 2005



Source: World Bank.

Table 13. Business Environment Indicators vs. Farm Machinery Imports 2005

Components of Ease of Doing Business Index	Correlation Coefficient (R^2)	
	Tractor Imports*	Combine Imports*
Business Start-Up		
Start-up costs as % per capita income	–0.41	–0.49
Number days to start a business	0.08	0.08
Number procedures to start a business	–0.33	–0.38
Property Registration		
Number days to register a commercial property transfer	0.12	–0.16
Number procedures to register a commercial property transfer	–0.47	–0.35
Cost of Registration (% of property value)	0.04	–0.12
Employment		
Rigidity of Employment Index (1 – low)	0.22	0.27
Building Construction** (Warehouse)		
Number days to obtain construction permit	–0.27	–0.43
Number procedures to obtain construction permit	–0.33	–0.41
Cost to obtain construction permit	–0.41	–0.34
Credit		
Legal Rights Index (1 – low, 10 – high)	0.36	0.23
Credit Information Index (1 – low, 6 – high)	0.54	0.53
Contract Enforcement		
Number procedures to enforce a contract	–0.42	–0.37

Continued Table 13

Components of Ease of Doing Business Index	Correlation Coefficient (R^2)	
	Tractor Imports*	Combine Imports*
Number days to enforce a contract	0.47	0.01
Cost as % of Debt	–0.07	–0.04
Total Taxes as % of Profit	–0.25	–0.11
Import Procedures **		
Number procedures to import	–0.53	–0.57
Number days to import	–0.63	–0.61
Import Costs ($US/container)	–0.54	–0.44
Closing Down a Business		
Time to close down a business (years)	0.33	0.09
Cost as % of Estate	0.01	–0.12
Recovery Rate (cents in dollar)	0.46	0.48

*$US/ha arable land.
** Data are for 2006 as the 2005 values were not compiled.
Sources: World Bank – Ease of Doing Business Index, Arable Land; Comstat – Import values.

VII.4 LEASING – LIMITED RESOURCES AND HIGH EXPECTATIONS

Leasing has considerable potential as a means to improve access to finance for moveable assets in developing countries. By using the leased object as collateral, leasing removes a fundamental barrier to finance for those who are unable to offer land as collateral (ownership of the leased object is retained by the lessor until completion of the lease). This advantage, plus the pent-up demand for investment in machinery and equipment across all sectors has resulted in strong growth in leasing throughout the ECA region. Using data from the International Finance Corporation (IFC), World Bank, national leasing associations and national banks, this section examines trends in financial leasing of moveable assets in general and farm machinery in particular.

In the ECA countries for which suitable data was available, financial leasing is a small albeit rapidly growing component of the financial system (Table 14). Even in the more advanced European accession countries where it is well established, financial leasing provides a relatively small volume of credit to the private sector as compared to banks (Table 9). The market for leasing finance for moveable assets is inherently much smaller than the market for bank finance. Numerous constraints further restrict leasing activity in the lower and middle-income ECA countries, as discussed below, and leasing activity in these countries is even smaller in relative terms. The rapid growth of financial leasing indicates that demand is high nevertheless, although growth is also high because it is from a small base.

In most ECA countries private leasing enterprises are owned and/or financed by private commercial banks. This has two important implications. First, in the more advanced European accession countries it suggests that leasing will complement rather than compete with commercial banking, at least until the expansion of capital markets creates suitable alternative sources of finance for leasing. Second, in low and middle income countries banks and leasing enterprises face the same supply-side constraints to growth in that both depend on bank deposits as their main source of capital. Where the banking sector is small and weak, low deposits will limit the growth of leasing just as it constrains the growth of commercial bank lending. Low levels of term deposits will be a particular constraint as they restrict the ability to provide medium and long-term leasing finance. Access to finance will improve as foreign banks become more active in these countries, but commercial bank ownership and finance will continue to underpin the leasing sector.

Table 14. Trends in Financial Leasing in Selected ECA Countries, 2004–2006

Country	Annual Financial Leasing as % of GDP			Growth ($US) 2004–2006
	2004	2005	2006	
Labor Extensive European Accession Countries				
Czech Republic		3.36%	3.29%	
Estonia	5.68%	6.97%	8.20%	101.3%
Hungary	2.02%	2.41%	2.63%	43.6%
Lithuania	4.63%	5.56%	6.46%	84.6%
Slovakia		3.01%	3.08%	
Labor Extensive Transition Countries				
Kazakhstan	0.40%			
Labor Extensive Truncated Reform Countries				
Russian Federation	1.08%	1.18%	1.29%	100.0%
Ukraine	0.18%	0.22%	0.44%	310.3%
Labor Intensive European Accession Countries				
Bulgaria	1.01%	2.19%	3.2%	306.9%
Poland	1.28%	1.39%	1.83%	93.5%
Turkey	0.74%	0.88%	0.99%	80.5%
Labor Intensive Transition Countries				
Albania		0.01%		
Kyrgyzstan	0.03%	0.01%	0.05%	129.2%
Labor Intensive Truncated Reform Countries				
Azerbaijan	0.10%	0.27%	0.27%	549.4%
Tajikistan		0.08%	0.02%	
Uzbekistan	0.36%	0.57%	0.63%	147.9%

Sources: World Development Indicators, International Finance Corporation (Azerbaijan, Kyrgyzstan, Tajikistan, Ukraine, Uzbekistan), National Leasing Associations of European Accession countries and Russia, World Bank ECA summaries (Albania, Kazakhstan, Russia).

A review of various reports on financial leasing in the ECA countries shows that inadequate contract enforcement, inappropriate taxation, lack of credit information and lack of medium and long-term finance are the major constraints to financial leasing (Table 15). Significantly, these constraints are reported more widely in countries with labor-intensive agriculture economies – where small farms predominate. It thus appears that both supply and demand side constraints are limiting the role of leasing for small-scale farmers. Clearly, lower incomes mean that these farmers are less likely to have the means to finance farm machinery through leasing, or to benefit from the tax advantages that leasing confers. Faced with weak contract enforcement, poor credit information and a lack of medium and long-term finance, leasing companies will also be less inclined to develop leasing products suited to the needs of small-scale farmers. Weak second hand markets and an inadequate legal framework are also reported as constraints to financial leasing.

Table 15. Constraints to Financial Leasing in the ECA Region 2004–2006

Country Group	Weak Contract Enforcement	Inadequate Legal Basis for Leasing	Inadequate Second Hand Market	Inadequate Credit Information	Inappropriate Taxation	Lack of Medium and Long-Term Finance
LEEA	+			+		
LETRA						
LETRU	+	+	+	+	+	++
LIEA	++	+	+	+	+	
LITRA	+++	+		+	+++	+
LITRU	+		+	+++	+++	+++

LE – Labor Extensive; LI – Labor Intensive; EA – European Accession Countries; TRA – Transition Countries; TRU – Truncated Reform Countries.

Sources: International Finance Corporation (Azerbaijan, Kyrgyzstan, Tajikistan, Ukraine, Uzbekistan), National Leasing Associations of European Accession countries and Russia, World Bank ECA summaries (remaining countries).

Leasing for farm machinery accounts for varying proportions of total financial leasing (Table 16). Agricultural leasing is a high proportion of overall leasing in Uzbekistan where a highly subsidized state owned leasing company has been established to boost investment in farm machinery. Large, state owned leasing companies were also set-up to fulfill this role in Russia, Ukraine and Kazakhstan. Their importance declined later when private sector leasing enterprises were allowed to operate, although these state owned companies still account for a large share of the market for farm machinery leasing. Leasing is new and donor driven in Kyrgyzstan and Tajikistan, and the total volume of leasing is still very small. It is too early to gauge the importance of leasing for agriculture as it fluctuates markedly from one year to the next. In the other countries, where leasing is driven by private sector companies, it accounts for less than 10% of overall financial leasing transactions despite very high growth.

Comparisons of farm machinery leasing per hectare of arable land further indicate the potential and limits of financial leasing as a means to finance farm machinery. Only in the more advanced, labor extensive European accession countries of Estonia and Slovakia does it appear to make a substantial contribution to farm machinery investment. These two countries, which have a well-developed financial system and a high proportion of larger corporate farms with a high requirement for mechanization, are in the best position to reconcile a strong demand for investment in farm machinery with a commensurate supply of leasing finance. In the other countries, supply and/or demand side constraints to leasing farm machinery limit its contribution. Demand side constraints appear to limit the role of leasing in Russia and Uzbekistan, despite access to subsidized finance from state funded farm machinery leasing companies. The predominance of small farms with lower incomes (Poland, Bulgaria, and Turkey) and the weakness of financial markets appear to restrict the role of leasing elsewhere (Kyrgyzstan and Tajikistan). Leasing may thus have a more limited role where farms are small and farm incomes are lower, even when financial markets are well developed.

