

Producing Cellulose from Straw

Opportunities in Ukraine

In partnership with:



STAATSMINISTERIUM
FÜR WIRTSCHAFT
ARBEIT UND VERKEHR



This material was prepared by IFC, a member of the World Bank Group.

The contents of this report are protected by copyright.

Neither this report nor its parts may be reproduced, copied, or distributed in any form without attribution to *IFC Producing Cellulose from Straw: Opportunities in Ukraine, 2013*.

IFC encourages dissemination of this publication and hereby grants permission to the user of this work to copy portions of it for the user's personal, non-commercial use, without any right to resell, redistribute, or create works derived from the contents or information contained herein. Any other copying or use of this work requires the express written permission of IFC, obtainable at the address below.

This report does not claim to serve as an exhaustive presentation of the issues discussed herein, and should not be used as a basis for making commercial decisions. Please approach independent legal counsel for expert advice on all legal issues.

Various equipment suppliers, technology developers, and other private companies are cited in this report. IFC does not represent the interests of any such organizations, and reference to specific organizations is made solely for information purposes.

The opinions and conclusions contained in this report do not necessarily reflect the opinions of IFC, the Board of Directors of the World Bank, or its Executive Directors. IFC does not guarantee the accuracy of the data herein and bears no responsibility whatsoever for any consequence of their use.

All information and materials used in the preparation of this report are the property of IFC.

© 2013 International Finance Corporation

1 Dniprovsky Uzviz, 3rd floor

01010, Kyiv, Ukraine

Tel: + 380 (44) 490 6400

Fax: +380 (44) 490 6420

Producing Cellulose from Straw

Opportunities in Ukraine



Acknowledgements

This report was prepared under the IFC Ukraine Resource Efficiency Program, with financial support from the Free State of Saxony, the Ministry for Foreign Affairs of Finland, and the Agency for International Business and Cooperation of the Dutch Ministry of Economic Affairs.

The report's authors are IFC Ukraine Cleaner Production Advisory Program specialist Sergii Nevmyvanyi and IFC pulp and paper industry specialist Kai-Erik Volumari. The authors wish to thank Yevheniy Lobanov (President, UkrPapir), and Eduard Litvak (Executive Director, UkrPapir) for their valuable input in the preparation of this report.

Background

This report is based on research conducted throughout 2011–2012 in cooperation with Ukrainian agricultural producer Mriya Agro Holding to assess the country's potential for producing cellulose from straw.

Mriya Agro Holding, one of Ukraine's largest agricultural producers, was founded in 1992. Its implementation of state-of-the-art agricultural technologies has seen it achieve market-leading status in the production of wheat, rapeseed, corn, sugar beet, potatoes, and other crops. It leases 298,000 hectares of land in western Ukraine, throughout the Ternopil, Khmelnytsky, Ivano-Frankivsk, Lviv and Chernivtsi Oblasts. Shares in Mriya Agro Holding have been traded on the Frankfurt Stock Exchange since 2008; its first issue of five-year Eurobonds was made in 2011. Further information on Mriya Agro Holding is available at: www.mriya.ua/en/.

This report, prepared in cooperation with UkrPapir, the Ukrainian Association of the Pulp and Paper Industry, provides a brief overview of that study.

The Ukrainian Association of the Pulp and Paper Industry, UkrPapir, represents several of the country's largest paper mills, which together comprise approximately 60 percent of the nation's paper and cardboard market. Further information on UkrPapir is available at: www.ukrpapir.org.

The objective of this report is to demonstrate – for the country's decision-makers, agribusinesses, paper-industry players and financial institutions – how Ukraine's available supply of straw could be efficiently used to produce paper and cardboard, through the implementation of a major straw-to-cellulose program.

KEY HIGHLIGHTS

1. Market demand for cardboard and paper products in Ukraine far exceeds domestic production: every year, Ukraine imports more than one million tons of cardboard and paper products – most of which are either not currently produced in Ukraine, or are not produced in sufficient quantities to be viable.
2. The most significant barrier to meeting this demand is the country's current shortage of raw materials and primary semi-finished products – specifically pulp and chemithermomechanical pulp (CTMP).
3. The potential use of straw, now widely used in paper production all over the world, has been vastly underestimated.
4. According to UkrPapir, Ukraine will require investment in the order of \$2 billion (including the construction of up to 10 new production facilities) to establish a viable long-term straw-to-paper program.
5. The use of straw pulp for paper production could extend both the range and the quality of cardboard and paper products currently produced in Ukraine, as well as increasing competitiveness, creating jobs, and providing a profitable outlet for the disposal of surplus straw.

