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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

FOOD LOSSES AND WASTE IN UKRAINE

COUNTRY REPORT

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More information on the Agrarian Structures Initiative and its projects is available at <http://www.fao.org/europe/agrarian-structures-initiative/en/>

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1. SUMMARY

In the framework of global, regional and country-level studies conducted by the Food and Agriculture Organisation of the United Nations (UN/FAO) in 2010-2014, this study, conducted in summer 2013, assesses food losses and waste in priority agri-food chains in Ukraine.

The objective of the study is to identify critical points and patterns of food losses and waste along selected food supply chains in Ukraine, which have the largest impact on food security and food supply in the country. For that purpose the country study aims to provide an overall assessment of food losses and waste and its impact on food security and food supply, as well as identifying and analysing critical points for food losses and waste along selected agri-food chains.

The methodology used, established by FAO, divides agri-food products into commodity groupings, i.e. cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood, milk and eggs for preliminary statistical analysis using UN/FAO Food Balance Sheet State Committee of Statistics of Ukraine data. Priority agri-food chains identified were wheat (among cereals), potato (roots and tubers), apple (fruits and vegetables), pork (meat, fish and seafood) and milk and dairy products (milk and eggs), after analysis of their economic impact, employment generation, contribution to foreign exchange and food security and magnitude of food losses and waste.

The five priority agri-food chains were then analysed to identify critical loss (and waste) points at five steps of each chain, i.e. (1) agricultural production, (2) post-harvest handling and storage, (3) processing and packaging, (4) distribution and (5) consumption. Analysis was conducted through desk research of existing papers, data and media sources, as well as through key informant interviews of stakeholders representing private and public sector actors at each stage of each chain. The approximate waste levels as percentages of the overall volumes of produce entering each step of the food supply chain were reported as follows:

Commodity Grouping (product)	Producer Category	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals (wheat)	Large Producer	2.5-5%	0.5-1.25%			
	Medium Producer	10-40%	5-10%	5-10%	4-10%	5-15%
Roots & Tubers (potato)	Modern Producer	20%	5-10%	2-5%	2-7%	5-10%
	Former Collective	20%	20%	5%	5-10%	10-15%
	Smallholder	10%	20-30%	5%	5-10%	10-20%
Fruits & Vegetables (apple)	Modern Producer	10%	10-20%	5%	5%	5-10%
	Former Collective	10%	30-40%	5%	10-20%	5-10%
	Smallholder	5-10%	30-40%	5%	10-20%	5-10%
	Processed fruit			15-22	1-5%	5%
Meat (pork)	Modern Producer	10-15%	15-22%	1-5%	5-10%	5%
	Former Collective	20-25%	15-22%	1-5%	5-15%	5%
	Smallholder	5-10%	0-5%	5-15%	10-20%	5%
	Processed meat			10-15%	2-5%	2-5%
Milk	Milk/yoghurt	10-30%	see previous / next column	3-15%	8-11%	5-10%
	Cheese	15-35%		10-20%	5-10%	5-10%
	Home processing	15-35%		15-30%	10-20%	10-15%

Given extreme variations in the technology and processes used within individual agri-food chains in Ukraine, analysis was broken down into sub-chains for each product, i.e. produce originating on modern commercial farms, that originating on outdated Soviet-era farms and that originating on smallholder farms. Additional sub-chains for processed fruit and vegetable and dairy produce and for processed meat were also analysed.

The bulk of losses were identified in the first two steps of the agri-food chains for all products, represented by damage and losses in harvest produce by insufficient and outdated machinery for wheat and potato crops; a preponderance of storage facilities without temperature and ventilation controls resulting in excessive losses of potatoes and apples stored through the winter; and poor maintenance and feed regimes as well as limited access to cold storage and sanitation resulting in high levels of losses in meat and milk production.

At the processing and packaging and distribution steps of the selected chains, losses and waste were lower, particularly for produce sold through supermarkets and modern retail outlets, although the lower figures can also be explained by the relative low penetration of food processing in Ukraine. Further, losses and waste of fresh produce, fruit and vegetables, milk and meat, sold by household producers through local markets is estimated to reach much higher levels as a result of an almost total absence of refrigeration and sanitation through such sub-chains.

In addition, it was revealed that losses at these steps of food chains are revealed only later, as substandard transportation and pre-sale storage are often merely passed on to the consumer through shorter fridge life in the home. At the consumption step of the food chains, waste is therefore inflated by high levels of discard and cleaning, particularly of fresh fruit and vegetables, which are purchased just before they perish, as are dairy products on local markets. Further, the practice of cutting excessive amounts of all products for display on tables is considered to result in early deterioration and unnecessary waste in the home.

Actions and policy proposals are divided into those that apply to most if not all food chains analysed and those aiming to reduce losses and waste in individual food chains.

1. Multiple Food Chain Actions and Policy Proposals

This set of actions and proposals aims to address the two key obstacles to reducing losses and waste across all agri-food chains analysed in this study, i.e. (a) investment in modern technology and (b) upgrading the skill sets of and stimulation of workers.

(a) Investment in upgrading technology in production, post-harvest handling, cold chain and processing

In the sphere of improving the investment climate, direct threats to existing and potential investors can be addressed by individual and coordinated action by ministries and government agencies to streamline business start-up and registration and particularly to reduce the burdens of permitting and inspection regimes and overlapping authorities of government agencies.

Across central and eastern Europe there are good examples of local authorities attracting foreign direct investment in Greenfield sites offered for sale or lease for the development of food processing and logistics hubs, an area in which Ukraine has competitive advantage. This could be used to support the ongoing development of regional agri-food wholesale markets.

Producer organization development is key to consolidating supply, improving production and post-harvest processes and reducing losses in the early stages of food chains. Efforts need to be made to showcase successful cooperative and lead-farmer models and to support investments in standardization of production, forage production and winter feed regimes, quality control, joint marketing and post-harvest handling (pre-cooling). Continued work by lead agencies in GlobalGAP and HACCP information and accreditation is also important.

(b) Upgrading the skill sets of and stimulation of agri-food chain personnel

Success stories from the region demonstrate the potential for engagement by producers and processors with local technical secondary schools in establishing apprenticeship programs under which pupils are allowed to train at local companies prior to employment. Similarly companies pay scholarships for the further qualification of those they consider worth the investment in return for a commitment to work for the sponsor on gaining a relevant qualification. Such initiatives also benefit from flexibility of local and national authorities in allowing pilot projects and a readiness to amend curricula to reflect employer demand for new skill sets.

(c) Reducing Losses and Waste in the Distribution & Consumption Phases

Engagement by governmental and/or consumer organisations of retail chains and their suppliers to discuss introducing the practise of lowering prices as products near their sell-by or best-before dates. Such initiatives would diminish the current role of secondary markets for expired food products. These actions could be supported by a joint initiative to inform the public of current systems of expiry dates, government control regulations and initiatives and related public health issues, as well as informing them of the benefits of improved buying, storage and cooking practises in relation to reducing waste, saving money and protecting family health.

(d) Monitoring and Reporting Mechanism for Food Losses and Waste

A group of up some ten associations, representing all stages of the key agri-food chains should be engaged to conduct a baseline study and thereafter annual anonymous monitoring a cross-section of members to allow benchmarking and progress reporting to a forum including government and civil society/consumer organisations and relevant international stakeholders. This forum could then identify priority interventions and coordinate their implementation using the staff of forum representatives, as well as interested stakeholders from the sector across the country.

2. Individual Food Chain Actions and Policy Proposals

This set of actions and proposals aims to address food losses and waste in the two agri-food chains analysed for which substantial quantities of potentially food-grade produce are relegated either to animal feed or simply discarded, i.e. the wheat and potato chains.

(a) The wheat agri-food chain

Development of coordinated public-private program for control of *Eurygaster Integriceps* Put. Given the impact of this pest both on quantity and quality of wheat harvests, Ukraine must make a concerted effort to coordinate its response, if it is to realise its potential and ambitions in the sphere of wheat production and particularly exports. A coordinated program now needs to be established in order to inform producers across prone areas on best preventative practises, as well as jointly to finance the establishment of early warning system infrastructure and to coordinate producer responses to outbreaks.

(b) *The potato agri-food chain*

Conduct of research and awareness raising among rural populations on optimal feed regimes for domestic livestock. Based on research results, development of an awareness program for rural populations showing the benefits of changing feeding patterns would not only lead to reductions in potato waste, but would also have positive downstream implications for spurring wheat production and reducing wasted wheat and also for overall animal productivity and thereby loss reduction in the meat and dairy sectors.

2. INTRODUCTION

In 2010 and 2011 the Swedish Institute for Food and Biotechnology conducted a series of studies at the request of the Food and Agriculture Organization of the United Nations (FAO) on global food losses (one for high/medium-income countries and one for low income countries) in order to raise awareness on global food losses and waste, and on the impact of these on poverty and hunger in the world, as well as on climate change and on the use of natural resources.

The results of the studies suggested that roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain.

The studies also underlined that food is lost or wasted throughout the supply chain, from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a significant extent wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. Significant losses also occur early in the food supply chains in the industrialized regions. In low-income countries food is lost mostly during the early and middle stages of the food supply chain; much less food is wasted at the consumer level.

The study also revealed the lack of monitoring and reporting of food losses and waste and the major data gaps in knowledge of global food loss and waste. It therefore urged further research in the area to provide the grounds for informed and coordinated decision making on actions and policy proposals aimed at reducing losses and waste throughout supply chains.

2.1 Concept

In response to this, the 2012 FAO Regional Conference for Europe requested that the FAO Regional Office for Europe produce three studies for the 2014 regional conference. One of these papers is on food losses and waste in Europe and Central Asia. In response to that the Regional Office for Europe, working within the framework of the FAO flagship programme on agrarian structures in Europe and Central Asia, initiated work on regional assessment of food losses and waste and identification of policy options for reduction of such losses and waste in the region.

Within the aforementioned initiative, this study, conducted under the supervision of Agribusiness and Enterprise Development Officer of the FAO Regional Office for Europe, provides an assessment study on food losses and waste along selected agri-food chains in Ukraine. Additional studies of food losses and waste in other selected countries in the Europe and Central Asia region were also prepared during 2013.

2.2 Objectives

The objective of the study is to identify critical points and patterns of food losses and waste along selected food supply chains in Ukraine, which have the largest impact on food security and food supply in the country. For that purpose the country study aims to provide an overall assessment of food losses and waste and its impact on food security and food supply, as well as identifying and analysing critical points for food losses and waste along selected agri-food chains.

2.3 Methodology

The study follows the methodology established by FAO and the Swedish Institute for Food and Biotechnology in dividing agri-food products into commodity groupings, i.e. cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood, milk and eggs for preliminary analysis.

Primary cereals crops in Ukraine are wheat, barley and maize, with rye and oats also featuring. In the roots and tubers grouping only potato featured as a significant Ukrainian crop. In the oilseeds and pulses grouping sunflower seed, rape and mustard seed and soybeans are significant crops. In the fruits and vegetables grouping fifteen products were analysed, with apple, cabbage, cucumber, onion and tomato prominent in terms of volumes and values. In the meat, fish and seafood grouping chicken, pork, beef and fish were the primary products, while fresh milk, cheese, processed milks and butter along with eggs featured in the milk and eggs commodity grouping.

While the methodology attempted to exclude crops not destined for human consumption, such as feed wheat and potatoes destined for use as animal feed, from analysis, as crops initially intended for human consumption tend to be redirected to animal feed uses when degraded, it was considered that if product quality could be improved, significant amounts of produce currently used for animal feed could be consumed by humans.

Five priority agri-food chains for Ukraine were identified through analysis of their economic importance, employment generation, contribution to foreign exchange and contribution to food security and the prioritisation was validated through key informant interviews on the magnitude of food losses and waste in the respective chains.

The five priority agri-food chains were then analysed to identify critical loss (and waste) points at five steps of each agri-food chain, i.e. (1) agricultural production, (2) post-harvest handling and storage, (3) processing and packaging, (4) distribution and (5) consumption. At each step loss and waste were quantified as percentages of the overall volume of produce entering the step. For vegetable (non-animal products) the analysis was initiated from the moment of a crops ripening (although in some cases earlier blights were also examined). For animal products production losses such as animal mortality and disease were considered.

The following tables provide the framework for this critical loss point identification and quantification analysis.