These results show that while financial leasing has considerable potential for agriculture, it is generally small and faces numerous constraints to growth in low and middle-income countries. If leasing is to make a difference to small-scale agriculture it will need more focused and innovative support, based on the sale of smaller, low cost farm machinery with long-term leases; plus good credit information, strong contract enforcement and active second-hand markets for farm machinery. It is also evident that leasing is not a panacea for investment in farm machinery. Even in the more advanced ECA countries farmers will not benefit fully from leasing until there is active competition within and between banks and leasing companies, with less bank ownership of leasing companies, and increased access to longer term leases. This requires access to deeper, more diverse capital markets that offer alternative sources of finance with longer maturities. The experience in Russia, Uzbekistan, Ukraine and Kazakhstan also shows that state supported leasing programs for farm machinery are poor substitutes for private sector leasing (Box 2). These programs crowd out private sector leasing, restrict and distort farmer choice of machinery and compromise overall levels of investment in farm machinery.

Table 16. Trends in Agricultural Machinery Leasing in Selected ECA Countries: 2004–2006

Country	Agricultural Machinery Leasing as % All Leasing			Growth ($US) 2004–2006
	2004	2005	2006	
Estonia	5.2	5.9	5.2	101%
Slovakia		5.3	6.2	
Russian Federation		7.8		
Bulgaria		1.8	1.6	
Poland	0.3	0.2	1.0	594%
Turkey	4.1	7.1	6.8	204%
Kyrgyzstan		64.8	12.0	
Tajikistan		19.2	0.0	
Uzbekistan	70.3	56.6	57.0	101%

Continued Table 16

Country	Agricultural Machinery Leasing $US/ha Arable Land			% Change 2004–2006
	2004	2005	2006	
Estonia	68	97	127	86.8
Slovakia		54	79	
Russian Federation		6		
Bulgaria		3	5	
Poland	1	1	5	400
Turkey	5	13	15	200
Kyrgyzstan		0.1	0.1	
Tajikistan		0.4	0.0	
Uzbekistan	6	10	13	116.7

Sources: World Development Indicators, International Finance Corporation (Azerbaijan, Kyrgyzstan, Tajikistan, Ukraine, Uzbekistan), National Leasing Associations of European Accession countries and Russia, World Bank ECA summaries (Albania, Kazakhstan, Russia).

VII.5 INSURANCE

Insurance facilitates farm mechanization by protecting valuable capital investments against the risk of theft, damage or accident; and by improving access to credit for machinery purchase. Lending institutions and leasing companies require that any machinery purchased on credit be insured in order to protect their collateral. The depth of the insurance industry is typically measured using two broad indicators: insurance density (premium income per capita) and insurance penetration (premium income as a percent of GDP). While insurance is available in all ECA countries, analysis of these indicators shows not only that its development is limited relative to advanced economies such as France, Germany and the United States; but also that there is a wide disparity among ECA countries in the depth of the insurance industry (Tables 18 and 19).

Box 2. The Impact of State Owned Leasing Enterprises for Agricultural Machinery

State-owned leasing enterprises are a major instrument of agricultural policy in Kazakhstan, Russia, Ukraine and Uzbekistan. Established around 2000 to enhance investment in machinery, they were initially the only leasing enterprises authorized to operate, and so had a monopoly over the leasing market for agricultural machinery. Private leasing enterprises were authorized from 2001 onwards, but operate on commercial terms with shorter leases (1–3 years) and much higher interest rates (15–25%). Low cost funding from government allows the state-owned leasing companies to offer long-term (3–7 year) leases at low interest rates (3–5%), with lower down payments.

Despite the favorable terms offered by state-owned leasing enterprises the majority of farmers prefer private leasing enterprises. The highly subsidized leases from state-owned leasing enterprises have also not stopped the de-mechanization of agriculture.

Table 17. Characteristics of State-Owned Leasing Enterprises, Selected Countries

	% Market Share (2006)	% Change in Tractor Numbers 2000–2006	Restricted Machinery Choice	Restricted Insurance Choice	Tax Exemptions for Domestic Machinery
Kazakhstan	40–50%	–11.4%			na*
Russia	20–33%	–37.0%	na	na	na
Ukraine	17–22%	–16.8%	na		na
Uzbekistan	44%	na	na	na	na

*na – not data.

The reasons for this lack of success provide important lessons for future policy. First, farmer choice as to the machinery they buy is highly restricted under the state-owned leasing programs, and the acquisition process is long. Only officially designated, domestically produced farm machinery can be financed in Russia, Ukraine and Uzbekistan (no restrictions in Kazakhstan). Applications for leasing finance are processed on the basis of regional needs as well as farmer creditworthiness. In Russia and Uzbekistan the lessee is also obliged to insure the leased object with a state-owned insurance company – further reducing choice. Ponderous, centrally controlled allocation rather than consumer choice is thus the basis for operation. This clearly deters farmers, as shown by their preference for more expensive private sector leasing.

Second, the higher cost of private sector leasing means that there are fewer farmers with the means to buy imported machinery. This factor plus the limited demand for subsidized state leasing has reduced overall demand, with lower corresponding levels of investment.

Domestic manufacturers of farm machinery, state owned leasing companies and state owned insurance companies are the major beneficiaries of this policy. Farmers willing to accept the restrictions of state leasing also benefit, but other farmers wishing to invest are penalized by the high costs of leasing imported machinery. Private sector leasing is also penalized by unfair competition and grows more slowly as a result.

If farmers are to be the principal beneficiaries of subsidized leasing then its use should be unrestricted, with no discrimination against imported machinery. The restrictions on insurance should also be removed. Farmers will then make their own decisions about whether imported or domestically produced machinery suits their needs and their budget, demand will increase and farm mechanization will increase wherever it is profitable.

Sources: FAO, 2008; World Bank, 2006.

Within the ECA region the insurance industry is least developed (penetration < 1% of GDP) among the labor-intensive transition and truncated reform countries. The small-scale farmers who predominate in these countries are thus more likely to face inadequate access to insurance when they consider whether or not to invest in farm machinery. The insurance industry is also weakly developed in Kazakhstan and Belarus. In Kazakhstan this may be due to lower per capita incomes and the lower consequent demand for insurance, while in Belarus the high level of state involvement in the insurance sector may be a deterrent.

Table 18. Insurance Density: ECA Countries 2005–2006

Country	Premium Income/Capita $US		
	2005	2006	% Change
Labor Extensive European Accession Countries			
Czech Republic	475.8	516.5	8.6
Estonia	234.0	279.1	19.3
Hungary	333.4	376.2	12.8
Latvia	119.0	157.4	32.2
Lithuania	110.1	155.0	40.7
Slovakia	315.6	337.7	7.0
Labor Extensive Transition Countries			
Kazakhstan	33.4	65.5	96.5
Labor Extensive Truncated Reform Countries			
Belarus	23.2	26.5	14.3
Russian Federation	121.2	155.4	28.2
Ukraine	53.3	58.5	9.9

Continued Table 18

Country	Premium Income/Capita $US		
	2005	2006	% Change
Labor Intensive European Accession Countries			
Bulgaria	88.7	103.0	16.0
Croatia	278.1	315.5	13.5
Poland	247.4	313.3	26.6
Romania	77.7	94.7	21.9
Slovenia	961.8	1078.3	12.1
Turkey	73.0	81.0	11.0
Labor Intensive Transition Countries			
Albania	12.7	14.6	14.7
Armenia	2.5	na*	na
Georgia	7.6	na	na
Kyrgyzstan	0.7	0.8	15.2
Labor Intensive Truncated Reform Countries			
Azerbaijan	na	11.9	na
Moldova	8.2	11.2	36.5
Tajikistan	1.2	3.0	144.7
Uzbekistan	1.3	1.4	10.4
France	3869	4768	23.2
Germany	3609	3370	–6.6
United States	4764	4647	–2.5

*na – not data.

Sources: Insurance Statistics Yearbook 1997–2006, OECD; IMF; World Bank ECA summaries; Sigma; National Statistics.