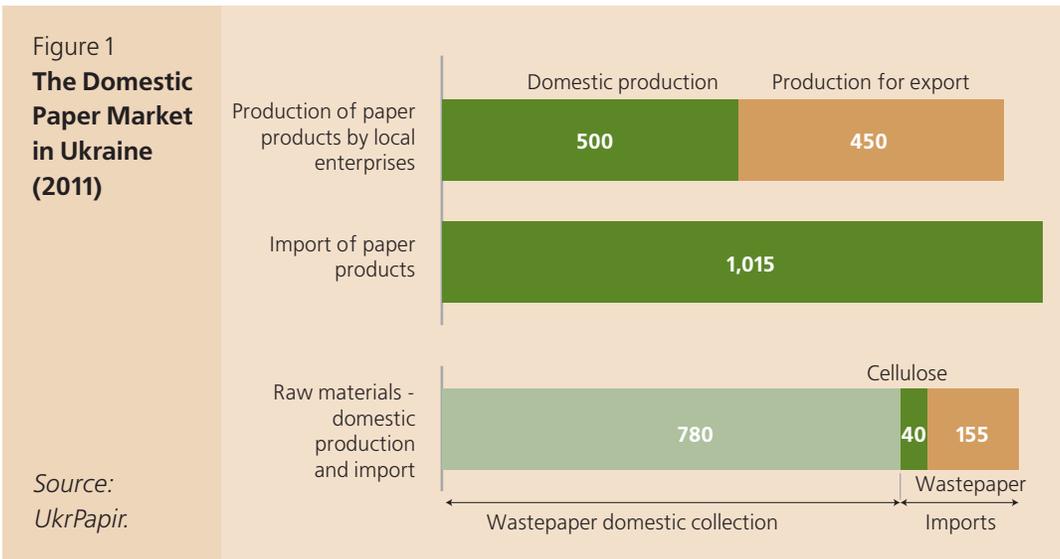
INTRODUCTION

Ukraine's geographic location and favorable climatic conditions place it among those few countries with climatic and environmental conditions ideal for growing crops, particularly cereals. While the country's major product, grain, is a highly liquid and marketable commodity, its byproduct, straw, is often disposed of to little economic benefit. Ukraine's annual wheat production is between 15 and 20 million tons: resulting in the production of at least 15 million tons of straw every year. Industry commentators estimate that up to 40 percent of this straw could be processed into various value-added materials.

Straw is traditionally used throughout Ukraine as fertilizer or bedding for animals. However, modern processing technologies now allow straw to be used in the production of biofuels and biopolymers, and as a building material. Such usage in Ukraine, however, remains rare. Straw is often burned directly in the fields – an illegal practice, and one highly damaging to soil. A promising and commercially viable business opportunity not yet widely adopted in Ukraine is the production of pulp from straw to produce a wide variety of paper products – specifically for packaging, stationery, and specialist office and scholastic paper products. In fact, after traditional uses as fertilizer and bedding for animals, the most common use for straw worldwide is to produce pulp for the paper industry. China is the largest producer of straw pulp, while India and Pakistan also have major straw-processing mills.

BRIEF OVERVIEW OF THE UKRAINIAN MARKET IN PAPER/CARDBOARD

UkrPapir data suggest that Ukraine consumed approximately 1.5 million tons of cardboard and paper products in 2011 (see Figure 1, below). In 2011 it also imported 1.015 million tons of cardboard and paper products, and approximately 195,000 tons of raw materials and semi-finished products, together worth \$1.6 billion: that same year, however, it exported 450,000 tons of pulp and paper, together worth about \$1 billion. Clearly, Ukraine's internal market demand for pulp and paper could consume up to twice the current domestic production of paper and pulp (see Figure 1, below).



More than 380 enterprises (including 39 producers) currently operate in Ukraine's domestic pulp and paper market. These enterprises primarily manufacture packaging and tissue paper, which is typically 95 percent recycled pulp. In terms of the country's own recycling potential, Ukraine produces about 780 thousand tons of wastepaper (and imports 150–200 tons) every year.