Vegetable (non-animal) product agri-food chains

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Mechanical damage/spillage during harvest - Crops left in field - Animal/disease attacks after finished growth
2. Post-harvest handling and storage	Storage facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Natural drying - Mechanical and handling damage - Transport to storage/processing

3. Processing and packaging	Farm industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing - Rodents (etc.)
4. Distribution	Wholesale Supermarkets Retailers Markets	<ul style="list-style-type: none"> - Transport to distribution - Lack of cooling - Outdated food - Unsold food
5. Consumption	Households Food services	<ul style="list-style-type: none"> - Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

Animal product agri-food chains

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Animal mortality - Animal disease/medical treatments
2. Post-harvest handling and storage	Farm / Slaughterhouse facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Mechanical damage - Transport to slaughterhouse/processing
3. Processing and packaging	Slaughterhouse industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing
4. Distribution	Wholesale Supermarkets Retailers Markets	<ul style="list-style-type: none"> - Transport to distribution - Lack of cooling - Outdated food - Unsold food
5. Consumption	Households Food services	<ul style="list-style-type: none"> - Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

Given extreme variations in the technology and processes used at each stage of agri-food chains in Ukraine, analysis was broken down into three sub-chains for each product, i.e. produce originating on modern commercial farms, produce originating on outdated Soviet-era farms and produce originating on smallholder (household) farms. Additional sub-chains for processed fruit and vegetable and dairy produce and for processed meat were also analysed.

2.4 Sources & Types of Information

The main sources of information used in developing this study, are outlined in the table below, grouped by type of information. A full listing of sources used in this study is provided in Annex 1, hereto.

Sources & Types of Information

Type of Information	Sources	Information Analysed
Statistical data	<p>FAO Food Balance Sheets</p> <p>FAO Producer & Commodity Prices</p> <p>State Statistics Service of Ukraine</p>	<p>Production</p> <p>Import quantity</p> <p>Stock variation</p> <p>Export quantity</p> <p>Food use</p> <p>of which processing use</p> <p>Feed use</p> <p>Seed use</p> <p>Waste</p> <p>Producer prices (domestic market)</p> <p>Commodity prices (exports)</p> <p>Production by product</p> <p>Production by farm type</p> <p>Production by region</p> <p>Processing volumes & values</p> <p>Per capita consumption</p>
Existing Research	<p>Academy of Agrarian Science</p> <p>State Crop Protection Inspectorate</p> <p>Nibulon LLC</p> <p>Association of Potato Producers</p> <p>International Finance Corporation</p> <p>USAID LINC Project</p> <p>APK Inform</p> <p>Freedom Farm Bacon Ltd.</p> <p>Ukrainian Agribusiness Club</p> <p>American Chamber of Commerce</p> <p>USAID AgroInvest Project</p> <p>EU SWAP Rural Project</p>	<p>Cereal losses caused by harvest delay</p> <p>Impact of crop disease and pests</p> <p>Eurygaster integriceps Put research</p> <p>Potato supply and demand analysis</p> <p>Horticultural cold chain analysis</p> <p>Doing Business rankings</p> <p>Horticultural market analyses</p> <p>Cereals and horticultural reviews</p> <p>Pig and pork quality assessment</p> <p>Dairy and meat sector losses</p> <p>Sector briefs and position papers</p> <p>Cooperative / infrastructure reviews</p> <p>Sector analyses and policy reviews</p>
Key informant interviews	<p>Ministry of Agrarian Policy and Food</p> <p>State Veterinary-Sanitary Factory</p> <p>Oblast Departments of Agriculture</p> <p>Industry Associations</p> <p>Commercial grain producers/traders</p> <p>Mills, bakeries and pasta producers</p> <p>Commercial potato producers</p> <p>Apple producers and processors</p> <p>Horticultural produce traders</p> <p>Large and medium pork producers</p> <p>Slaughterhouses</p> <p>Meat processors</p> <p>Dairy cooperative managers</p> <p>Dairies and cheese producers</p> <p>Smallholder producers</p> <p>Retail chain representatives</p> <p>Consumers</p> <p>Consultants and analysts</p>	<p>Cereals and horticulture overview</p> <p>Animal waste reprocessing systems</p> <p>Sector and product overviews</p> <p>Product/chain analyses and positions</p> <p>Harvest and logistics systems/losses</p> <p>Processing/distribution systems/losses</p> <p>Production/storage systems/losses</p> <p>Production/processing systems/losses</p> <p>Storage/distribution systems</p> <p>Produce flows and losses</p> <p>Reuse and losses of by-products</p> <p>By-product and processing markets</p> <p>Production and local market losses</p> <p>Collection systems / processing losses</p> <p>Production and consumption patterns</p> <p>Storage, distribution and shelf-life</p> <p>Consumption and discard patterns</p> <p>Chain analysis and clarifications</p>

2.5 Structure of Analysis

The structure of the analysis, as developed by FAO for the purposes of this study is as follows:

1. **Commodity groups with the largest impact on food security and food supply on domestic and international markets**

The analysis initially provides an introductory overview of volumes produced for each commodity grouping. Within the relevant commodity groups two to three of the most important products are identified with the largest economic importance, taking into consideration employment generation, contribution to foreign exchange, impact on smallholder producers, significance of share in agricultural production of the country/region and level of processing and marketing activities.

2. **Assessment of food losses and waste in selected agri-food chains**

The analysis then identifies priority agri-food chains from the commodity groupings reviewed and provides, provides an overview of product flows within such chains and then identifies critical loss points and quantifies the levels of losses.

(a) Priority agri-food chains for in depth analysis

Five priority agri-food chains are identified for detailed Critical Loss Point analysis based on their economic importance, employment generation, contribution to foreign exchange, contribution to food security.

(b) Brief description of priority agri-food chains

For each agri-food chain, chain components, agents and organizations are identified and a description provided of the chain maps and flows, outlining components that to be analysed in-depth.

(c) Assessment of food losses and waste in priority agri-food chains (critical loss points)

Analysis is provided of the critical loss points (points in the agri-food chains where food losses and waste have the highest magnitude, the highest impact on food security, and the highest effect on the economic result of the food supply chain). Assessment of the magnitude of food losses and waste is based on available reports and studies and key informant interviews with the representatives and stakeholders in analysed agri-food chains. Food losses both in quality and quantity terms are taken into consideration.

(d) Summary assessment of food losses and waste

An overall assessment of food losses and waste is presented for all commodity groups along the main points of the supply chain: agricultural production, postharvest handling and storage, processing and packaging, distribution (retailers and supermarket), and consumption.

3. **Analysis of key factors for food losses and waste**

The study then provides an analysis of factors impacting the magnitude of food losses and waste, including resources and technologies, management-marketing-product development, market structure and governance structure including value chain coordination-supply-logistics, trade and taxation policies and food safety and quality standards.

4. **Priority actions and policies for reduction of food losses and waste**

Finally, the study provides an overview of the agri-food policy environment and government support programs in the sphere of food loss and waste reduction as well as a series of potential initiatives that may impact positively on further reduction from current levels of food loss and waste.

(a) Enabling environment for agri-food chains performance

The current macroeconomic and policy environment is outlined, including current government initiatives and levels of support in the sphere of food losses and waste and the impact of macroeconomic policies on the ability of the state to formulate and carry out policies regarding the agri-food chain.

(b) Actions and policy proposals

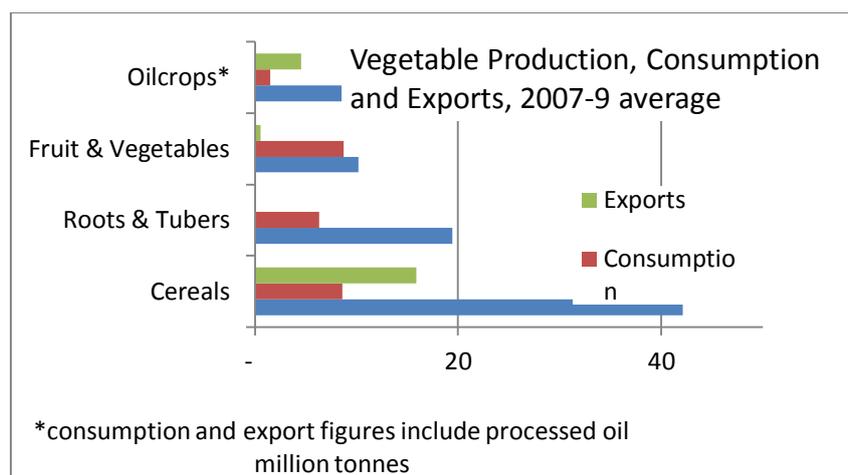
Recommendations are made for potential actions and policies, taking into account cooperation opportunities with the private sector, the need to consider whole value chains rather than single levels where losses occur, good practices and approaches from the country and region, and including actions to set up a food loss reporting mechanism to see further development of food loss and waste reduction.

3. CORE COMMODITY GROUPINGS

This section provides analysis in the Ukrainian context of the six commodity groupings established for the purposes of the UN/FAO Food Losses and Waste study, i.e. (1) cereals, (2) roots and tubers, (3) oilseeds and pulses, (4) fruits and vegetables, (5) meat, fish and seafood, (6) milk and eggs. In analyzing the volumes and values of production in Ukraine, the extent of domestic processing and the levels of domestic consumption and export of the commodities within each grouping, conclusions are drawn on which commodities have the largest economic importance and greatest impact on employment generation, foreign exchange earnings and smallholder producers.

3.1 Overview

In terms of overall volumes of production of vegetable (non-animal) commodities, the graph below shows that cereals dominate, accounting for over 40 million tonnes produced per annum, which amounts to over 50% of total vegetable production in the country. Roots and tubers (which in the Ukrainian context relates only to potatoes) are second in terms of volumes produced (nearly 20 million tonnes per annum or 25% of overall non-animal production), followed by fruits and vegetables (10 million tonnes or just under 15% of the total) and oilseed crops (8.5 million tonnes or 10% of the total).

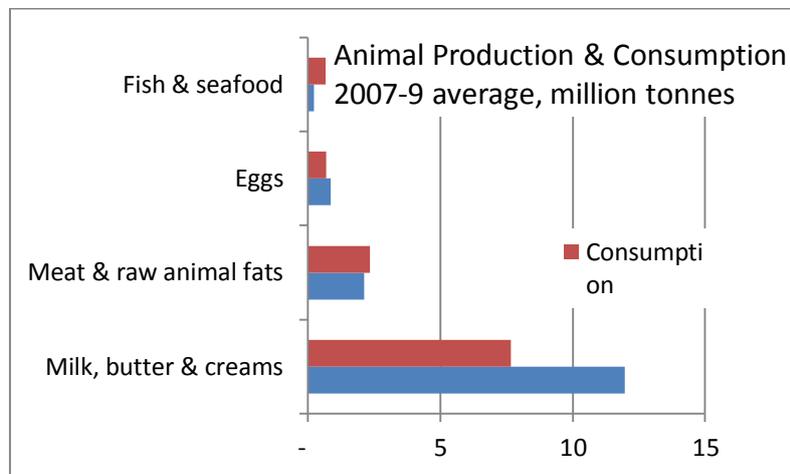


In terms of human consumption of vegetable commodities, however, the picture is more balanced, with domestic consumption of fruit and vegetables matching the level of cereals consumption (both approximately 8.5 million tonnes per year or 35% each of total vegetable product consumption). Approximately 6 million tonnes of roots and tubers and 1.5 million tonnes of vegetable oils are consumed annually, accounting for 25% and 5% of overall non-animal food product consumption in Ukraine.

The main export commodities in terms of volume are cereals, followed by oil crops and vegetable oils. The discrepancies between the balance of production on the one hand and consumption and exports on the other, most marked in the cereals and roots and tubers commodity groups, illustrate the high levels of use of these commodities (particularly wheat, barley, maize and potatoes) as animal feed.