These data also show that while the insurance industry is growing in absolute terms in the ECA region (Table 18), this growth is not always commensurate with underlying growth in GDP (Table 19). Falling levels of insurance penetration are observed in numerous countries throughout the ECA region, although this trend is most apparent in the labor extensive truncated reform countries.

Table 19. Insurance Penetration: ECA Countries 2005–2006

Country	Premium Income as % of GDP		
	2005	2006	% Change
Labor Extensive European Accession Countries			
Czech Republic	3.9	3.7	–5.1
Estonia	2.3	2.3	0.0
Hungary	3.0	3.4	10.5
Latvia	1.7	1.8	5.3
Lithuania	1.5	1.8	21.2
Slovakia	3.6	3.3	–8.9
Labor Extensive Transition Countries			
Kazakhstan	0.9	1.2	40.3
Labor Extensive Truncated Reform Countries			
Belarus	0.8	0.7	–6.7
Russian Federation	2.3	2.2	–1.3
Ukraine	2.9	2.5	–12.7
Labor Intensive European Accession Countries			
Bulgaria	2.5	2.5	–1.2
Croatia	3.2	3.3	2.5
Poland	3.1	3.5	12.5

Continued Table 19

Country	Premium Income as % of GDP		
	2005	2006	% Change
Romania	1.7	1.7	–1.2
Slovenia	5.5	5.7	3.5
Turkey	1.5	1.4	–4.1
Labor Intensive Transition Countries			
Albania	0.5	0.5	6.3
Armenia	0.2	na*	na
Georgia	0.5	na	na
Kyrgyzstan	0.1	0.1	–6.0
Labor Intensive Truncated Reform Countries			
Azerbaijan	na	0.5	na
Moldova	1.1	1.3	17.8
Tajikistan	0.4	0.7	102.3
Uzbekistan	0.2	0.2	–8.7
France	10.3	12.4	20.8
Germany	7.3	7.2	–1.9
United States	10.5	10.7	1.8

*na – not data.
Sources: Insurance Statistics Yearbook 1997–2006, OECD; IMF; World Bank ECA summaries; Sigma; National Statistics.

VII.6 GLOBAL EVENTS – FOOD PRICES, FINANCIAL MARKETS AND CLIMATE CHANGE

Recent global events are likely to have influenced farm mechanization. The world food price crisis of 2008 raised public awareness of the global impact of inadequate food supply and the need for continued increases in food production. However it didn't change the underlying rationale for investment in farm machinery. There is no evidence that this crisis has altered medium-term trends in the cost of labor and capital, which are the principal determinants of rates of mechanization. The impact lies elsewhere. For farmers seeking to mechanize, the food price crisis may well have reduced the willingness to invest. The massive increase in food price volatility that occurred during and after the food price crisis, and the associated impact on the stability of farm incomes will have made farmers more wary of large capital investments – of any kind.

The recent contraction of financial markets in response to the global financial crisis has undoubtedly further constrained investment in farm machinery. Access to finance, for any kind of investment, has plummeted. Higher income farmers in more reform-minded countries, with a greater exposure to world markets are probably the worst victims of these events, however, rather than low-income farmers in poorer countries.

In the medium term, climate change will influence farm mechanization to the extent that it stimulates production of more climate friendly farm machinery, with lower levels of emission; and the increased use of low-cost, minimum tillage cultivation systems. The rate at which such changes occur will depend on the cost of these innovations relative to conventional systems of farm mechanization, and the nature and extent of taxes and subsidies to encourage change. In the long-term climate change will inevitably result in the need for different production systems, with different crops more suited to the eventual climatic conditions. But the type and level of mechanization adopted in response to these changes will still ultimately depend on the relative costs of labor and capital.

VIII AGRICULTURAL MACHINERY MANUFACTURING AND DISTRIBUTION

With over $US 3.5 billion in sales in the growing market for agricultural machinery in developing countries, the ECA region is of significant interest to manufacturers and distributors'. Developing countries now account for more than 40% of world sales and are the fastest growing component of world markets. This chapter reviews current and future trends in the market for agricultural machinery, and the activities and perceptions of the main manufacturers engaged in this market. Analysis is based on market research on the world market for agricultural equipment (Freedonia Group) and a survey of international and national manufacturers active in the ECA region.

VIII.1 THE WORLD MARKET FOR AGRICULTURAL MACHINERY – CURRENT AND FUTURE TRENDS[17]

The world market for agricultural machinery is currently dominated by demand from countries with large, modern agriculture sectors. North America, western Europe and Japan accounted for 60% of total sales in 2005 (Figure 24). These are mature markets, however, with most sales for replacement and moderate prospects for future growth. Manufacturers compete by improving the energy efficiency, sophistication and comfort of their machinery, and by providing finance and strong after sales service. For 2010–2015 sales are forecast to increase by approximately 2.5% annually for North America and Western Europe, and 1% for Japan.

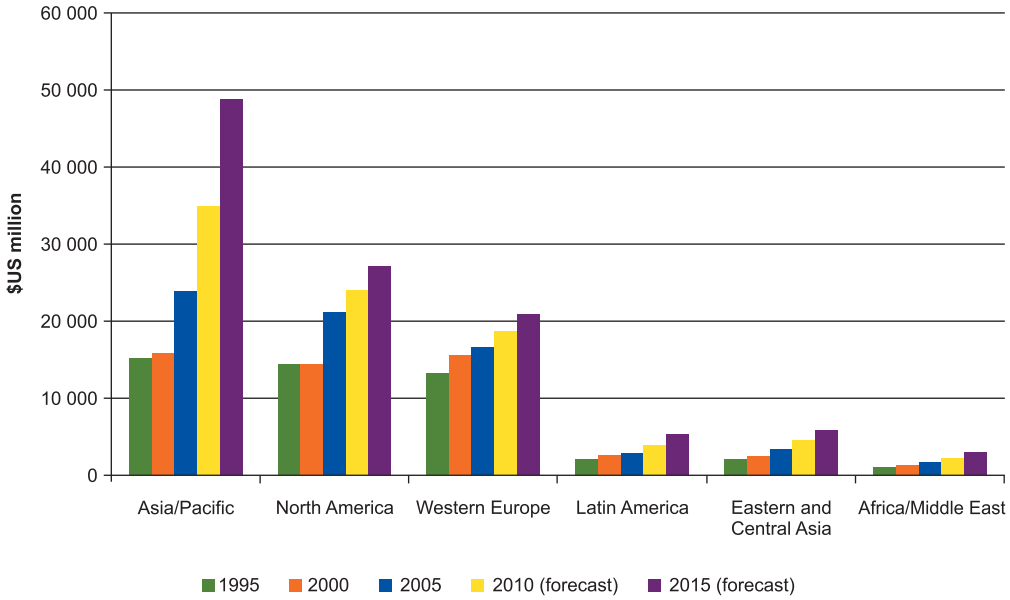
Farm machinery markets in developing countries offer much greater potential for the future in terms of both market size and market growth. Driven by the rapid mechanization of agriculture in Asia and Latin America, developing country markets are expected to grow by 6%–10% annually from 2010–2015. By 2015 developing countries are expected to account for more than 50% of world agricultural machinery sales. China is likely to surpass the USA as the biggest single market for agricultural machinery.

Agricultural machinery manufacturers in China, India, Pakistan, Brazil, Turkey, Iran and Belarus have benefitted substantially from this increased demand for farm machinery in developing countries. Mahindra and Mahindra of India has become the fourth largest producer of tractors in the world, and is expected to challenge Deere and Company as the largest producer by 2010. Many of these manufacturers have built their businesses around production of small, low-cost tractors, harvesters and farm implements suited to the small-scale, low-income farmers who dominate agriculture in their countries. But while this low-cost technology has a ready market in the developing world, exports to other low-income countries are limited. Most of the low cost farm machinery produced by the major manufacturers in China, India and Turkey is sold on their growing domestic markets.

The ECA region accounts for approximately 5% of the world market for agricultural machinery. Sales increased by 55% from 1995–2005, with a 30% sales increase forecast for 2005–2010 and a 23% increase forecast for 2010–2015. Past growth has been highly uneven between countries, however, due to the wide diversity in economic and agricultural development in the region. With their higher farm incomes, better access to finance and more favorable business environments the European accession countries have invested more in farm machinery than the low income agricultural economies of the Caucasus and Central Asia. And large-scale corporate farms' have invested more heavily than small-scale farms', especially in countries where farm incomes are low and access to finance is limited.

[17] Data from this section are drawn from "World Agricultural Equipment to 2010". Freedonia Group. 2006.