Analysis undertaken for this report suggests that Ukraine's pulp and paper industry meets only 25 percent of local demand for newsprint and only 10 percent of local demand for offset paper. The country produces only negligible volumes of paper sacks, coated paper, greaseproof paper, paper for soft furnishings, and similarly negligible volumes of disposable products such as paper bags, plates, cups and drinks containers, which are made of virgin fiber or from a combination of mechanical and chemical pulp. More than 80,000 tons of paper would be needed to meet Ukraine's annual demand for such disposable products and packaging. Meeting this demand will require new production facilities with total annual output capacity in the order of 120,000 tons.

Total demand for paper products in Ukraine is currently estimated at 1.5 million tons per year. Given that total output of paper and cardboard is currently estimated at around 0.95 million tons (of which 0.5 million tons is exported), it would appear that domestic production is currently meeting only one third of current domestic demand. It is for this reason that Ukraine is forced to import approximately one million tons of paper (newsprint, offset, and coated) every year. Insufficient feedstock for the production of these papers is currently a major problem, limiting domestic growth, preventing the wider expansion of these product ranges, and impeding the replacement of imports.

The data presented here make clear the need for a reliable domestic source of raw material, readily accessible to domestic pulp and paper enterprises, to boost output of newspaper, offset, and packaging paper products.

THE USE OF STRAW TO PRODUCE PULP FOR PAPER PRODUCTION

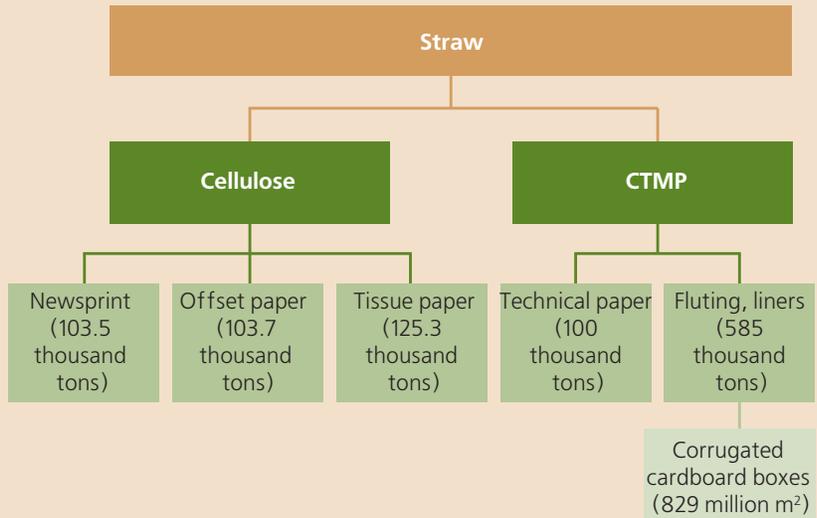
Development of Ukraine's pulp and paper industry is likely to require the establishment of manufacturers able to process straw (from wheat, rye, rapeseed, and other plants) into the much-needed raw materials of cellulose and mechanical pulp. UkrPapir estimates Ukraine's available supply of straw suitable for paper production at five million tons. Given that producing one ton of pulp consumes 2.5–2.7 tons of straw, a paper mill with annual output capacity of 60,000 tons is likely to require approximately 160,000 tons of straw every year.

This volume could be harvested from about 55,000 hectares of farmland. The precise number of mills necessary to process this would be driven by market demand and the nature of industry development, but implementation of such a program is likely to require total investment in the order of \$2 billion; the priority in building such new facilities, of course, would be in those areas most likely to lead to a drop in current import volumes.

The use of straw in paper production requires two primary materials: unbleached or chemical-bleached pulp (also known as cellulose), and chemithermomechanical pulp (CTMP) or bleached-chemithermomechanical pulp (BCTMP). Cellulose is mainly used as fiber in wood-free or re-enforcement pulp for stationery and offset paper, etc. Brown (unbleached) chemical fibers are used in the production of packaging grades and semi-chemical fluting. Mechanical fibers (CTMP, BCTMP) are the main component (comprising nearly half of total components) in the middle ply of folding cartons, providing bulk and improving stiffness.

Market potential for the use of straw in the production of cardboard and paper products in Ukraine (as at 2011) is shown in Figure 2, below.

Figure 2
**Potential Use
of Straw in the
Production of
Cardboard and
Print Papers**



Source:
UkrPapir.

The technologies used to produce cellulose and mechanical pulp (CTMP, BCTMP) from straw are not the same. Though cellulose is more expensive (and its production thus more profitable), its production is more complex, requiring more sophisticated technology than CTMP production. Producing chemical cellulose from straw requires greater investment because of the chemical recovery processes used: such processes, however, are more environmentally friendly and, depending on the case, may also produce surplus energy.