In terms of overall volumes of production of animal commodities, the graph below shows that milk and milk products dominate, accounting for nearly 12 million tonnes per annum, which amount to

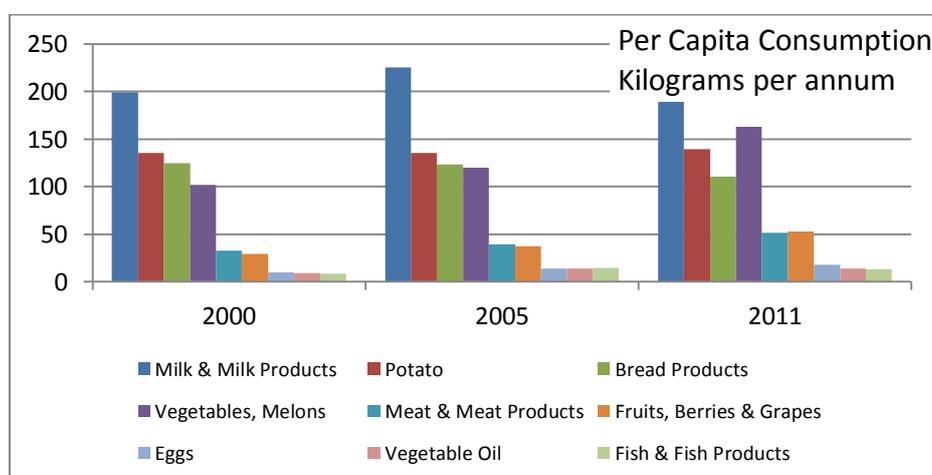
nearly 80% of overall animal product output in the country. Meat and raw animal fats are second in terms of volumes produced (just over 2 million tonnes per annum or 15% of overall animal product output), followed by eggs (0.9 million tonnes or 5% of the total) and fish and seafood (0.2 million tonnes or 2% of the total).



In terms of animal product consumption in Ukraine, the relative importance of the commodity groups is similar to production patterns. Milk and dairy products dominate consumption with nearly 8 million tonnes consumed annually (over 65% of all animal products consumed), followed by meat at just over 2 million tonnes consumed (20% of the total), fish and seafood and eggs (both under one million tonnes consumed and each accounting to 6-7% of overall animal product consumption).

Further, among animal products, Ukraine exports only milk and dairy products on any significant scale, the graph above illustrating that in both the meat and fish and seafood groupings, domestic demand can only be met through imports.

The chart below illustrates the relative importance of foodstuffs by commodity grouping to the Ukrainian consumer. It shows that over the last decade milk and milk products have dominated the average Ukrainian food basket, consistently accounting for over 200 kilograms consumed and accounting for over 30% of all food consumed by volume.



The other three key staples in the Ukrainian diet are bread products, potatoes and vegetables, of which the average Ukrainian consumes between 100 and 170 kilograms per annum, and making each product grouping account for 15-20% of food consumed. Between these three product groups,

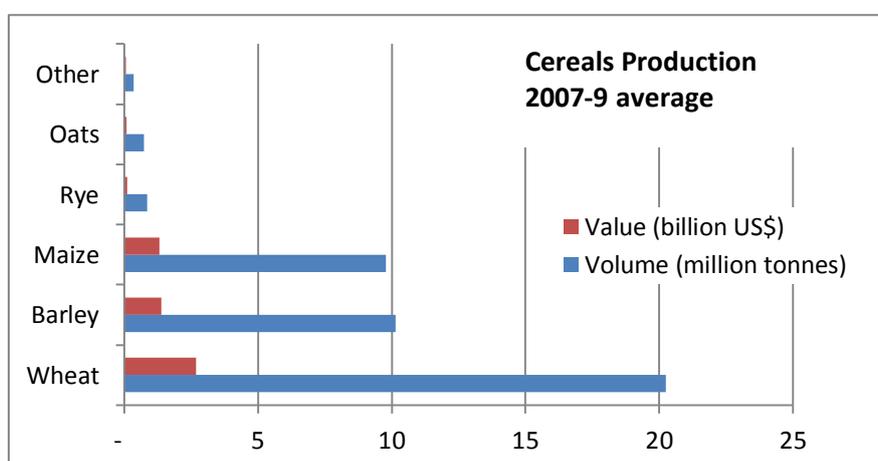
however, it is interesting to note that while potato consumption levels have remained almost constant over the last decade, bread and bread products are the only group to have declined in absolute volumes (by 12%), while vegetable consumption has grown 60% since 2000, rising from fourth to second place in terms of volumes consumed.

Meat and fruit have both seen growth in consumption, from approximately 30 kilograms per capita in 2000 to 50 kilograms in 2011 (an increase from 5 to 7% of overall consumption each), although in absolute terms the increase in fruit consumption has grown fastest, by nearly 80% since 2000, as compared to nearly 60% for meat.

Eggs, vegetable oil and fish have each accounted for only between 1 and 3% of total food consumed by the average Ukrainian over the past 10 years. In absolute terms, however, egg consumption has seen the steepest increase among all products, rising 90% from 166 eggs per annum in 2000 to 310 in 2011. Consumption of fish and fish products increased 60% over the same period, from 8 kilograms per capita in 2000 to 13 kilograms in 2011 and vegetable oil consumption increased by nearly 50% from 9 to 14 kilograms per capita per annum.

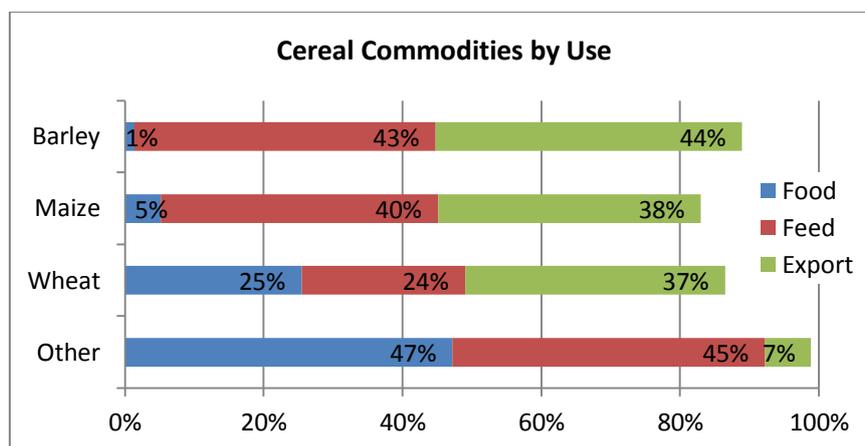
3.2 Cereals

As discussed in the preceding section, cereal production dominates agricultural production in Ukraine, accounting for over 50% of total crop production in terms of volume and amounting to over 40 million tonnes per annum. Within the cereals commodity grouping, wheat has historically constituted the primary crop and in the period 2007-9 accounted for nearly 50% of cereals produced by volume and value, amounting to over 20 million tonnes per annum, valued at producer prices at approximately US\$ 2.7 billion.



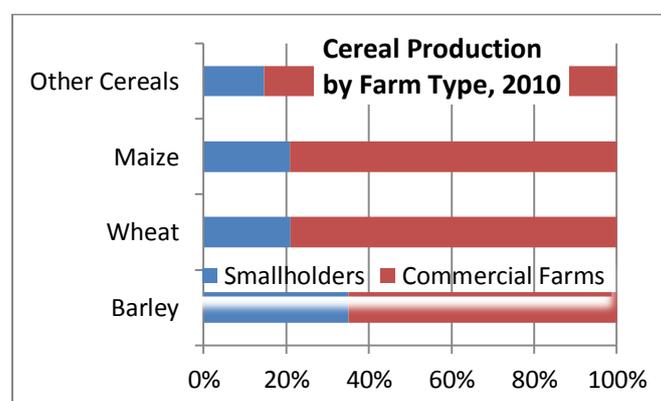
Other core cereals crops include barley and maize, representing approximately 24% and 23% of overall cereals production respectively in both volume and value terms and equating to just over and just fewer than 10 million tonnes of production, valued at US\$ 1.4 billion and US\$ 1.3 billion, respectively. Recent years have seen increased areas of maize sown relative to barley and this tendency is expected to continue, particularly given ongoing policy constraints on barley exports. Rye and oats play a relatively minor role in Ukrainian cereals production (each accounting for 2% of total cereal production by volume and value) and other cereals, comprising millet, sorghum and rice, together make up only 1% of overall production.

The graph below shows the uses of the main cereals in Ukraine for the period 2007-9. Barley and maize are used primarily in animal feed, split roughly equally between domestic and export markets, each of which account for approximately 40% of domestic production. Only 1% of total domestic production of barley and 5% of maize is consumed as food. Wheat shows the most balanced use pattern, with 25% or approximately 5.1 million tonnes of domestic production being used as food, 24% or 4.8 million tonnes used as animal feed and some 37% or 7.6 million being exported.



While the 'other' cereals category has a relatively higher proportion of use as food (reaching 47%), the overall production figures of 2 million tonnes per annum as against 20 million tonnes for wheat and 10 million tonnes each for barley and maize and the high levels of human consumption of rice, a primarily imported commodity, show the relative unimportance of this category in terms of food security and domestic food supply.

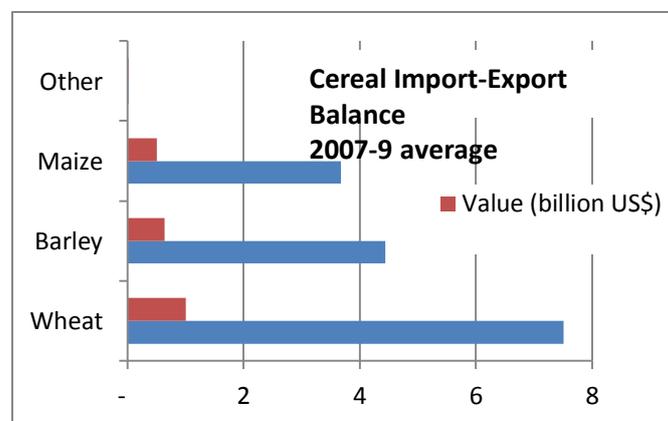
In terms of domestic food security, the graph below shows that smallholder producers account for between 15% and 35% of cereals production in Ukraine. For wheat, the main food crop, smallholders account for a considerable 20% of national production. This provides an indication of the importance of wheat produced at the household level to household consumption, although a substantial proportion of such wheat is used as animal feed rather than being consumed by household members.



In addition, given the current moratorium on sale-purchase of agricultural land and the fact that during the land reforms of the 1990s previously collectively-owned farmland was distributed to the

rural population (collective farm members), commercial farms are forced to lease land from multiple landowners. In many cases lease payments are made in grain harvested, providing another direct access point for rural populations to grain that can be consumed or used as animal feed at the household level, the latter being the primary use of such grain, as larger lessee farmers use such arrangements to dispose of lower quality cereals harvested.

Further, while per capita annual consumption of bread and bread products has fallen from 125kg in 2000 to 110kg in 2011, current levels remain high in comparison both to levels of consumption of other staple foodstuffs in Ukraine and to European levels of bread consumption. Given government controls on bread prices, wheat therefore remains a mainstay of food security, particularly for Ukraine's poor.



Despite these high levels of domestic consumption and the importance of cereals in national consumption, Ukraine is also a net exporter of all the cereal crops it produces, with the exception of rice, and its economy relies on its competitive advantage in cereal production and the export earnings that this generates. Ukraine is also a major contributor to global food security through historical and current cereal exports, ranking among the world's top ten wheat exporters.

While over the last 10 years on average 50% of its exports have been of low and medium quality wheat, primarily used as animal feed inputs, particularly in the last five years exports to African and Asian countries have risen with increased demand for medium quality food wheat. Ukraine also retains considerable potential to increase production, decrease harvest and post-harvest losses and increase exports of wheat and other cereals.

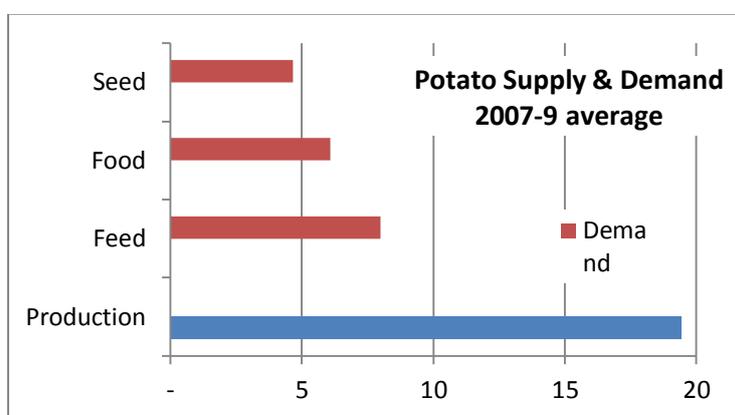
In terms of volumes, wheat remains Ukraine's primary cereal export commodity, with an average annual export/import balance for the years 2007-9 of 7.5 million tonnes, valued at US\$ 1 billion. Barley and maize also maintain substantial export surpluses, with average annual balances of 4.4 and 3.7 million tonnes valued at US\$ 0.6 and 0.5 billion, respectively. Other cereals crops' contribution to exports are negligible, together providing an average annual export surplus of less than 20,000 tonnes, valued at less than US\$ 20 million.