Figure 24. World Sales of Agricultural Machinery 1995–2015



Source: Freedonia Group. 2006.

Together with western Europe, the ECA region is currently a net exporter of agricultural machinery. The central European countries provide a low cost base for export to western Europe, the CIS countries and North America, and the major western manufacturers are expanding their presence in central Europe accordingly. Belarus is also expanding exports beyond its traditional markets in the CIS countries. Hence while production capacity in the ECA region is increasing, it is being increased to meet worldwide demand not just demand within the ECA region itself. Furthermore, the emphasis to date has been on increasing production of medium and large size tractors (70 HP – 250 HP) suitable for large-scale farms', rather than the low cost machinery sought by small-scale, low-income farmers.

VIII.2 COMPANY ACQUISITIONS, INVESTMENTS AND AGREEMENTS

Several hundred companies manufacture agriculture equipment for world markets. The three largest: Deere and Company (USA), CNH Global (majority owned by Fiat of Italy) and AGCO (USA) are all major multi-national companies, which together supply one third of the world market. A second tier of international manufacturers includes Kubota (Japan), Yanmar (Japan), CLAAS (Germany), Iseki (Japan), Same-Deutz-Fahr (Italy), Caterpillar (USA), ARGO (Italy), Mahindra and Mahindra (India), Kuhn Group (Bucher Industries Switzerland), and Kverneland (Norway). Of the major international companies, Deere and Company, CNH Global, AGCO, CLAAS, Caterpillar, Same-Deutz-Fahr, ARGO, Kverneland and Mahindra and Mahindra are all active in the ECA region. National companies with a strong presence in the ECA region include: Minsk Tractor Works (Belarus), Concern Tractor Plants (Russia), Rostselmash (Russia), KAMAZ (Russia), Uzel (Turkey), Turk Tractor (Turkey), Escort Group (India), Zetor (Czech Republic) and Ursus (Poland). TAFE (India) and the Iran Tractor Manufacturing Company (Iran) are also expanding their activities in the ECA.

The ECA agricultural machinery sector has changed substantially during the last 10 years due to widespread re-organization and investment. Many of the western, international companies have increased their presence, spurred by the prospect of a growing market and the potential cost advantages for manufacturing in the region. This growth is the result of acquisitions, joint ventures and green field investments in production and assembly plants, and distribution and service systems. Central and eastern Europe, Turkey, Russia, Ukraine,

Uzbekistan and Kazakhstan have been the major areas of interest (Table 20); and large-scale farmers have been the major client focus (Box 3).

Table 20. Agricultural Machinery Company Acquisitions, Joint Ventures and Agreements in the ECA Region

Company	Action	Partner	Country	Products
Western International Companies				
John Deere International	Production Plant		Russia	Agricultural equipment
	Distribution, Training and Parts Centre		Russia	All John Deere machinery
	Distribution networks		Russia, Ukraine	Grain Harvesters, equipment
CNH Global	Joint Venture – Production	Uzselmash Holding	Uzbekistan	Tractors, combines, cotton harvesters
	Joint Venture – Servicing	Uzagromashservice	Uzbekistan	Service Centers (R&M)
	Production Plant		Poland	Combines, Hay balers
	Joint Venture – Assembly	Turk Tractor	Turkey	Tractors
AGCO	Joint Venture – Assembly/ Distribution	Concern Tractor Plant	Russia, Kazakhstan	Tractors, Combines, equipment
	Joint Venture – Assembly	Concern Tractor Plant	Russia	Diesel engines
Same-Deutz-Fahr	Joint Venture – Assembly/ Marketing	Concern Tractor Plant	Russia	Tractors
	Production Plant		Poland	Combines
	Acquisition	Duro Harvester Plant	Croatia	Combines
CLAAS	Production Plant		Russia	Combines
	Production Plant		Hungary	Combines
	Distribution		Ukraine	Combines
Caterpillar	Production Plants		Poland, Hungary, Russia	Diesel engines
ARGO	Joint Venture – Assembly	KAMAZ	Russia	Tractor assembly
Kverneland	Production		Russia	Equipment (seeders)
	Distribution	Uzel	Turkey	Agricultural equipment
Asian and Middle East Companies				
Mahindra and Mahindra	Distribution	Intermotoors	Serbia	Tractors (39–50 HP, 2WD and 4WD)
	Distribution	ILCE	Turkey	Tractors (55–65 HP)
	Distribution	Dealers	Croatia, Bosnia, Macedonia	Tractors
Escort Group (India)	Distribution	Spolka	Poland	Tractors
	Distribution		Turkey	Tractors
TAFE (India)	Production/Distribution		Turkey	Tractors (45–80 HP)
Hozo-SK (China)	Assembly – under discussion		Romania	Tractors
Iran Tractor Manufacturer	Assembly		Tajikistan	Tractors
ECA National Manufacturers				
Uzel (Turkey)	Acquisition	Ursus Tractor Company	Poland	Tractors

Continued Table 20

Company	Action	Partner	Country	Products
Zetor (Czech Republic)	Acquisition		Poland, Czech Republic, Slovakia	Tractors
Tractor Concern Plants	Joint Venture – AGCO (see above)			
	Joint Venture – Same-Deutz-Fahr (see above)			
	Distribution		Ukraine, Kazakhstan	Tractors
New Community (Rostelsmash)	Acquisition	Buhler Industries	Canada	Combines, Tractors
	Joint Venture – Assembly		Kazakhstan	Combines, Tractors
	Distribution		Kazakhstan, Turkey, Ukraine	Combines
MTW (Belarus)	Joint Venture – Assembly		Moldova	Tractors
	Distribution		Kazakhstan	Tractors
	Joint Venture – assembly		Bulgaria	Tractors

Manufacturer interest in small-scale farmers has been minimal but is now beginning to grow, led by the major Indian agricultural machinery companies. As would be expected, these initiatives have focused on areas where small-scale farming is predominant. Mahindra and Mahindra is developing distribution networks in Turkey and the Balkans, Escorts Group is developing distribution networks in Turkey and Poland, and TAFE is building an assembly plant in Turkey. These companies bring a critical new dimension to the agricultural machinery sector in the ECA – the capacity to design, produce and market farm machinery suited to small-scale, low income farmers. In addition, a Chinese manufacturer (Hozo-SK Modern Agricultural Equipment) has recently agreed to establish a tractor assembly plant in Romania, and the Iran Tractor Manufacturing Company has established a tractor assembly plant in Tajikistan.

ECA manufacturers have also influenced trends in investment and re-organization in the region. The Turkish tractor company Uzel has recently acquired the Polish tractor producer, Ursus; and the Czech tractor producer, Zetor, has been rejuvenated under new management and is expanding sales in Poland, Slovakia and the Czech Republic. The re-emergence of these two brands will add a further source of competition to the rapidly growing markets of eastern and central Europe, and a lower cost alternative to the sophisticated, high cost tractors sold by western companies.

In the CIS countries re-organization and investment has been used as a means to facilitate control of traditional agricultural machinery markets. This process began with consolidation of the Russian agricultural machinery sector, which is now dominated by two privately owned holding companies, "Concern Tractor Plants" and the "New Community." Foreign investment was resisted during this process although the import of western agricultural machinery increased substantially. Both holding companies are now actively building partnerships with western international companies, but are using these initiatives to strengthen their position in CIS markets and to build a stronger base for non-CIS exports. Concern Tractor Plants, which owns the main tractor producers in Russia,' formed a joint venture with AGCO in 2006 to assemble and distribute large (> 150 HP) Fendt and Valtra tractors and farm equipment in Russia and Kazakhstan; and a second joint venture in 2008 to assemble diesel engines in Russia. They are also planning a joint venture with Same-Deutz-Fahr to assemble combines and large tractors (> 150 HP) in Russia. Rostselmash, the main entity of the "New Community" holding company acquired the Canadian agricultural machinery company, Buhler Industries, in 2007 as part of its strategy to expand exports world-wide.

Minsk Tractor Works (MTW), which dominated the regional market before independence, has thus far maintained its dominance of the CIS market through preferential trade agreements and its well-developed

distribution and service system. To expand its presence, MTW is planning to build assembly plants in Bulgaria, Moldova and Kazakhstan. But MTW remains firmly under state control and continues to resist partnerships with international companies. As the Russian manufacturers modernize and expand they will inevitably become less inclined to accept MTW's use of preferential trade agreements to secure its place in CIS markets.