STRAW-TO-PULP AND STRAW-TO-CTMP PRODUCTION: COMPARATIVE EFFICIENCY AND PROFITABILITY

Traditionally, wood is considered the primary raw material and the major source of pulp in paper production. Today's global production of pulp is 185 million tons per year. Some 16 million tons of this are produced from straw – an amount which is increasing every year. In the summer of 2012, Kimberley Clark, the global leader in tissue paper products, announced plans to replace half of its timber consumption with alternative source of fiber by 2025.

The quality of straw pulp produced depends on the processing technology used. The main advantages of straw (which apply whichever technology is used) are smoothness and good tensile strength vis-a-vis other hardwoods, as well as opacity and good beatability (the ease with which pulp can be beaten to achieve the desired properties). The disadvantages are higher density, lower stiffness, porosity, and a slow de-watering rate (see Table 1, on the next page).

Table 1: **Appropriateness of Straw as a Raw Material for Various Paper Types**

Paper type	Major requirements	Straw pulp (as percentage of total composition)	Comments
Newsprint	<ul style="list-style-type: none"> ■ whiteness ■ opaqueness ■ tensile strength/ resistance to tearing ■ stiffness 	65	If wastepaper is not available, either mechanical pulp or straw pulp can be used
Offset and printing papers	<ul style="list-style-type: none"> ■ smoothness ■ whiteness ■ opacity ■ tensile strength/ resistance to tearing ■ thickness ■ absorbability 	75	Higher filler content may be required (to deliver necessary surface strength for offset papers), resulting in a reduction of straw pulp in the blend
Tissue paper	<ul style="list-style-type: none"> ■ softness ■ moisture resistance ■ wet strength 	65	Up to 10–15% in high-quality facial tissues
Cardboard	<ul style="list-style-type: none"> ■ smoothness ■ thickness/density ■ mechanical strength ■ stiffness 	85	Straw pulp can be used to produce greater whiteness and smoothness (mainly in top and bottom plies)
Container board (including corrugated papers)	<ul style="list-style-type: none"> ■ thickness/density ■ mechanical strength ■ stiffness 	40	White straw pulp can be used in container board (mainly in top white ply) and in corrugated papers (medium unbleached, up to 50–100% depending on specific paper properties)

Note: IFC Project staff estimate that newsprint and stationery paper products are likely to have the greatest potential for substitution of straw pulp for wood pulp (between 50 and 75 percent): further feasibility studies and production trials will be necessary, however, to confirm realistic substitution levels for various products.

Source: UkrPapir.

The most important characteristic influencing the application of straw pulp in the Ukraine pulp and paper industry is undoubtedly price. Straw pulp is cheaper to produce than wood pulp, but has a significantly higher production cost than pulp produced from wastepaper. However, since Ukraine has a deficit of both wood and wastepaper (importing 150,000 tons of wastepaper in 2011), straw can be considered a viable potential domestic raw material.

Estimated long-term raw material prices in the pulp and paper industry are outlined in Table 2, below (excluding delivery costs, typically in the order of 10 percent of total product costs).

Table 2: Indicative Market Prices of Pulp and Paper Products	Long-fiber (pine) or northern bleached softwood pulp	800
	Short-fiber (euca) bleached hardwood pulp	700
	Bleached CTMP	600
	Bleached straw pulp	500
	Waste paper, white, clean without printing (white shavings)	350–400
	Waste paper, old newsprint (ONP)	70–100
	Waste paper, old corrugated containerboards (OCC, or boxes)	100–200

Because production costs are lower than for chemical wood pulps, straw pulp will (despite its weaknesses) continue to have a role in a fiber-hungry world, as both a substitute and a component.

PROJECTS USING STRAW IN CARDBOARD AND PAPER PRODUCTION

Option 1: Production of CTMP, Cardboard, and Boxes from Straw

Global best practice suggests that the production of CTMP from straw is most viable when integrated into the production of packaging paper and cardboard. For example, it is economically most viable to establish a production plant on the basis of the following facilities and products: straw processing for the manufacture of CTMP; wastepaper processing; fluting and liner production; and the further manufacture of corrugated board and boxes (see Table 3, below).

Table 3:
Production of Carton and Cardboard Products from Straw

Capacity (tons per year)	100,000
Output (tons per year):	
Fluting and liner as commercial products	50,000
Board and boxes	50,000
CAPEX	\$200,000,000
Estimated payback period (years)	4–5

Source: UkrPapir.