The main cereals production regions of Ukraine (those with over 800,000ha sown to cereals in 2011) lie in southern and central Ukraine in the regions (oblasts) of Dnipropetrovsk, Odesa, Poltava, Kharkiv, Mikolayev, Vynnytsya, Kirovohrad and Zaporizhe. Areas with over 3 million tonnes of cereals production in 2011 include the oblasts of Poltava, Vynnytsya, Cherkasy, Kharkiv, Kirovohrad, Dnipropetrovsk, and Odesa. Central oblasts of Poltava, Vynnytsya and Cherkasy have grown fastest in overall cereals production since Ukrainian independence in 1991.

3.3 Roots & Tubers

As the FAO Food Losses and Waste methodology groups roots such as carrot and beetroot under the Fruit and Vegetable commodity grouping, the only crop falling within the Roots and Tubers commodity grouping produced in Ukraine in any significant quantity is potato. Indeed, Ukraine was ranked 4th among global potato producers by FAO in 2011, after China, India and Russia.

Overall potato production in Ukraine increased slightly from 19.1 million tonnes in 2007 to 19.7 million tonnes in 2009, with domestic production averaging 99.6% of overall supply. Potato exports are negligible due to an absence of quality standards and high levels of production by neighbouring countries. Potato imports are low, averaging only 72,000 tonnes or 0.4% of domestic supply in 2007-9. These imports are nevertheless significant due to their relatively high value as they occur particularly during January-March when supermarkets are forced to import due to the absence of adequately stored local produce.



On the demand side the primary use of potatoes in Ukraine is for animal feed, which averages nearly eight million tonnes per annum and accounts for just over 40% of domestic supply. Human consumption of potatoes accounts for a further six million tonnes (31% of supply) and use of potatoes for seed accounts for 4.7 million tonnes (24% of supply). While official statistics for potato waste average only 250,000 tonnes or just over 1% of domestic supply, the analysis conducted below shows that the levels of waste are considerably higher, particularly when taking into account that the use of substandard and perished potatoes as animal feed can be considered as a loss of food potentially consumable by humans.

The production of potatoes in Ukraine is dominated by household production, with 98% of potatoes being produced by smallholder farmers. This provides a strong indication of their importance both in household food security and as a cash crop for sale on local markets. Traders pay cash for root vegetables at the farm gate and at local markets and sell on to regional wholesale markets and retail food chains.

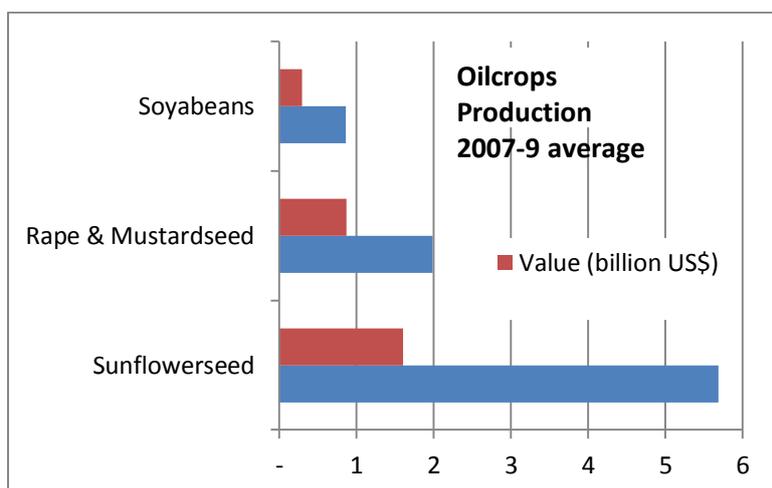
Further, perhaps contrary to trends in consumption of other staple foods, per capita annual consumption of potatoes in Ukraine, despite fluctuations actually rose from 135kg in 2000 to 139kg in 2011. This compares with a global average per capita consumption of 33kg in the first decade of the 21st century and underscores the key food security role still played by potatoes in Ukraine, particularly for poorer and more vulnerable segments of the population.

Regions that produced over 1 million tonnes of potato per annum on average between 2006 and 2010 were the oblasts of Vynnytsya, Khmelnytsk, Kyiv, Chernihiv, Zhitomyr, Rivne and Zakarpattya. The traditional potato production regions of the north-western 'Polissya' zone and central and western Ukraine focus on production of 'old' (autumn harvest) varieties.

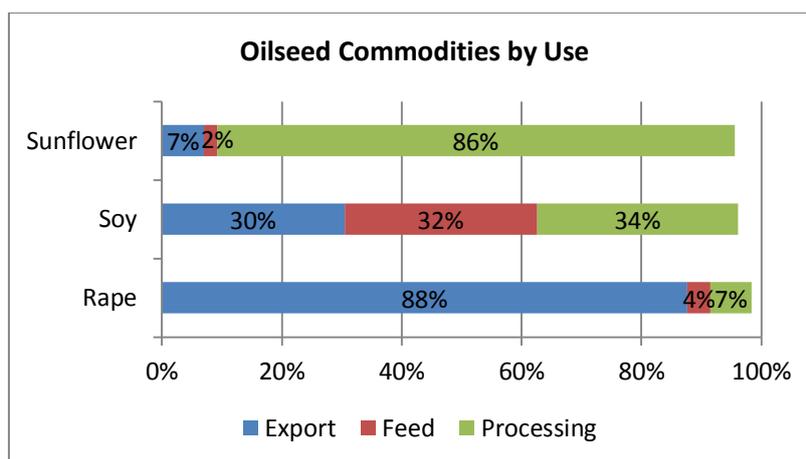
In comparison with 1990 figures of regional potato production, however, there is a marked increase of potato production in southern and eastern Ukraine and in the Carpathian region in the far west, which due to higher spring temperatures, are increasingly engaging in the lucrative production of 'new' (spring-summer harvest) potatoes. In southern oblasts and on the Crimean peninsula two harvests of new potatoes are being produced between May and August.

3.4 Oilseeds & Pulses

The oilseed and pulse commodity grouping is dwarfed by cereal production in terms of harvested volumes, with oilseeds and pulses accounting for only 11% of overall crop production or approximately 8.6 million tonnes per annum. Within the oilseeds and pulses grouping, pulses are negligible in terms of volumes produced, their value and importance in human consumption when compared to oilseeds. Sunflower seed production has historically constituted the primary crop among oilseeds and in the period 2007-9 accounted for over 65% of oilseeds produced by volume or just under 60% by value, amounting to over 5.7 million tonnes per annum, valued at approximately US\$ 1.6 billion.



Other important oilseed crops are rape and soy, representing approximately 25% and 10% of overall oil crop production respectively in volume and value terms. This equates to production of approximately 2 million tonnes of rapeseed per annum, valued at US\$ 0.9 billion; and production of approximately 0.9 million tonnes of soybean per annum, with a value of just under US\$ 0.3 billion. Recent years have seen increased areas of rape and soy sown and this tendency is expected to continue, given increased demand as animal feed ingredients and interest in bio fuel production.



The graph above shows the primary uses of oilseed crops in Ukraine. As can be seen, 86% of the sunflower seed crop is processed in-country, with only 7% exported unprocessed. The picture for soybean is more balanced, with 30% of the crop being exported unprocessed, 32% going to animal feed and 34% being processed in Ukraine. Rape seed on the other hand is almost exclusively produced for export in an unprocessed form, with this use accounting for 88% of the total rape seed crop.

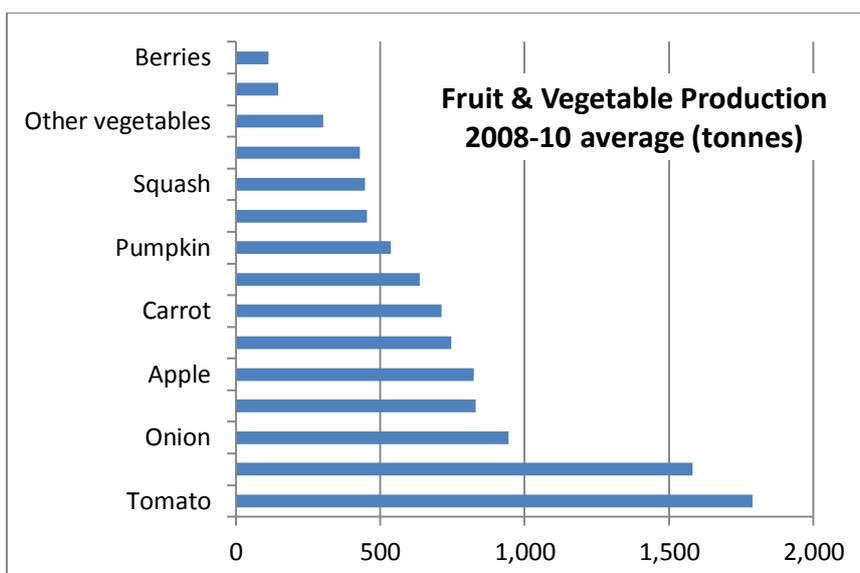
The 4.9 million tonnes of sunflower seed processed annually in Ukraine produces approximately 2.3 million tonnes of oil, which accounts for 95% of all vegetable oil produced in the country. Ukraine exported 83% of the sunflower oil it produced or 1.9 million tonnes of oil annually in the period 2007-9. Further, during this period, it accounted for the highest value of all Ukrainian agri-food exports, contributing approximately US\$ 1.6 billion annually to Ukrainian export earnings, with sunflower cake and sunflower seed also featuring in Ukraine’s top ten agri-food export earning products.

In terms of domestic food security, sunflower oil remains the primary oil used in food in Ukraine, accounting for nearly 90% of all vegetable oils consumed in the country. Further, per capita annual consumption of vegetable oils rose nearly 50% from nine litres in 2000 to nearly 14 litres in 2011, showing that despite being a major export commodity, domestic demand for sunflower products remains strong and growing.

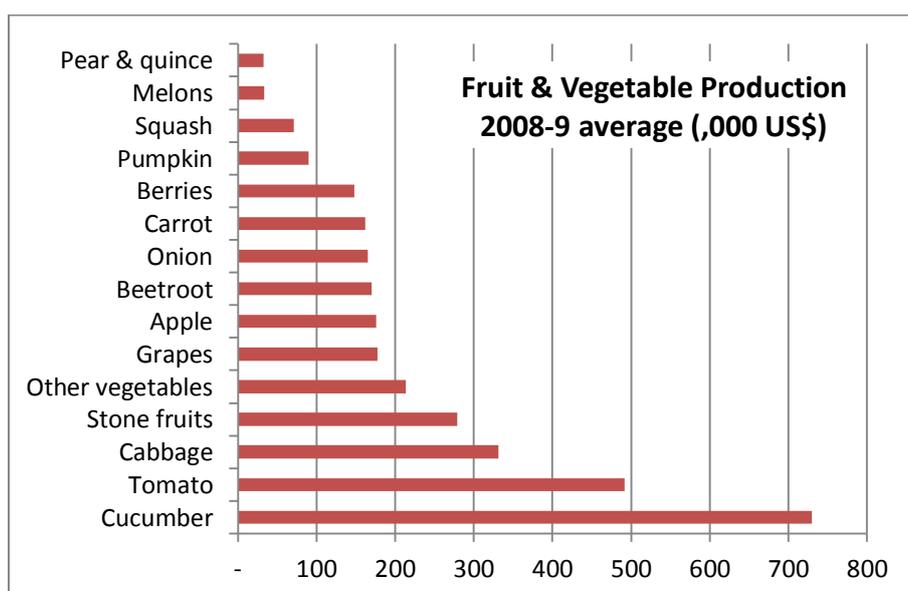
The main production regions (those with over 400,000 hectares sown to industrial crops in 2011) lie in southern and central Ukraine in the oblasts of Kirovohrad, Zaporizhe, Dnipropetrovsk, Kherson, Odesa, Mikolayev, Kharkiv, Donetsk and Vynnytsya.