VIII.3 MANUFACTURER PERCEPTIONS OF ECA OPPORTUNITIES AND CONSTRAINTS

To gauge manufacturer perceptions' of the market for agricultural machinery in the ECA the multi-national companies active in the region were surveyed, plus the largest producers in Russia and Ukraine. Eight companies responded to the survey, including: three of the seven main multi-national companies, with approximately 25% of sales in the ECA region in 2007; four Russian companies with approximately 85% of combine production, 50–60% of tractor production and 35–40% of fodder harvester production; and one Ukrainian company with 38% of tractor production in Ukraine. The results of this survey are presented in Tables 21 and 22 below, with the response of each company represented by a '+'.

Table 21. Multi-National Agricultural Machinery Manufacturer Survey, 2008

	Turkey	Central and Eastern Europe	Russia	Ukraine & Belarus	Caucasus Countries	Central Asia
Current Sales Activity/Potential for Growth						
Tractors < 50 HP	++/++	+++/++	+/		+/+	/+
Tractors 50–120 HP	+++/+++	++/+	++/+	++/+	+/+	+/+
Tractors > 120 HP	++/+	++/++	++/++	++/++	/+	+/+
Grain Harvesters	+/+	+/+	+/+	+/+	/+	+/+
Favorable Start-Up Environment	+++	++				
Formation of Joint Ventures	+++	++	++	+	+	+
Ancillary Services Developed						
Dealer networks	++	+++	++	++	+	+
Service centers	++	+++	++	++	+	+
Spare parts	++	+++	++	++	+	+
Provision of Manufacturer Finance						
For dealers						
For buyers						
Dealer finance for buyers	+	+	+	+	+	+
Second-hand machinery (dealers)			+	+		
Constraints to Market Growth						
Competition from western manufacturers	+					
Competition from local manufacturers	+	+	+	+		
Inadequate Finance	++	+	++	++	+	+
Lack of Dealers	+++	++	++	++	+	+
Lack of Service Centers	++		+	++	+	+
Lack of Spare Parts	+					
Trade Agreements			+	+		
Reasons for Not Operating in these Markets						
Other regions have higher priority			+	+	++	++
Market is too small			+	+	+	+
Lack of information				+	+	+
High Import Duties					+	

Continued Table 21

	Turkey	Central and Eastern Europe	Russia	Ukraine & Belarus	Caucasus Countries	Central Asia
Competition from local manufacturers			+			
Not Viable			+			
Lack of Distributors					+	++
Lack of Servicing						
Equipment too Expensive						

Source: Survey responses from three major multi-national agricultural machinery companies operating in the ECA region, 2008. FAO and World Bank.

Although the number of respondents is small, there is sufficient uniformity in the results to suggest the following characteristics and conclusions:

- The multi-national manufacturers perceive a growing market for tractors and combines throughout the ECA, particularly in Turkey, central and eastern Europe (CEE), Russia, Ukraine and Belarus. The establishment of joint ventures in production and distribution and/or licensing agreements demonstrates their willingness to back this perception with investment.
- Certain areas are perceived as having more potential than others, with Turkey and the CEE offering the greatest opportunities and the Caucasus and Central Asia the least. Turkey and the CEE offer more favorable start-up environments, in addition to more advanced levels of reform and access to the markets of the European Union. The markets in the Caucasus and parts of Central Asia are seen as being too small relative to other areas and more difficult to develop.
- All manufacturers, both multi-national and companies in Russia and Ukraine, view the establishment of distributor networks, service centers and spare parts supply as the basis for successful operation. The provision of finance and sales of second-hand machinery are also viewed as important but only the largest companies have the resources to establish and operate these services.
- All manufacturers cite the difficulty of finding suitable distributors and dealers as a major constraint to market development. Inadequate finance is viewed as a further constraint by multi-national companies but less so by Russian and Ukraine companies – due perhaps to the state-subsidized leasing and finance programs in these countries.

Table 22. Russian and Ukraine Agricultural Machinery Manufacturer Survey, 2008

	Domestic Markets	CIS Markets	Non-CIS Markets
Current Sales Activity/Potential for Growth			
Tractors < 50 HP	++/Average	++/Weak	+/Weak
Tractors 50–120 HP	+/High-Average	+/Average	Average
Tractors > 120 HP	++/Average	+/Average	
Grain Harvesters	++/High	++/High	++/Average
Fodder Harvesters	+/Average	+/Average	+/Average
Ancillary Services Developed			
Dealer networks	+++++	+++	+++
Service centers	++++		
Provision of Manufacturer Finance			
For Dealers	+		
For buyers	+ (leasing)		
Second-hand machinery (dealers)	+		
Constraints to Market Growth			
Competition from western manufacturers	+++	+	++
Competition from CIS manufacturers	+	++	

Continued Table 22

	Domestic Markets	CIS Markets	Non-CIS Markets
Competition from local manufacturers	+++	++	
Inadequate Finance	+	+	+
Lack of Dealers	++	++	
Lack of Service Centers			
Low incomes	+++	++	
Administrative barriers	++	+++	+
High import duties		+	
Trade agreements		++	++

Source: Survey responses from five major regional agricultural machinery companies in Russia and Ukraine, 2008. FAO and World Bank.

- Multi-national companies view competition from other manufacturers as a moderate constraint to market development, in contrast to Russian and Ukraine companies who view external competition as a major problem. This perception of "unfair competition" was maintained even when the Russian and Ukraine companies were asked to take into account the widely disparate price/quality ratios of their products and the fact that they were effectively operating in different segments of the market.
- The Russian and Ukraine companies cite administrative barriers to market entry and operation, in both their own and neighboring CIS countries, as further important constraints. This is consistent with the multi-national perception that these countries do not offer favorable start-up conditions.
- The larger, more export oriented companies identified trade policy as a constraint to market development in the CIS region. The instability of CIS trade agreements and government restrictions on both imports and exports were both noted in this context and appear to be of greater concern than the actual level of import protection.

Box 3. Large-Scale Agro Holdings in Russia and Ukraine: Implications for Mechanization

In both Russia and Ukraine agriculture is dominated by large, former collective farms with an average size of 4,500 ha and 1,000 ha, respectively. Privatized during the reform process, these farms struggled to achieve profitability until the late 1990s, and their growth was minimal. Profitability then improved after the Russian financial crisis in 1998, buoyed by devaluation of the ruble, improving world commodity prices and increased government support. Growth has continued but productivity remains low by western standards, due to low fertilizer use, lack of machinery and weak management. Most of these farms continue to operate below their potential.

The more favorable conditions of the late 1990s also resulted in the amalgamation and transformation of many of these farms into very large, modern "agro-holdings," which have become a major presence in the agriculture sectors of both countries. Spurred by the prospect of favorable returns, agri-business enterprises (including agro-processors and custom hire services), financiers and businessmen began leasing and buying arable land at very favorable prices – often by buying up bankrupt former collective farms. They then used their access to finance to re-capitalize these farms and increase input use, and improved and streamlined management. With an average size of around 50,000 ha these agro-holdings now account for around 9% of arable land use in both Russia and Ukraine. They continue to grow in importance, and in Russia are major beneficiaries of the increasing subsidization of agriculture.

Large, sophisticated tractors and combines and associated farm implements are a critical input for the modern, labor extensive production systems that are the basis for operation. Expenditure on farm machinery thus accounts for a major component of the capitalization of these farms. In the Ukraine, Renaissance Capital estimates that outlays of $5–6 million for farm machinery are required for every

10,000 ha of land. A Russian agro holding with 129,000 ha of land in 2008, estimated its overall capital requirements at $30 million for land, $50 million for machinery, $15 million for working capital and $35 million for storage.

With their ready access to finance, and requirement for large, sophisticated, expensive farm machinery these agro-holdings have become a major target for farm machinery manufacturers and distributors. Both multinational and domestic manufacturers are competing actively for this market, although imported machinery seems to have the edge. The multinational manufacturers active in these countries perceive the market for large-scale tractors (> 120 HP) as offering strong potential for growth while domestic manufacturers view it as "average" (Table 21). This has doubtless motivated "Tractor Concern Plants," the major Russian manufacturer, to initiate joint venture activities with AGCO and Same-Deutz-Fahr to manufacture more technologically advanced large-scale machinery.

These influences explain much of the strong recent growth in the markets for farm machinery in Russia and Ukraine. They also indicate that the needs of lower income farmers, for smaller lower cost machinery, may not be receiving the attention they warrant.)