Note: These data are indicative only. Actual parameters should be calculated and specified in any project feasibility study.

Typical requirements for establishment of a greenfield production site:

- twenty hectares of land;
- additional land/facilities for storage of straw (size subject to feasibility study);
- sufficient water and power supplies; and
- adequate sources of straw, accessible within viable distance – i.e., within 150 km.

Using straw as a raw material would allow paper companies to expand their product ranges and minimize their risks vis-a-vis raw materials. Utilizing straw to produce 50,000 tons of CTMP per year at an existing (brownfield) production site would require investment in the order of \$35–40 million.

**Option 2:
Production of Paper and Chemical Market Pulp from Straw**

Integrating a straw-pulp mill into a paper mill can prove highly effective and cost-efficient. The benefits of this would include lower fixed operating costs, efficient use of surplus energy (steam and power), and lower drying capacity requirements (i.e., a smaller drying machine would be viable since some pulp could be used on-site – e.g., in the paper mill, without drying). Such a project might consist of a combined production site – i.e., a pulp production facility with annual capacity of 60,000 tons of bleached pulp (175 tons of pulp per day), together with a paper production facility with annual capacity of 100,000 tons of paper (see Table 4, below).

<p>Table 4: Production of Paper and Chemical Market Pulp from Straw</p>	Capacity (tons per year)	100,000
	Output (tons per year):	
	Bleached pulp	60,000
	Paper products	100,000
	CAPEX	\$100,000,000
	Estimated payback (years)	5–6
Source: UkrPapir.	<p>Note: These data are indicative only. Actual parameters should be calculated and specified in any project feasibility study.</p>	

Typical requirements for establishment of a greenfield production site are as outlined in section 4.3.1, above.

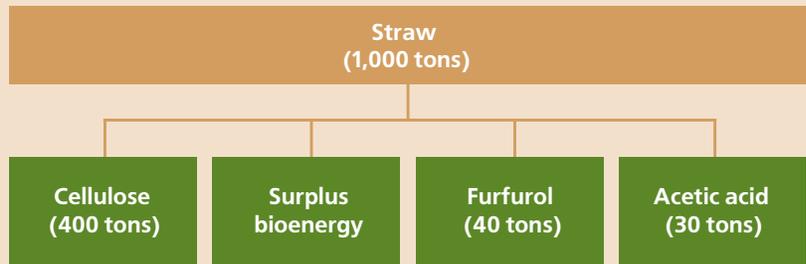
MODERN TECHNOLOGIES ALLOW THE PRODUCTION OF CELLULOSE FROM STRAW*

Key considerations in selecting a straw-to-pulp production technology include both economic benefits and the environmental security and safety of such process. Historically, the absence of effective waste management technologies (that might short-circuit the process and reduce emissions) has been a major limiting factor. Today, however, several technologies exist which eliminate such traditional environmental problems, including, for example, alkaline processes (the "Soda process," "Kraft process," etc.) with modified chemical recovery (Siloxy), as well as new processes such as formicofib™, "Free Fiber," and others. While detailed analysis of each of these is beyond the scope of this report, a number of current highly resource efficient developments merit examination.

One such example is the formicofib™ process, developed by Finnish company Chempolis. This is a zero-waste process to produce high quality pulp, fuel, and some chemicals from biomass (see Figure 3, below). According to Chempolis, due to the additional production of chemicals such as furfural and acetic acid, profitability under the formicofib™ process can be 25 percent higher than under traditional methods.¹

* IFC does not represent interests of any equipment suppliers or technology developers. Reference to specific suppliers is made exclusively for information purposes.

Figure 3:
Production of Pulp and Value-added Products from Straw, Using formicofib™ technology



Source: Chempolis.

¹ Additional information on new, resource-efficient technologies can be found at the supplier websites: www.siloxy.com; www.metso.com; www.chempolis.com and others.