3.5 Fruits & Vegetables

Although dwarfed in terms of production volume by cereals and oilseeds, the fruit and vegetable commodity grouping is nevertheless a substantial contributor to non-animal agri-food production in Ukraine, accounting for 15% of overall non-animal food products by volume or just over 10 million tonnes per annum. Within the commodity grouping the graph below shows that tomato and cabbage production dominates in terms of volume, accounting for 17% and 15% of overall fruit and vegetable production. This is followed by onion, cucumber, apple, beetroot and carrot, each comprising 7-9% of output in this grouping.



Although substantially lower in production volumes, such subsectors as stone fruits (particularly cherries and plums) and berries, as well as table grapes and early (greenhouse) vegetables enjoy strong and growing demand and thus offer a high value and rapidly growing market niche.

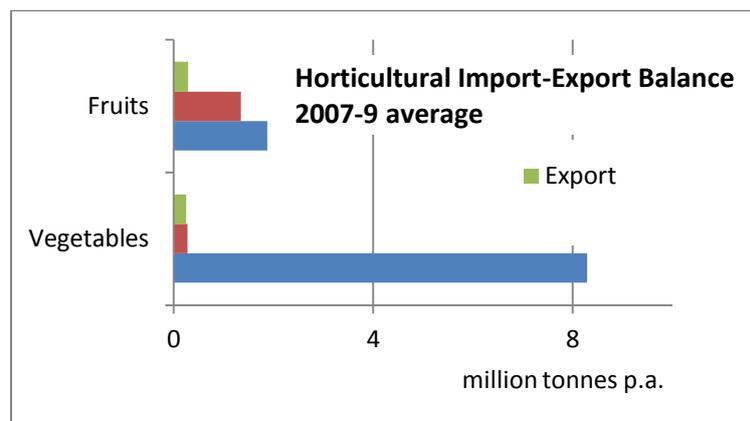


The production of open-field fruits and vegetables in Ukraine is dominated by household production, which accounts for over 90% of production for all types of fruit and vegetable, with the exception of tomato, onion, watermelon, apple and peach (and even for these products, over 70% of production is accounted for by households). As with the analysis of potatoes above, this provides a strong indication both of their importance in household food security and as their key role as a cash-crop for sale on local markets.

Approximately 35% of fruits and vegetables produced in greenhouses is currently accounted for by commercial producers and while this level is likely to grow, smallholders currently dominate even in this higher technology and higher value area of production.

Further, probably one of the most impressive increases in domestic consumption patterns over the past decade has been in Ukrainian consumption of fruit and vegetables. Vegetable (including melon) consumption has risen 60% from 102kg per capita in 2000 to 163kg per capita in 2011, overtaking

both bread and potatoes in terms of per capita consumption. Similarly annual consumption of fruits (including berries and table grapes) rose 80% from a mere 29kg per capita in 2000 to 53kg per capita in 2011.



As the graph above illustrates, Ukraine’s exports of vegetables roughly balance its imports and imports comprise only 3% of its total domestic supply. Given growing domestic demand, however, as shown in the consumption figures above, it is considered highly unlikely that Ukraine will emerge in the short to medium term as a major exporter of vegetables.

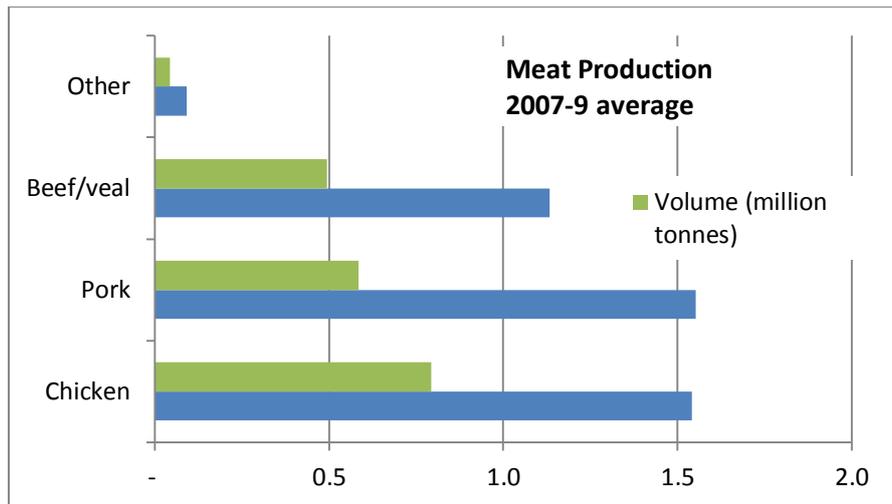
The picture for fruits, however, is more dramatic, with domestic production, though growing, still unable to meet fast-growing domestic demand, with the result that imports not only far outstrip exports, but fluctuate between 40 and 50% of total domestic supply.

Kherson Oblast in central southern Ukraine stands out as the single largest vegetable producing region, accounting for nearly 10% of national vegetables and melon production. Southern and eastern regions (oblasts) of Odesa, Dnipropetrovsk, Poltava, Kharkiv and Donetsk, as well as Kyiv and in far west also produced over 400,000 tonnes of vegetables and melons during the 2006-2010 period.

In terms of fruit production, the western regions (oblasts) of Lviv and Zakarpattia, central western Vynnytsya and Khmelnytsk and south-eastern Donetsk and Dnipropetrovsk averaged over 80,000 tonnes of production per annum in the 2006-2010 period. Of these the western and central regions dominate apple and pear production, while the more temperate eastern region dominates in stone fruits (plums, cherries and apricots). In berry production Vynnytsya, Donetsk and Dnipropetrovsk oblasts account for the bulk of production and in grape production (for consumption and wine production) Odesa Oblast and Crimea account for over 70% of national production, each producing over 100,000 tonnes annually.

3.6 Meat, Fish & Seafood

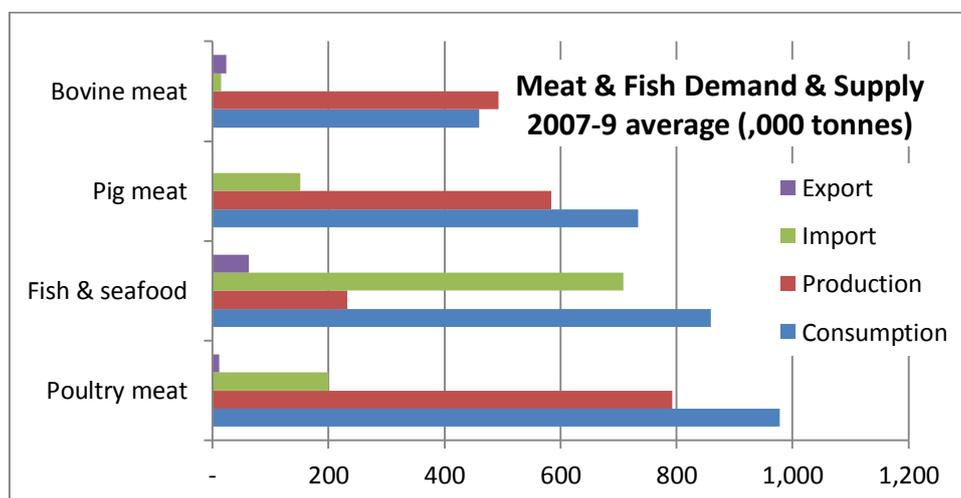
The meat, fish and seafood commodity grouping, although dwarfed by dairy production in terms of output volumes of animal products, holds its own in terms of value, with meat valued at a total of US\$ 4.6 billion produced in Ukraine annually.



Within the meat grouping, chicken, pork and beef dominate production, with chicken accounting for 41% of overall meat production by volume (790,000 tonnes) and 36% by value (US\$ 1.5 billion). Less pork is produced (31% or 580,000 tonnes annually) although its value is also US\$ 1.5 billion. Beef holds third place in terms of volume (26% or 490,000 tonnes) and value (US\$ 1.1 billion). Other meat produced includes rabbit, horse, goat and sheep, although between them they account for a mere 2% of the volume and value of meat produced, equating to some 42,000 tonnes annually, with a value of US\$ 90,000.

Longer term production trends show that beef and veal production has almost halved over the last decade, falling from 754,000 tonnes in 2000 to 428,000 tonnes in 2010. Although fluctuating, pork production has decreased only slightly, from 676,000 tonnes in 2000 to 631,000 tonnes in 2010. Poultry meat production on the other hand has shown fivefold growth over the decade, rising from 193,000 tonnes in 2000 to 954,000 tonnes in 2010, and making it the fastest growing chicken meat producer in Europe, which had risen to become the continent's sixth largest producer by 2010 according to a recent FAO/USDA study.

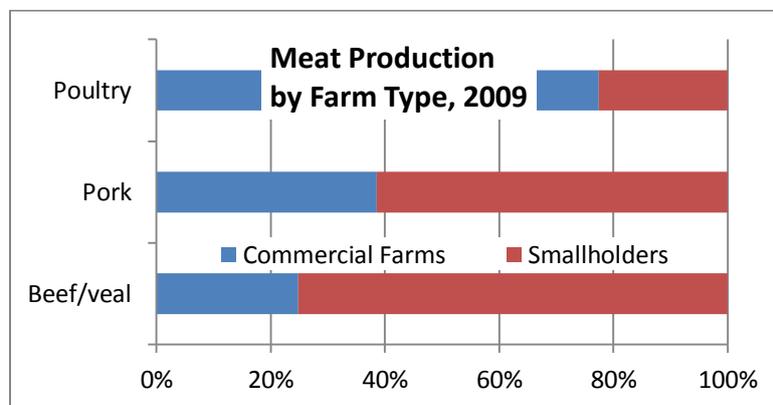
In terms of demand and supply the graph below shows that during the 2007-9 period Ukraine was self-sufficient only in beef production and needing to import approximately 20% of its pork and poultry requirement and as much of 80% of its domestic supply of fish and seafood. This situation changed dramatically in 2009, as Ukraine began to export increasing amounts of poultry, boosted by investments in increased production and EU export certifications of chicken meat.



Leading regions of production are those around the major population centres, with Cherkasy and Kyiv oblasts in central Ukraine, Lviv oblast in the west, Donetsk and Dnipropetrovsk oblasts in the south and the Autonomous Republic of Crimea all producing over 100,000 tonnes of meat per annum in recent years.

Meat processing in Ukraine is dominated by the production of boiled and smoked sausages in regions including Dnipropetrovsk, Donetsk, Poltava and Kharkiv in central-eastern Ukraine and Crimea in the south. Production levels have fluctuated between 270,000 tonnes and 335,000 tonnes in the first decade of the 21st century, which equates to some 10-15% of overall meat supply.

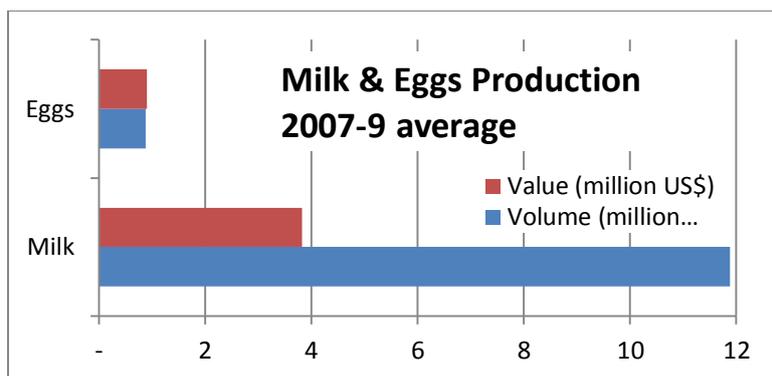
In terms of domestic food security, the graph below shows that smallholder producers account for over 75% of beef and veal production and over 60% of pork production in Ukraine. Indeed, only in poultry production for which large new poultry farms have been established do commercial entities outweigh small producers in volumes of production, where they make up nearly 80% of poultry meat.



Ukrainian per capita consumption of meat, fish and seafood has risen 40-50% over the past decade, albeit from very low levels. In 1990 the average Ukrainian consumed 33kg of meat and 8kg of fish and seafood. While this had risen to 51kg of meat and 13kg of fish and seafood in 2011, levels remain low, both in comparison to national consumption of more basic foodstuffs and compared to European levels.