IX CONCLUSIONS AND RECOMMENDATIONS

The study provides broad support for the view that farm mechanization is an adjunct to more fundamental influences on agricultural production and productivity in the ECA region, rather than a means to directly increase output. It also shows that policy reform influences the level of mechanization and that labor costs are generally a more important determinant of the demand for mechanization than the cost of capital, with existing forms of mechanization. Hence, mechanization augments agricultural productivity where reform is advanced and farm wages are high, as in the more advanced accession countries. Policies that improve access to finance and create a business environment conducive to the supply of farm machinery are thus essential in these countries. In transition countries, where reform is active and labor costs are rising towards the levels observed in accession countries, policy should also be directed to strengthening the financial sector and the business environment. Farmers will then be in a position to increase their mechanization of agriculture, as it becomes appropriate.

In the truncated reform countries, where agriculture sector reform is partial and rural wages are low, farm mechanization is declining – with falling machinery numbers and a significant ageing of the machinery fleet. Yet this de-mechanization is not the fundamental constraint to agriculture sector growth. Increased mechanization does not resolve the problems caused by inadequate reform of factor and product markets, weak financial systems and poor business environments. Where this combination of partial reform and low wages prevails, policies to boost farm mechanization based on subsidized finance to reduce the cost of capital are likely to have a more limited impact on growth than fundamental reform. Mechanization is an increasing constraint to agriculture growth in the labor extensive truncated reform countries, nevertheless, due to the outflow of rural labor. The combination of declining labor and declining capital cannot be ignored.

There is no evidence that mechanization compromises rural poverty reduction in low income ECA countries, by driving down rural wages or reducing rural employment. Machinery does eventually substitute for labor, but only in more advanced countries where rural poverty is limited. There is also no direct evidence that farm mechanization contributes to poverty reduction, at least with existing types of farm machinery. Low income farmers seek to mechanize their operations nevertheless, as evidenced by the increased use of horses among small-scale farmers. The growing use of farm machinery in low-income Asian countries also shows that there are low-cost alternatives to animal power, and that the benefits of mechanization can be extended to low-income farmers. This machinery enhances the capacity to mechanize farm operations, but at a much lower cost of capital relative to farm labor. Improved access to such machinery could facilitate increased mechanization in the less advanced countries in the ECA region, especially where labor-intensive production systems and small-scale farms predominate.

Based on these broad conclusions, we round out the analysis by showing where support for farm mechanization is a legitimate focus for agriculture sector development and where it is not, and how it can be encouraged and supported.

IX.1 TRANSITION COUNTRIES – A ROLE FOR LOW-COST MECHANIZATION

In labor intensive transition countries the substantial increase in farm wages (Table 6) suggests that there is potential for increased farm mechanization. Land reform, market liberalization and farm privatization are also generally well-advanced, creating strong incentives for farmers to raise productivity. Yet the stock of farm machinery has remained relatively static, and machinery fleets are ageing due to inadequate replacement. Farmers appear to be investing in horses rather than tractors as a means to increase productivity.

Wage rates have yet to approach the levels observed in the accession countries, however, which suggests that a significant increase in mechanization may not yet be appropriate – at least with the type of machinery currently available. The immediate constraint to mechanization may thus be limited access to low-cost farm machinery, suited to this type of agriculture. Driven by tractor manufacturers from India and Turkey, investment in this type of machinery is already growing in ECA countries where small farms predominate, such as Poland, Serbia, Croatia and the Former Yugoslav Republic of Macedonia. To broaden access to this, and all other types of farm machinery, transition countries will need to improve their business environments', strengthen their financial systems, facilitate imports and more actively seek investment by foreign farm machinery manufacturers.

IX.2 TRUNCATED REFORM COUNTRIES – DE-MECHANIZATION IS NOT THE REAL PROBLEM

The truncated reform countries have all experienced a sustained "de-mechanization" of agriculture, characterized by a marked decline in the number of tractors, combines and farm implements; and a significant ageing of the machinery fleet. In countries with labor extensive production systems, this de-mechanization of agriculture has been accompanied by a parallel reduction in farm labor supply – and a significant consequent decline in the resource base for agriculture. De-mechanization has also occurred in countries with labor-intensive production systems, but it has been offset by an increase in horse numbers and the farm labor supply has remained fairly constant. Wage rates are increasing in the truncated reform countries, although in the labor intensive countries they remain extremely low.

Under pressure to address this de-mechanization of agriculture, the governments' of most truncated reform countries have given high priority to policies and programs to increase investment in farm machinery. These measures have been most evident in labor extensive countries such as Russia and Ukraine where farmers rely more heavily on machinery. Public programs to reduce the cost of capital, based on subsidized leasing and credit, have been the major response. But most of this subsidized finance has been restricted to the purchase of domestically produced farm machinery, as a means to support domestic manufacturers of farm machinery. None of these programs have been successful in arresting the de-mechanization of agriculture. Farmers who used the subsidized finance have benefitted, but they are a minority and most are large-scale producers. The major beneficiaries of these measures have been domestic tractor manufacturers.

While the de-mechanization of agriculture observed in these countries is a constraint to production, it is symptomatic of deeper problems in the agricultural sector. The real constraints lie with incomplete reform of factor and commodity markets and the low incentives for farmers to invest. Returns to agriculture remain low, farmer ability to fully appropriate these returns remains uncertain, and rural people have little incentive to remain in rural areas. The transition countries have been far more successful at arresting de-mechanization and stimulating investment in farm machinery, based on a commitment to reform rather than subsidized finance and skewed industrial policies.

IX.3 EXPANDING THE ROLE FOR LOW-COST, SMALL-SCALE FARM MACHINERY

Most of the new farm machinery sold in the ECA is unsuitable for small-scale, low-income farmers. The markets are dominated by medium and large-scale machinery sold by western multi-national manufacturers and large corporations in Belarus, Russia and Ukraine. These enterprises view this segment of the market as their most profitable focus for the foreseeable future. They have limited interest in designing and building simple, low-cost, small-scale machinery suited to low income farmers.

There are many developing country manufacturers with the capacity to design, manufacture and distribute farm machinery suited to low income farmers, however, and they are doing so on a very large scale. Indeed the limited presence of farm machinery manufacturers from China, India and Brazil in the ECA region is due in part to surging demand in their own domestic markets. This is beginning to change. The larger and more international of these corporations are now establishing manufacturing and distribution operations in the more advanced ECA countries where small-scale agriculture is predominant, as noted above. The opportunities for growth in the ECA region in this segment of the market have clearly been recognized.

The next step is to further this expansion into the transition countries. There is scope for donors to facilitate this expansion through the use of political risk guarantees coupled with support for national programs to improve business environments and improve access to financial services. Governments can also do much more to encourage foreign direct investment by these manufacturers, and to facilitate imports.

IX.4 PROMOTING FARM MECHANIZATION – WHAT CAN BE DONE?

The study identifies numerous ways to promote farm mechanization in low and middle-income countries, by addressing both demand and supply side constraints. These are summarized below. Much can be done indirectly, without distorting factor markets or factor prices, but there is also scope for direct government or donor support.

Truncated Reform Countries

The governments of truncated reform countries have chosen to maintain high levels of state intervention in their economies, and to accept the economic distortions and inefficiencies this creates. By precluding full land reform, market liberalization and farm privatization this policy stance compromises their ability to improve farm mechanization. There is scope to modify and rationalize some of their existing policies nevertheless, as suggested below:

- Rationalize the industrial policies designed to protect domestic farm machinery manufacturers by removing preferential access to subsidized finance, removing tax exemptions for domestic machinery, reducing import protection and removing the barriers to foreign investment.
- Remove inappropriate restrictions to the import and sale of new and second-hand farm machinery, including the preferential trade agreements with CIS countries.
- Terminate the centralized procurement of farm machinery through state organizations and the state managed allocation of this machinery to farmers.
- Privatize state owned farm machinery stations and servicing stations.
- Reform of the business environment should focus on reducing start-up costs, reducing taxation and removing the differential taxation of local and foreign firms, streamlining import procedures, improving contract enforcement, improving access to insurance, improving leasing legislation, and ensuring that farm machinery distribution and sales outlets can be established and operated.
- Where state subsidized leasing and credit programs are operated as the basis for support to farm mechanization the emphasis should be on making these programs open to both imported and domestically produced farm machinery. A cap should also be placed on the amount of subsidized leasing or credit received by any single farmer to limit the high transfers to large corporate farms.
- A sunset clause should be placed on the operation of state leasing agencies, after which they should be privatized. Private leasing agencies should be allowed to operate in parallel with public leasing agencies.