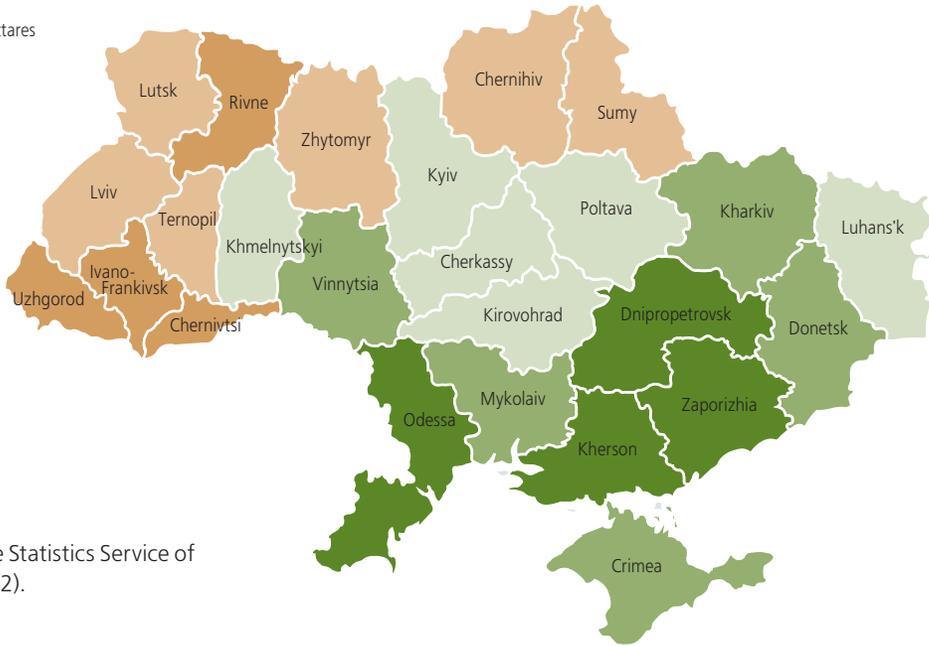
ANNEXES



Ukraine: Regions with Greatest Volumes of Land under Wheat

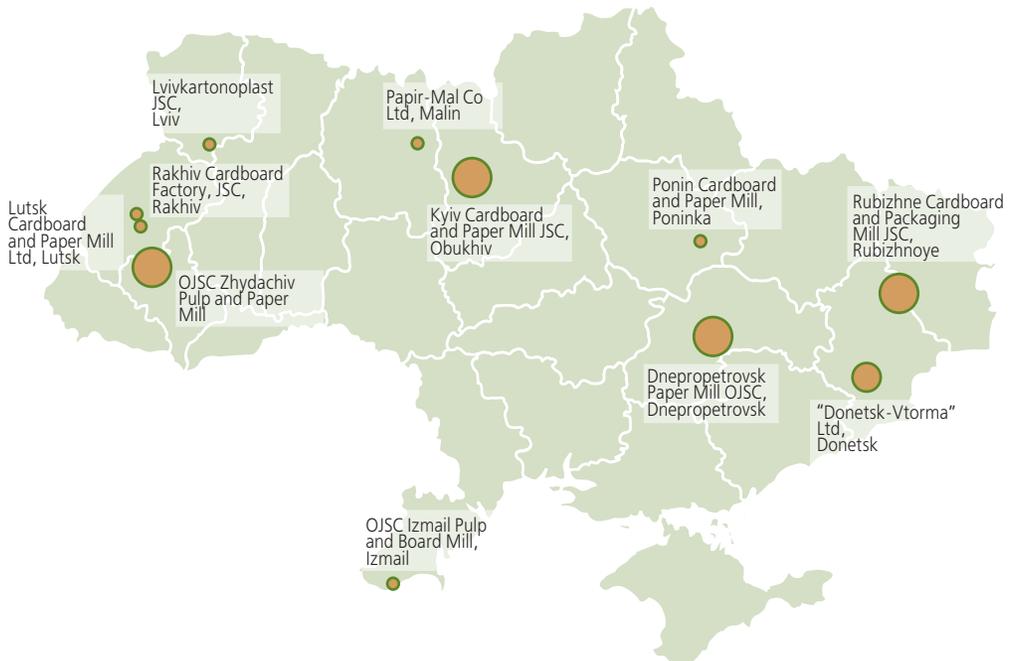
thousands of hectares

- 0-100
- 101-200
- 201-300
- 301-400
- 401-500



Source: State Statistics Service of Ukraine (2012).

Most Significant Producers of Cardboard and Paper Products in Ukraine



With the support of the Free State of Saxony, the Ministry for Foreign Affairs of Finland,
and the Agency for International Business and Cooperation of the Dutch Ministry of Economic Affairs.

Contacts:

IFC

01010, Kyiv,

1 Dniprovsky Uzviz, 3rd floor

Tel: +380 44 4906400

Fax: +380 44 4906400

www.ifc.org/ukraine



IFC

**International
Finance Corporation**
World Bank Group

2013