3.7 Milk & Eggs

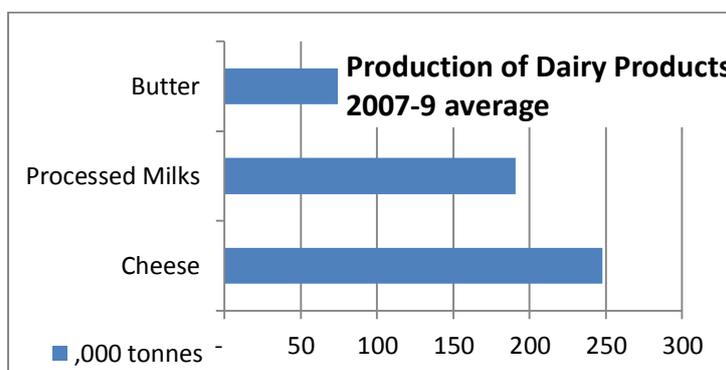
In the years 2007-2009 Ukraine produced an average of just under 12 million tonnes of milk per annum valued at some US\$ 4 billion. These averages, however, mask highly fluid milk prices caused both by world markets and regional trade policy, which led to a fall of 40% for producer milk prices during 2009 and subsequent reductions in herd sizes by producers. Indeed, milk production has been decreasing annually in Ukraine since it peaked at nearly 14 million tonnes in 2005.



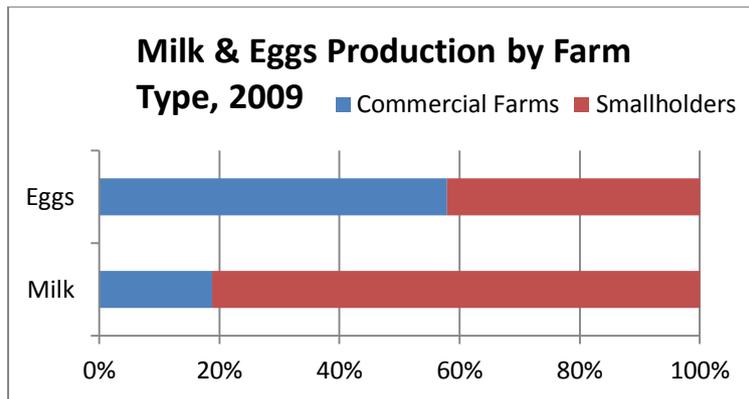
Egg production, on the other hand has been growing steadily, nearly doubling between 2000 and 2010 on the back of strong investment in large modern poultry farms in Ukraine. While it nevertheless accounts for a mere 7% of production volumes in this commodity grouping (on average just under one million tonnes per annum), it still makes up nearly 20% of the total value of production (approximately US1 million).

Further, while increases in domestic production of eggs is acting primarily to meet rises in domestic demand, with negligible quantities of eggs going to export, on average 13% (or 1.5 million tonnes) of fresh milk produced in Ukraine is exported and this rises to nearly a third of Ukrainian cheese products, making it an important, actor in regional dairy markets, though one that has suffered a number of setbacks through import bans on Ukrainian dairy produce by its neighbours.

The graph below shows that cheese is the most important processed dairy product, accounting for nearly 50% (or 250,000 tonnes) of dairy produce by volume. This is followed by processed milks, primarily dry skimmed and whole evaporated milks, accounting for 35% (190,000 tonnes) and butter, which accounts for 15% (90,000 tonnes) of overall dairy produce.



As we saw from analysis of the meat, fish and seafood commodity grouping above, cattle production in Ukraine is primarily in the hands of small farmers. This holds true also of milk production, of which smallholders account for 82%, or 9.5 million tonnes in 2009. And as we saw that poultry meat production in Ukraine is now in the hands of large commercial poultry farms, so in the sphere of egg production, large producers now account for 58% of eggs produced, which amounted to 9.3 billion eggs in 2009.



Milk, dairy products and eggs remain the most important contributors to the average Ukrainian diet in terms of volume. National milk and dairy product consumption has remained relatively stable over the past decade at around 10 million tonnes per annum, equating to approximately 210kg per capita annually. Eggs, although the only monitored foodstuff measured by unit rather than weight have seen an absolute increase of nearly 90% in per capita consumption, from an average of 166 eggs per capita in 2000 to 310 in 2011.

The primary dairy production regions of Ukraine are Vynnytsya, Zhitomyr, Lviv, Poltava, Khmelnytsky and Chernihiv oblasts, which all produced over 500,000 tonnes of milk per annum in recent years and feed major cheese and butter producers such as PE Prometey (in Chernihiv Oblast) and JSC Pyriatyn Cheese Factory and LLC Hadiachyr (both in Poltava Oblast).

Egg production is located close to the main markets of Ukraine to minimize transportation and therefore the largest producing regions are Kyiv, Donetsk, and Kharkiv, which all produced over a billion eggs in 2010, with Kyiv producing over 2 billion in recent years. Other regions producing over 800,000 eggs annually are Crimea, Dnipropetrovsk, Luhansk and Vynnytsya.

4. FOOD LOSSES & WASTE IN SELECTED AGRI-FOOD CHAINS

4.1 Identification of priority agri-food chains

The following sections identify the five agri-food chains to be analysed in depth in this study, prioritizing them in terms of economic importance, employment generation, contribution to foreign exchange and contribution to food security (national and global).

Cereals priority agri-food chain: Wheat

As noted in Section 2, above, wheat remains the dominant cereal crop, with annual output levels of over 20 million tonnes or nearly 50% of all cereals produced and with a value of US\$ 2.7 billion. Wheat further shows the greatest balance of all Ukrainian cereals in terms of uses, with 25% of annual production, or 5.1 million tonnes, being consumed domestically and 37% or 7.6 million tonnes exported. At producer prices this amounts to over US\$ 1 billion in foreign exports, which constitutes some 10% of all Ukrainian agri-food exports. In 2009 wheat was Ukraine's highest valued agri-food export, in 2008 its second highest and in 2007 its ninth highest, making it, along with sunflower oil a crucial contributor to Ukraine's export earnings.

In terms of food security, at the national level we have seen that per capita consumption of bread and bread products is high in Ukraine, at 110kg in 2011, which is approximately 15% of food consumed by weight in Ukraine, making wheat and bread a mainstay of domestic food security, particularly among lower income groups, as is acknowledged by government policies toward trade in wheat and bread price controls. At the global level, while exported Ukrainian grain may traditionally have been used more in animal feed than for human consumption, recent trends show an increase in demand for medium quality food wheat from African and Asian countries, where Ukraine's contribution to food security of growing low income populations, could prove of key importance.

In terms of employment generation, given trends towards extensive cultivation of cereals, this commodity grouping is unlikely to be a major long-term generator of employment, but with households maintaining their share of 20-25% of total cereals production (5-10 million tonnes per annum), cereals look likely to remain an important generator of rural employment, income and food production. Further, given the volumes of wheat processed into flour (2.5-3 million tonnes per annum) and bread and flour products produced (1.8-2.3 million tonnes per annum) domestically, the overall impact of employment generation in the wheat agri-food chain is considerable.

By comparison, the other two major cereals produced in Ukraine, barley and maize, are used primarily in animal feed and are therefore largely irrelevant for the purposes of this study.

Roots and tubers priority agri-food chain: Potato

Since, for the purposes of this study, root vegetables such as carrot, turnip and beetroot are categorized within the fruits and vegetables commodity grouping, potato is the only major root and tuber produced in Ukraine. With production levels at just under 20 million tonnes per annum, levels of potato production are nearly twice those of all fruits and vegetables combined, making this a product of key importance to Ukrainian producers. Further, with 40% of potatoes produced being used as animal feed rather than consumed by humans, the potential transfer from feed to food and the impact this would have on food supply both in Ukraine and globally is significant.

In terms of foreign exchange and global food security Ukrainian potato exports are currently negligible (accounting for only 2% of production), but at the domestic level, per capita consumption remains high at 139kg in 2011, or 20% by volume of all foodstuffs consumed. Further, with 98% of potatoes being produced by households in Ukraine, the importance of potato production to employment and income generation as well as food production in some of Ukraine's lowest-income regions should not be underestimated.

Oilseeds and pulses priority agri-food chain: None

As wheat dominates the cereals commodity grouping, so sunflower seed does the oilseed and pulse grouping, accounting for over 65% of all oilseed production by volume (over 5.7 million tonnes per annum) and just under 60% by value (US\$ 1.6 billion per annum). Of these volumes, over 85% is processed domestically, producing some 2.3 million tonnes of edible sunflower oil, of which 83% or 1.9 million tonnes is exported.

While this represents one of the largest single agri-food contributors to foreign exchange and a success story in terms of adding value through domestic processing prior to export, the following factors are considered to mitigate against selection of sunflower seed/oil as a priority agri-food chain for the purposes of this study:

- Low impact on low-income producers including on employment and incomes, with the percentage of sunflower seed production by smallholders having fallen from a high of 22% in 2006 to 16% in 2011, a trend that is likely to continue;
- Despite increased per capita consumption of sunflower oil in Ukraine, sunflower oil remains relatively insignificant in terms of basic food security in Ukraine, making up only 2% of the average annual food basket in terms of volume and understandably dwarfed by milk, vegetables, potatoes and bread products;
- Relatively low levels of losses given modern production techniques of large commercial producers and processors and increasing vertical integration and low levels of waste given the long shelf-life of sunflower oil compared to other agri-food products under analysis.

In comparison to sunflower, other major Ukrainian oilseed crops are of little importance for the purposes of this study, with nearly 90% of rape seed produced in Ukraine exported raw for industrial use and soybean going almost exclusively into domestic or international animal feeds either raw or in processed form.

Fruits and vegetables: priority agri-food chain: Apples

While relatively small in terms of volume of production in Ukraine, representing only 13% of overall non-animal production after cereals and roots/tubers, fruit and vegetable production represents a key and growing high-value market for large numbers of small and medium producers.

Within the fruit and vegetable commodity grouping, vegetables are far more significant than fruits in volume terms, accounting for 82% of the total tonnage of fruits and vegetables produced annually. Among vegetables, tomato, cabbage and onion rank as the top three in terms of quantities produced in Ukraine. Among fruits, apples and grapes dominate, although the latter are primarily non-table varieties and therefore approximately 80% go into processing, primarily for wine and therefore lie outside the remit of this study.

Apples have been selected over vegetables and other fruits as the priority agri-food chain for analysis in this study, for the following reasons:

- Strong and growing domestic demand, as illustrated by an 80% increase in per capita consumption of fruit in Ukraine between 2000 and 2011, compared to 60% in vegetables;
- Ukraine's being almost on a par with the world average per capita vegetable consumption but still far behind in fruit consumption;
- Fruit imports constituting nearly 50% of total domestic supply (3% for vegetables) and over 70% of domestic production (3% for vegetables);
- The dominance of smallholder production in fruits (with over 75% of apples produced by households and family farms);
- The scale of losses and waste as a result of poor post-harvest handling, cold storage and transportation networks for perishable products;
- Similarities in FLW issues between main winter vegetables cabbage and onion with potato, selected for analysis under the Roots and Tubers commodity grouping above;
- Faster turnover of fresh summer vegetables such as tomato and cucumber and more established pickling and processing market for substandard products, reducing levels of waste;
- Dominance of apple production and consumption in overall domestic fruit market and opportunities to build on current export base.

Meat, fish and seafood priority agri-food chain: Pork

Within the meat, fish and seafood commodity group, chicken meat production leads in terms of volumes (on average 790,000 tonnes per annum) and continues to grow strongly, although its overall value is (US\$ 1.5 billion) is matched by pork, which has seen levels of production relatively steady at between 600,000 and 700,000 tonnes per annum over the last decade. Beef and veal continue to experience contracting production from current levels of 490,000 tonnes per annum, valued at US\$ 1.1 billion.

In terms of domestic food security, employment and incomes, poultry production is dominated by large commercial farms (80% of output), while pork production is still primarily the domain of the smallholder (which account for 60% of output). Further, overall meat consumption has grown nearly 60% over 2000 levels, showing strong domestic demand growth, and while the precise breakdown of meat consumed by type is not available, it is likely that given relative weight gain, production costs and levels of smallholder engagement in pork production, that pork retains a significant proportion of overall meat consumption in Ukraine.