Transition Countries

Transition countries should focus on: reducing barriers to imports (the main source of farm machinery), increasing access to finance, improving the business environment, and increasing foreign investment in manufacturing and distribution. Particular areas of activity include:

- Reform of the business environment should focus on reducing start-up costs, reducing taxation and removing the differential taxation of local and foreign firms, streamlining import procedures, improving contract enforcement, improving access to insurance, and ensuring that farm machinery distribution and sales outlets can be established and operated.
- Promote the establishment and expansion of machinery distributors and dealerships through training and profit sharing systems.
- Encourage foreign direct investment by farm machinery manufacturers and distributors able to supply low-cost appropriately scaled farm machinery, and ongoing servicing and parts supply.
- Support measures to strengthen and deepen financial markets, including the development of leasing and associated legislation. Care should be taken not to place undue emphasis on leasing as opposed to normal commercial credit. It has fewer advantages for low-income farmers who are unlikely to benefit from the tax savings conferred by leasing.
- Broaden the coverage of medium-term donor credit lines for agriculture to include investment in farm machinery. These credit lines should include provision for the design of appropriate financial products and lending for second-hand machinery.

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APPENDICES

APPENDIX I. WORLD BANK REFORM INDICES AND EBRD TRANSITION INDICATORS

World Bank Policy Indices

Market Conforming Policy Environment	Land Reform	Rural Financial Systems
1–2. Direct state control of prices and markets	1–2. System dominated by large-scale farms	1–2. Soviet type system, with "Agrobank" as the sole financing channel
3–4. Deregulation with indicative prices, and price controls; significant NTB on exports or imports	3–4. Legal framework for land privatization and farm restructuring in place, implementation launched only recently	3–4. New banking regulations are introduced; little or no commercial banking
5–6. Mainly liberalized markets constrained by the absence of competition and some remaining controls on trade policy	5–6. Advanced stage of land privatization, but large-scale farm restructuring is not fully complete	5–6. Restructuring of existing banking system, emergence of commercial banks
7–8. All command economic type interventions are removed. Market and trade policies are in compliance with WTO, however domestic markets are not fully developed	7–8. Most land privatized, but titling is not finished and land markets not fully functioning	7–8. Emergence of financial institutions serving agriculture
9–10. Competitive markets with market conforming trade and agricultural policies, and no more than modest protection	9–10. Farming structure based on private ownership and active land markets	9–10. Efficient financial system for agriculture, agro-industries, and services

EBRD Transition Indicators

The transition indicator scores reflect the judgment of the EBRD's Office of the Chief Economist about country-specific progress in transition. The scores are based on the following classification system, which was originally developed in the 1994 EBRD Transition Report, but has been refined and amended in subsequent reports.

"+" and "–" ratings are treated by adding 0.33 and subtracting 0.33 from the full value. Averages are obtained by rounding down, for example. a score of 2.6 is treated as 2+, but a score of 2.8 is treated as 3–.

Large-scale privatization

1 – Little private ownership.

2 – Comprehensive scheme almost ready for implementation; some sales completed.

3 – More than 25% of large-scale enterprise assets in private hands or in the process of being privatized (with the process having reached a stage at which the state has effectively ceded its ownership rights), but possibly with major unresolved issues regarding corporate governance.

4 – More than 50 per cent of state-owned enterprise and farm assets in private ownership and significant progress with corporate governance of these enterprises.

4+ – Standards and performance typical of advanced industrial economies: more than 75 per cent of enterprise assets in private ownership with effective corporate governance.

Small-scale privatization

1 – Little progress.

2 – Substantial share privatized.

3 – Comprehensive program almost ready for implementation.

4 – Complete privatization of small companies with tradable ownership rights.

4+ – Standards and performance typical of advanced industrial economies: no state ownership of small enterprises; effective tradability of land.

Trade and foreign exchange system

1 – Widespread import and/or export controls or very limited legitimate access to foreign exchange.

2 – Some liberalization of import and/or export controls; almost full current account convertibility in principle, but with a foreign exchange regime that is not fully transparent (possibly with multiple exchange rates).

3 – Removal of almost all quantitative and administrative import and export restrictions; almost full current account convertibility.

4 – Removal of all quantitative and administrative import and export restrictions (apart from agriculture) and all significant export tariffs; insignificant direct involvement in exports and imports by ministries and state-owned trading companies; no major non-uniformity of customs duties for non-agricultural goods and services; full and current account convertibility.

4+ – Standards and performance norms of advanced industrial economies: removal of most tariff barriers; membership in WTO.

Competition policy

1 – No competition legislation and institutions.

2 – Competition policy legislation and institutions set up; some reduction of entry restrictions or enforcement action on dominant firms.

3 – Some enforcement actions to reduce abuse of market power and to promote a competitive environment, including break-ups of dominant conglomerates; substantial reduction of entry restrictions.

4 – Significant enforcement actions to reduce abuse of market power and to promote a competitive environment.

4+ – Standards and performance typical of advanced industrial economies: effective enforcement of competition policy; unrestricted entry to most markets.

Banking reform and interest rate liberalization

1 – Little progress beyond establishment of a two-tier system.

2 – Significant liberalization of interest rates and credit allocation; limited use of directed credit or interest rate ceilings.

3 – Substantial progress in establishment of bank solvency and of a framework for prudential supervision and regulation; full interest rate liberalization with little preferential access to cheap refinancing; significant lending to private enterprises and significant presence of private banks.

4 – Significant movement of banking laws and regulations towards BIS standards; well-functioning banking competition and effective prudential supervision; significant term lending to private enterprises; substantial financial deepening.

4+ – Standards and performance norms of advanced industrial economies: full convergence of banking laws and regulations with BIS standards; provision of full set of competitive banking services.

Securities markets and non-bank financial institutions

1 – Little progress.

2 – Formation of securities exchanges, market-makers and brokers; some trading in government paper and/or securities; rudimentary legal and regulatory framework for the issuance and trading of securities.

3 – Substantial issuance of securities by private enterprises; establishment of independent share registries, secure clearance and settlement procedures, and some protection of minority shareholders; emergence of non-bank financial institutions (e.g. investment funds, private insurance and pension funds, leasing companies) and associated regulatory framework.

4 – Securities laws and regulations approaching IOSCO standards; substantial market liquidity and capitalization; well-functioning non-bank financial institutions and effective regulation.

4+ – Standards and performance norms of advanced industrial economies: full convergence of securities laws and regulations with IOSCO standards; fully developed non-bank intermediation.

APPENDIX II. REGRESSION RESULTS – AGRICULTURAL PRODUCTIVITY

Determinants of Agricultural Productivity (Agricultural Value-Added/ha arable land) – Random Effects Model, GLS

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
No. Workers/ha (t)	1.157	–0.128	–1.906	1.528**	0.808*
	(0.95)	(–0.38)	(–0.43)	(2.30)	(3.40)
No. Tractors/ha (t–1)	–0.031	0.226**	1.853	–0.025	–0.761*
	(–0.19)	(2.05)	(0.48)	(–0.15)	(–5.82)
Tractor Investment (t) ($/ha)	0.194**	0.163**	–1.161	0.418**	0.144
	(2.56)	(2.10)	(–0.61)	(2.08)	(1.25)
No. Horses/ha (t)	–0.271	0.023	–0.005	–0.329*	–0.252*
	(–1.23)	(0.23)	(–0.01)	(–2.68)	(–2.44)
Wheat yield (kg/ha)	0.051**	0.077**	0.002	–0.012	0.105
	(2.34)	(2.22)	(0.00)	(–0.13)	(1.90)
Wheat price ($US/ton)	–0.125	–0.129	1.627	–0.396	–0.304
	(–1.25)	(–1.40)	(0.59)	(–0.87)	(–1.55)
Labor Extensive Dummy	0.615	–0.739	–2.409		
	(0.42)	(–1.52)	(–0.64)		
Transition Dummy	–0.648			–0.441	
	(–0.56)			(–0.77)	
Truncated Reform Dummy	–0.862		–0.159	–1.008	–1.905*
	(–1.73)		(–0.16)	(–1.79)	(–5.54)
Trend Variable	0.020	–0.017	0.271	–0.038	0.048*
	(1.06)	(–0.86)	(0.78)	(–0.85)	(2.24)
Intercept	–31.883	40.735	–545.133	86.093	–85.742**
	(–0.88)	(1.01)	(–0.76)	(0.95)	(–2.04)
R^2	0.75	0.69	0.92	0.81	0.94
Number of Observations	126	72	54	70	56
Number of Countries	16	9	7	9	7

t – statistics in brackets.
* Statistically significant at 1%.
** Statistically significant at 5%.