Further, given weak and falling levels of cattle meat production and the modern technologies used by vertically integrated poultry farms and their close interaction with retail chains, their losses are considered likely to be considerably less than in the pork agri-food chain.

While relatively high levels of fish are consumed in Ukraine, the value chain is not considered of critical importance for the purposes of this study given low levels of domestic fish production and the relatively low impact of fish products on employment, foreign exchange and food security.

Milk and eggs priority agri-food chain: Milk and milk products

Milk and milk products not only remain the dominant animal products produced in Ukraine, but also the single largest contributors to the average Ukrainian diet (nearly 30% of food consumed in terms

of volume). In terms of exports, cheese is among Ukraine’s top ten agri-food export products, with between 60,000 and 80,000 tonnes exported annually at a value of between US\$ 250-400 million. Although such exports have been targeted with for restriction by regional importers, notably Russia, they remain an important contributor to Ukrainian export earnings.

In addition, given the high penetration of commercial farms in the poultry sector, smallholders account for less than 60% of egg production in Ukraine, compared to over 80% of milk production and as mentioned above in relation to trends in broiler farming, the modern technologies now used in egg production, transportation and sales mean that losses and waste in this chain are well below those in the milk-dairy chain, where processors are required to collect milk from multiple small producers and thereafter face major cold chain challenges in terms of transportation and storage.

4.2 Description of priority agri-food chains

Foodstuff production and consumption patterns in Ukraine are highly differentiated between size and sophistication of producers and between income levels of consumers. In numbers terms Ukraine is dominated by smallholder farmers, with a small number of medium-sized producers and an even smaller number of large commercial farms, often termed ‘agro-holdings’, which can control hundreds of thousands of hectares of agricultural land as well as vertically integrated logistics capacity and processing facilities. In terms of areas cultivated and production, the medium to large farms show greater prominence, particularly in extensive cereal and oilseed production, cattle rearing and egg production, where they account for over 60% of domestic production.

Levels of mechanization and production techniques between these groupings ranges from manual and horse-drawn mechanization and primitive storage technologies on smallholdings to the employment of highly sophisticated modern equipment on agro-holdings, with levels of farm and post-harvest losses reflecting the level of modernization of technology employed.

Agri-food product consumption patterns also vary widely, with proportionately little wasted by the majority of Ukrainians who fall into the low-income, producer-consumer, bracket. The growing middle-income segment of the population, increasingly moving away from reliance on ‘dacha’ plot produce towards retail and supermarket shopping wastes relatively more. For the purposes of this study the small high-income bracket, likely the highest in terms of food waste, is considered of little relevance, particularly given its tendency to consume more imported rather than domestically produced food products.

Wheat and bread products agri-food chain

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Mechanical damage/spillage during harvest - Crops left in field - Animal/disease attacks after finished growth

Wheat production in Ukraine is highly diverse in terms both of agronomic practises and levels of mechanization. As noted above, smallholders currently produce approximately 20% of wheat in Ukraine and suffer losses as a result of low levels and poor quality of inputs, ranging from seed to fertilizer and crop protection products and low levels of access to usually outdated farm machinery, including tractors, harvesters and grain transport.

Increasingly, however, grain production is being dominated by larger commercial enterprises, which predominantly are entities farming between 100 and 1,000 hectares, but increasingly vertically-integrated 'agro-holdings', farming areas of 3,000 hectares and above are developing in wheat production. These larger farms use modern production technologies (including no-till) and have access to global inputs markets and modern farm machinery.

Reflecting these large discrepancies in access to production technology, there is a wide range of levels of exposure to losses during the wheat harvest period. Critical loss points at this step in the supply chain considered applicable across the spectrum of farm sizes and subject to further analysis below, are as follows:

- Shortage of harvesting machinery and transportation during peak harvest periods,
- Outdated harvesting machinery leading to major losses, particularly by smaller farms,
- Crops not harvested before onset of poor conditions and therefore harvested late,
- Adverse weather (wind, rain) during harvest period.

Supply chain step	Location	Causes of food loss/waste
2. Post-harvest handling and storage	Storage facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Natural drying - Mechanical and handling damage - Transport to storage/processing

While the large, vertically integrated producers have their own transport, storage and often processing facilities, smaller producers are again exposed to the vagaries of transport and storage infrastructure available on the local market, which are for the most part Soviet-era grain trucks and elevators. The following are therefore considered to be the critical loss points at this step in the supply chain subject to further analysis below:

- Outdated truck fleet and subsequent in-transit spillage and grain degradation,
- Inadequate drying and treatment of grain for storage.

Supply chain step	Location	Causes of food loss/waste
3. Processing and packaging	Farm industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing - Rodents (etc.)

Flour milling in Ukraine is also characterized by large mills that are part of vertically integrated holdings operating largely independently from the main market of large, medium and small mills, which buy the bulk of their grain from farmers and traders and either sell on flour to state bakeries or traders or have side lines producing pasta and/or bread and bread products. The primary loss points at this step in the supply chain, subject to further analysis below, are therefore considered to be as follows:

- Rejection of grain by flour millers on grounds of poor quality (grain therefore used as food grain further down the market or used as animal feed),
- Losses during flour milling and baking as a result of outdated machinery and poor work practises,

- Poor or non-existent packaging of bread, bread products and pasta,
- Inadequate pre- and post-processing storage, leading to additional losses.

Supply chain step	Location	Causes of food loss/waste
4. Distribution	Wholesale Supermarkets Retailers Markets	- Transport to distribution - Lack of cooling - Outdated food - Unsold food

Distribution is likely to be one of the most functional steps in the wheat-wheat products agri-food chain in Ukraine, with a relatively well established and state controlled transportation and retail system for bread, bread products and pasta. Nevertheless, outdated, unsealed trucks lead to product degradation and losses. Systems of return of unsold bread to bakeries for reprocessing into dry bread products limits waste of unsold bread, while a relatively flexible approach to ‘best before’ dates on products such as pasta mean that levels of waste of pasta products are also relatively low. The following are therefore the critical loss points subject to further analysis below at this step:

- Transport of bread and pasta products on outdated and unsealed trucks,
- Outdated and unsold bread and bread products.

Supply chain step	Location	Causes of food loss/waste
5. Consumption	Households Food services	- Outdated food - Poor storage - Plate waste - Passed ‘use by’ dates - Other waste

Little bread, bread products or pasta is wasted by the majority of Ukrainians (particularly those in the lower-income segments of the population), who consider it taboo to throw even stale bread away as waste. Levels of such waste are likely to be much higher in the food services industry, although even such bread is likely to find an outlet either to low-income consumers or into animal feed. Passed ‘use by’ dates are not considered likely to be a major cause for wastage of pasta products, either in households or food services. The following are therefore the critical loss points at the consumption step of the supply chain that will be further analyzed below:

- Disposal as waste of un-fresh bread and bread products by higher income consumers and food services,
- Plate waste of bread, bread products and pasta by higher income consumers and food services.

Potato agri-food chain

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	- Mechanical damage/spillage during harvest - Crops left in field - Animal/disease attacks after finished growth

As noted above, smallholders dominate potato production in Ukraine, accounting for 98% of output. This factor, combined with the situation that Ukraine is not engaged in import or export of potatoes

(each account for less than 1% of production), means that producers are strongly affected by excess production. In years of when larger areas are planted and climatic conditions result in high yields, farmers are faced with a glut on the market and given a shortage of cold storage capacity large volumes are simply left un-harvested.

Manual harvesting of is the norm on smallholder farms, with the result that little of the crop is lost through mechanical damage or spillage, although pre-harvest losses through disease can be considerable. Given varied access to modern potato varieties and agronomic practises, post-harvest sorting, particularly of crops destined for on-sale, but also for those to be consumed by the producer, result in considerable quantities being relegated to animal feed.

Critical loss points to be analysed further under this step of the potato agri-food chain are therefore as follows:

- Crops left un-harvested due to excess production and absence of storage capacity,
- Losses to disease in the pre-harvest phase,
- Post-harvest sorting and relegation of harvested potatoes to animal feed.

Supply chain step	Location	Causes of food loss/waste
2. Post-harvest handling and storage	Storage facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Natural drying - Mechanical and handling damage - Transport to storage/processing

Ukraine is characterized by three categories of cold storage facilities for potatoes. Firstly the smallholders' cellars, dug some five metres underground to act as storage for winter supplies of horticultural produce, including fresh and conserved fruits and vegetables and conserved meat products. Secondly large Soviet era horticultural stores, now for the most part dilapidated and retaining little, if any, cooling capacity. Thirdly modern cold storage facilities, which while increasing in prominence, still account for an estimated 30% of overall capacity. Losses to degradation and pests, particularly insects and rodents are therefore significant.

The critical loss points to be analysed further for this step of the potato agri-food chain in Ukraine are therefore as follows:

- Damage and spillage in transportation from the field to storage facilities,
- Losses to degradation and pests in storage facilities.

Supply chain step	Location	Causes of food loss/waste
3. Processing and packaging	Farm industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing - Rodents (etc.)

While a large proportion of potatoes produced in Ukraine undergo no processing or packaging, being consumed by their producers. Potatoes to be sold on local markets are sold in 40kg sacks and commercially produced potatoes destined for retail through shops and supermarket chains are sorted, washed and packaged in smaller net sacks.

In terms of potato processing, currently less than 5% of the total fresh potatoes consumed in Ukraine are used in processing, of these, according to the Association of Ukrainian Potato Producers, some 60% are used for potato crisps, 30% for starch and 10% for other uses, including French fries. Thus, while this segment of the market is anticipated to grow, its current importance and potential impact on losses is considered minimal.

The following are therefore the loss points that will be subject to further analysis below for this step in the potato agri-food chain in Ukraine:

- Damage through insufficient or inadequate packaging.

Supply chain step	Location	Causes of food loss/waste
4. Distribution	Wholesale Supermarkets Retailers Markets	- Transport to distribution - Lack of cooling - Outdated food - Unsold food

Potatoes in Ukraine as a rule are transported, stored and traded at local and wholesale markets without any cooling. Losses through degradation and waste of unsold produce are therefore significant. Potatoes destined for retail through shops and supermarkets are subject to better transport and storage logistics, but given the absence of long-term and binding supply contracts and the possibility of rejection by retail outlets on quality grounds, considerable losses of potatoes in the retail chain also occur.

The following are therefore the loss points that will be subject to further analysis below for this step in the Ukrainian potato agri-food chain:

- Losses to potatoes traded through wholesale and retail markets through substandard transportation and packaging and absence of cold storage,
- Losses to potatoes destined for shops through rejection by retail purchasers or consumers.

Supply chain step	Location	Causes of food loss/waste
5. Consumption	Households Food services	- Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

As mentioned above, the practise by rural households of storing potatoes in cellars with inadequate refrigeration and ventilation leads to significant losses both in terms of spoilage leading to potatoes being fed to animals or simply discarded and also in terms of increased peeling and cleaning waste as inedible parts of potatoes are cut out and discarded.

Potatoes sold to consumers through markets witness relatively high waste levels, as a result of inadequate packaging, refrigeration and ventilation in storage, transportation and retail, with consumers discarding or cutting out inedible produce. Potatoes sold through retail outlets, such as supermarkets, enjoy the lowest levels of consumer waste, given the better condition of the produce sold.

The following are therefore the loss points that will be subject to further analysis below for this step in the Ukrainian potato agri-food chain:

- Waste by smallholder producer/consumers through inadequate storage in cellars through the winter.
- Waste by consumers purchasing potatoes stored, transported and sold with inadequate refrigeration and ventilation through local market networks.

Apple agri-food chain

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Mechanical damage/spillage during harvest - Crops left in field - Animal/disease attacks after finished growth

With the breakup of the collective farm system, considerable areas of apple orchards have been lost to production, with areas under cultivation contracting nearly 75% between 1990 and 2010. Reflecting this, production of apples by commercial entities (largely based on former collective farms) has fallen to a level of 25% of overall production in Ukraine, the remainder being produced by smallholders.

Production losses by producers, which primarily employ manual harvesting techniques, to be analysed in more detail below include the following critical loss points:

- Damage by birds and inaccessibility of crop due to continued use of high-growing trees,
- Annual production excesses leading to fruit being left un-harvested or fed to animals,
- Poor (bulk, uncooled) transportation from the field to storage.