Determinants of Farm Labor Use (Agricultural workers/ha arable land) – Random Effects Model, GLS

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Monthly Wage	–0.068	–0.138	–0.551*	–0.327**	–0.481**
	(–1.28)	(–1.39)	(–3.58)	(–2.21)	(–2.20)
Wheat Price	0.059	0.082	0.387*	0.620*	0.360
	(0.97)	(0.97)	(2.96)	(5.89)	(1.69)
No. Tractors/ha (t–1)	0.113	0.104	0.451*	0.243*	0.235
	(1.86)	(1.14)	(2.98)	(2.61)	(1.85)
Tractor Investment (t) ($/ha)	0.009	0.087*	0.013	0.010	0.272*
	(0.46)	(2.58)	(0.20)	(0.20)	(3.11)
No. Horses/ha (t)	0.161*	0.198*	–0.144	0.051	0.370*
	(2.80)	(3.01)	(–1.51)	(0.81)	(5.57)
Labor Extensive Dummy	–1.206*	–1.032*	–1.135*		
	(–7.68)	(–4.53)	(–6.22)		

Continued

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Transition Dummy	0.953*			0.305	
	(4.26)			(1.02)	
Truncated Reform Dummy	0.380**		–0.266	0.282	0.537
	(1.98)		(–1.50)	(0.94)	(1.14)
Trend Variable	–0.186*	–0.038*	0.066*	0.021	–0.032
	(–2.63)	(–3.59)	(2.63)	(0.93)	(–1.19)
Intercept	35.814*	75.426*	–133.299*	–45.805	60.686
	(2.55)	(3.56)	(–2.66)	(–1.00)	(1.15)
R^2	0.88	0.87	0.95	0.81	0.76
Number of Observations	127	72	55	71	56
Number of Countries	16	9	7	9	7

t – statistics in brackets.
* Statistically significant at 1%.
** Statistically significant at 5%.

Determinants of Tractor Investment ($US/100 ha arable land) – Random Effects Model, GLS

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Monthly Wage	0.938*	0.533	1.239*	0.724**	1.260*
	(4.81)	(1.61)	(3.88)	(1.98)	(3.99)
Wheat Price	0.234	0.671**	0.542	0.445	0.381
	(0.95)	(2.31)	(1.83)	(1.64)	(1.07)
No. Tractors/ha (t–1)	0.153	0.129	0.939**	0.246	0.668*
	(0.90)	(0.48)	(2.39)	(1.07)	(3.50)
Nominal Interest Rate	–0.480**	–0.828*	0.042	–0.750*	0.131
	(–2.10)	(–3.22)	(0.09)	(–2.87)	(0.55)
No. Horses/ha (t)	0.336	0.259	0.636*	0.576*	0.060
	(1.75)	(1.16)	(2.56)	(3.12)	(0.53)
Labor Extensive Dummy	0.471	0.457	0.603		
	(1.23)	(0.74)	(1.18)		
Transition Dummy	–0.569			–0.818	
	(–0.92)			(–1.11)	
Truncated Reform Dummy	–0.456		1.088*	–0.158	0.042
	(–0.89)		(2.95)	(–0.21)	(0.05)
Trend Variable	0.044	0.058	0.035	0.065	0.041
	(1.05)	(1.30)	(0.38)	(1.00)	(0.79)
Intercept	–90.761	–118.055	–78.525	–131.440	–88.424
	(–1.08)	(–1.32)	(–0.43)	(–1.03)	(–0.86)
R^2	0.90	0.79	0.54	0.89	0.94
Number of Observations	126	72	54	70	56
Number of Countries	16	9	7	9	7

t – statistics in brackets.
* Statistically significant at 1%.
** Statistically significant at 5%.

APPENDIX III. REGRESSION RESULTS – DEMAND FOR INVESTMENT IN TRACTORS AND COMBINES

Determinants of Tractor Demand

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Nominal Interest %	–0.39**	–0.760*	–0.089	–0.391	–0.286
	(–2.05)	(–3.90)	(–0.22)	(–1.63)	(–1.35)
Access to Credit	0.051	0.005	–0.214	0.128	0.071
	(0.30)	(0.03)	(–0.70)	(0.48)	(0.45)
Wage	0.981*	0.405	1.581*	0.906*	0.556*
	(5.58)	(1.70)	(4.02)	(4.26)	(2.49
Wheat Price	0.136	0.779*	–0.609**	–0.311	0.639**
	(0.59)	(3.08)	(–2.29)	(–1.07)	(1.97)
Roads	0.492**	0.968*	0.688*	0.440	0.377*
	(2.29)	(2.57)	(4.33)	(1.86)	(4.16)
Accession Dummy	–0.670			–0.725	–144.101
	(–0.84)			(–1.34)	(–1.69)
Truncated Reform Dummy	–0.475		–1.260*	–0.793	–144.904
	(–0.85)		(–2.64)	(–1.79)	(–1.69)
Trend Variable	0.060	0.073**	–0.012	0.101*	0.070
	(1.82)	(2.30)	(–0.88)	(2.19)	(1.64)
Intercept	–124.076	–151.301**	23.251	–202.516**	
	(–1.86)	(–2.37)	(0.13)	(–2.18)	
R^2	0.89	0.71	0.63	0.87	0.95
Number of Observations	135	88	47	71	64
Number of Countries	17	11	6	9	8

t – statistics in brackets.
* Statistically significant at 1%.
** Statistically significant at 5%.

Determinants of Combine Investment

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Nominal Interest %	–0.577*	–0.695*	–0.480	–0.642	–0.304
	(–2.92)	(–3.41)	(–0.42)	(–1.90)	(–1.06)
Access to Credit	0.777*	0.878*	–0.009	0.678	0.722*
	(3.52)	(3.93)	(–0.01)	(1.11)	(3.35)
Wage	–0.204	–0.545**	1.133	–0.508	0.431
	(–1.08)	(–2.48)	(1.27)	(–1.19)	(1.41)
Wheat Price	0.253	0.896**	0.055	–0.076	0.999**
	(0.69)	(2.20)	(0.05)	(–0.11)	(2.25)
Roads	0.300**	0.605*	0.477	0.686**	0.253**
	(2.15)	(2.84)	(1.34)	(2.04)	(2.04)
Accession Dummy	0.681			1.289**	–0.209
	(1.50)			(2.38)	(–0.29)
Truncated Reform Dummy			367.287		
			(0.78)		
Trend Variable	0.033	0.044	–0.186	–0.009	0.018
	(0.85)	(1.22)	(–0.79)	(–0.18)	(0.31)

Continued

Parameter	All Countries	Accession Countries	Transition and Truncated Reform Countries	Labor Intensive Countries	Labor Extensive Countries
Intercept	–67.404	–91.151		–20.518	–44.406
	(–0.88)	(–1.28)		(–0.19)	(–0.38)
R^2	0.67	0.59	0.16	0.49	0.82
Number of Observations	111	88	23	47	64
Number of Countries	14	11	3	6	8

t – statistics in brackets.
* Statistically significant at 1%.
** Statistically significant at 5%.

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Farm Mechanization: A New Challenge for Agriculture in Low and Middle Income Countries of Europe and Central Asia is part of the World Bank Working Paper series. These papers are published to communicate the results of the Bank's on-going research and to stimulate public discussion.

To date, the international community has focused on land reform and the liberalization of agriculture commodity markets as the basis for agriculture sector growth. Substantial progress has been made with these reforms in many countries of Europe and Central Asia Region (ECA); however, new challenges such as farm mechanization are emerging. Although the governments of low and middle-income ECA countries have long stressed the need to raise investment in farm mechanization, well-informed guidance on whether and how to address this issue is lacking. This study will assist both national governments and donor organizations to discern the constraints to farm mechanization and to decide how best to enhance its contribution to sustainable agriculture sector growth.

The diversity within the ECA region provides a rich platform for comparative analysis. Numerous approaches to economic reform have been followed since 1990, with widely different outcomes. The reform programs of the more advanced European Union (EU) "accession" countries provide valuable lessons for the low and middle-income countries in this respect, and this insight is used wherever possible to inform the study. Agricultural production systems also vary widely, from small-scale private farms in Central Europe and the former Yugoslavia to the huge former collective farms in Russia and the Commonwealth of Independent States (CIS). This diversity is used to show how differing resource endowments further influence the role and impact of farm mechanization.

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