Supply chain step	Location	Causes of food loss/waste
2. Post-harvest handling and storage	Storage facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Natural drying - Mechanical and handling damage - Transport to storage/processing

The three categories of storage facilities available for potatoes and described above, also apply to apple storage. Losses of apples, however, are considerably higher than for potatoes, given their increased damageability and perishability. In Ukraine the practice of storing and transporting apples in used cardboard banana boxes is widespread, particularly for those apples not destined for high-end domestic or export retailers.

The following are considered the main critical loss points for apples at the post-harvest handling step in the supply chain:

- Losses to degradation and pests in storage (particularly insects and rodents),
- Mechanical, handling and transportation damage and losses as a result of an absence of containers or use of inadequate containers,
- Sorting, resulting in relegation of edible apples to animal food.

Supply chain step	Location	Causes of food loss/waste
3. Processing and packaging	Farm industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing - Rodents (etc.)

As mentioned above, packaging of fresh apples is for the most part limited to used banana boxes, which results in considerable damage and losses. Processing, which accounts for some 40% of overall production, is primarily for juice production, but also for purees and concentrates. Processors can be divided between processors continuing to use Soviet era facilities and predominantly Soviet technologies and processors that have invested in modern lines and practices, such as the major juice producers, Nash, Rich and Sandora, the latter which was bought in 2008 by Pepsi Cola.

Critical loss points at this step in the apple supply chain to be analysed further below are as follows:

- Damage and losses from inadequate packaging,
- Losses due to absence of cold storage and cooled transportation,
- Losses during processing as a result of technical failure, human error and power outages.

Supply chain step	Location	Causes of food loss/waste
4. Distribution	Wholesale Supermarkets Retailers Markets	<ul style="list-style-type: none"> - Transport to distribution - Lack of cooling - Outdated food - Unsold food

Apples in Ukraine as a rule are transported, stored and traded at local and wholesale markets without any cooling. Losses through degradation and waste of unsold produce are therefore significant.

Apples destined for retail through shops and supermarkets are subject to better transport and storage logistics, but given the absence of long-term and binding supply contracts and the possibility of rejection by retail outlets on quality grounds or due to produce not being sold, may also result in considerable losses. It is worth noting that retail outlets often stock better sorted, packaged and presented imported produce, meaning that domestically produced apples can be overlooked by consumers and are therefore more likely to remain unsold.

Waste of apple juices and other apple products is considered to be much less significant in distribution than that of fresh apples, given longer shelf life, less need for cold storage and improved transport logistics between processors and retailers.

The following are therefore the loss points that will be subject to further analysis below for this step in the Ukrainian apple agri-food chain:

- Losses to apples traded through wholesale and retail markets through substandard transportation and packaging and absence of cold storage,
- Losses to apples destined for shops through rejection by retail purchasers,
- Spoilage of apples in retail outlets.

Supply chain step	Location	Causes of food loss/waste
5. Consumption	Households Food services	- Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

Although waste of fresh apples or apple products in Ukraine is likely to be significantly less than in western Europe, spoilage and waste of apples due to non-refrigeration or non-consumption plays a role, as does the practice of peeling apples and cutting excessive amounts of fruits for display prior to consumption. Food services are more likely consciously to waste fresh apples and apple products, although their levels of consumption are also considerably less than those of household consumers.

Pork meat agri-food chain

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	- Animal mortality - Animal disease/medical treatments

Pork production in Ukraine is divided approximately 60%: 40% between smallholders and commercial farmers respectively. As in other agri-food chains this has implications for the levels of losses and waste at the production step of the chain. Smallholder pork producers, generally holding 1-5 pigs in outlying buildings, suffer relatively low levels of losses during the production stage, given increased care provided to livestock by smallholder owners.

On commercial pig farms, again dichotomized between Soviet-era facilities and modern farms, in addition to the question of breed genetics, key factors driving losses during pork production, to be analysed in more detail below, are as follows:

- Poor maintenance, meaning absence of temperature control, unsanitary conditions and poor control of medicine and antibiotics application;
- Poor feed, particularly for piglets, usually a result of absence of adequate feed production capacity and reliance on purchasing feed on volatile markets;
- Poor quality of personnel, as reflected in their inability to respond to the maintenance and feed requirements of the livestock.

Supply chain step	Location	Causes of food loss/waste
2. Post-harvest handling and storage	Farm / Slaughterhouse facilities	- Insects, rodents, birds, pests, disease - Mechanical damage - Transport to slaughterhouse/processing

The slaughter of pigs in Ukraine by smallholders is performed by farmers on their holdings and almost every body part finds use in a cottage food product. Only commercial producers therefore transport live animals to slaughterhouses. While losses during transportation are relatively low, losses through discarding of blood, innards, hooves and head, which could be used in pork products is the critical loss factor in the slaughter process that will be analysed in more detail below.

Supply chain step	Location	Causes of food loss/waste
3. Processing and packaging	Slaughterhouse industry	- Damage from packaging - Losses during processing - Mechanical damage during processing

The processing and packaging phase of the pork supply chain includes both butchery and processing of meat and animal parts into pork products. Skilled butchers will lose minimal amounts of edible meat during butchery and post-butchery hanging of meat. Significantly higher levels of loss occur due to inadequate packaging of fresh meat, with the absence of vacuum packing leading to a halving of shelf life from ten days after butchery for vacuum packed meat to five days for meat transported and stored without packaging.

Approximately 10-15% of meat consumed in Ukraine is processed and in the pork agri-food chain this comprises cured salamis, sausages and smoked and baked meats. While losses during processing as a result of mechanical failure and human error and lack of refrigeration are present, those during distribution are lower than for fresh meat, given longer shelf-lives of processed produce and improved packaging used.

Packaging of pork meat for storage by smallholders consists of sealed five litre jars, stored in cellars, where it can be kept for months without spoiling. Fridges are now widespread even in remote rural areas and while larger chest freezers allow for the storage of large quantities of unconserved meat, more often meat is conserved in jars, which once opened are kept in fridges. This lack of adequate refrigeration leads to losses, primarily due to breakage of jars or poor sealing, uncontrolled temperature rises and vermin.

Supply chain step	Location	Causes of food loss/waste
4. Distribution	Wholesale Supermarkets Retailers Markets	- Transport to distribution - Lack of cooling - Outdated food - Unsold food

The distribution phase of the retail pork supply chain is swift, given regulations limiting shelf life to five days after slaughter. As meat is sold by producers to retailers and cannot be returned if unsold, the level of pork waste in shops and supermarkets is hard to establish, particularly given shelf-life extension practises employed by retailers, to be analysed in more detail below.

Transportation of meat to local markets, particularly that produced by small farmers is generally conducted without or with inadequate packaging and cooling, as is its storage and sale in local and wholesale markets. Spoilage and losses in this system are therefore considerable.

The following will therefore be the critical loss points for this step in the pork supply chain:

- Losses during transportation due to inadequate packaging and cooling,
- Losses at markets due to inadequate packaging and cooling,
- Losses at retail outlets due distribution and outdated or unsold food.

Supply chain step	Location	Causes of food loss/waste
5. Consumption	Households Food services	- Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

While household waste of pork and pork products is likely to be relatively low in Ukraine, given the absence of or tolerance of expired 'use by' dates, it is likely that there is waste caused both by inadequate cold storage and as a result of the practice of slaughtering an animal that cannot be stored adequately (given its size) or consumed before spoiling.

As in other food chains, while sensitivity to outdated pork products and levels of plate waste are likely to be higher among food service providers, their relatively low market penetration compared to households, will likely render such waste relatively insignificant.

The following are therefore the critical loss points at the consumption step of the pork supply chain that will be subject to further analysis below:

- Household waste as a result of excess meat and inadequate refrigeration capacity,
- Food service plate waste and outdated meat practices.

Milk and dairy products agri-food chain

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	- Animal mortality - Animal disease/medical treatments

As in other agri-food chains, there is a clear dichotomy in milk production techniques and therefore losses in Ukraine between the 80% of milk produced by smallholders and the 20% produced by commercial dairy farms. While given the general shortage of milk supply dairies make considerable efforts to collect milk from large numbers of small producers, increased supply in summer months and market shocks caused by trade policy changes, have led to waste at the farm level as falling milk prices have resulted in the refusal of farmers to sell milk. The following critical loss points will therefore be analysed according to farm size below:

- Waste due to farm-gate milk price drops caused by external trade policies,
- Losses of dairy cattle to by mortality, poor feed and maintenance (including medication and antibiotics regimes)
- Losses of milk during milking due to poor milking techniques, obsolete equipment and absence of cold storage capacity.

Supply chain step	Location	Causes of food loss/waste
2. Post-harvest handling and storage	Farm / Slaughterhouse facilities	- Insects, rodents, birds, pests, disease - Mechanical damage - Transport to slaughterhouse/processing

Milk collection remains one of the biggest challenges facing the dairy sector in Ukraine, given the logistical difficulties of collecting small quantities of milk daily from multiple small suppliers. Even larger dairies, such as Milkiland, that keep substantial dairy herds, rely for over half of their milk supplies on small producers and cooperatives of such producers.

The following are therefore the critical loss points that will be analysed below under this step of the dairy supply chain:

- Losses and spillage due to inadequate transportation (cold tank quality and cooling capacity) and handling practices,
- Milk rejected for quality reasons and because of poor storage prior to collection,
- Losses due to contamination of bulked milk by individual producers.

Supply chain step	Location	Causes of food loss/waste
3. Processing and packaging	Dairies, Cheese processing facilities	- Damage from packaging - Losses during processing - Mechanical damage during processing

While milk packaging and processing is primarily conducted by commercial dairies and therefore losses controlled by sanitary and temperature regimes, there remains a significant amount of milk and milk products produced, packaged and sold by small farmers and cottage dairies. The latter bottle milk in used plastic bottles and store, transport and sell produce with little or no cold storage.

The following are therefore the critical loss points to be analysed in detail below in relation to the processing and packaging step of the dairy supply chain:

- Losses in commercial dairies as a result of mechanical failure of production lines,
- Losses in commercial dairies as a result of over production of new products,
- Losses through non-commercial dairy lack of sanitary and temperature controls.

Supply chain step	Location	Causes of food loss/waste
4. Distribution	Wholesale Supermarkets Retailers Markets	- Transport to distribution - Lack of cooling - Outdated food - Unsold food

As in the meat supply chain, the distribution phase of the milk/dairy supply chain is characterised by relatively low levels of losses during logistics i.e. spoilage or damage in transit. Low recorded losses, however, mask significant reduction in the shelf life of all fresh Ukrainian produce and therefore increased waste at the level of retail and consumption, as a result of substandard refrigeration in transport and large distances between major markets in Ukraine.

Much higher recorded levels of waste during the distribution phase arise from produce failing to sell in retail outlets prior to its 'sell-by' date. As with horticultural products, unsold dairy products in Ukraine are returned by retailers to their suppliers. Generally dairies simply discard such returned produce.

Losses of the small amounts of milk and milk products produced and sold by cottage industries on local markets are significantly higher at the distribution stage due to primitive packaging and almost total absence of cold storage.

Supply chain step	Location	Causes of food loss/waste
5. Consumption	Households Food services	- Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

As in all agri-food sectors, relative to Western Europe and other higher income societies, Ukraine wastes less milk and dairy products. Nevertheless its relative shortage of refrigeration at the household level invariably leads to significant waste particularly of fast-spoiling dairy products. In the food services sector, more attention is likely paid to outdated produce and higher levels of plate waste generated.

The following are therefore the critical loss points under this step of the dairy supply chain to be analysed in more depth below:

- Household waste of milk and dairy products as a result of inadequate refrigeration,
- Food service waste of milk and dairy products as a result of passed 'use by' dates and plate waste.

4.3 Assessment of food losses and waste and critical loss points

This section analyses the points in the agri-food chains where food losses and waste have the highest magnitude, the highest impact on food security, and the highest effect on the economic result of the food supply chain (the Critical Loss Points). The assessment of the magnitude of food losses and waste is based on available reports and studies and key informant interviews with the representatives and stakeholders in analysed agri-food chains.

Wheat and bread products agri-food chain

Although infecting wheat prior to its full ripening, a major cause of losses of Ukrainian wheat intended for use as food, is the sunn pest or corn bug *Eurygaster integriceps*, which not only impacts the level of grain harvested but also the quality of the grain, reducing gluten levels by over 25% and rendering it usable at best for animal feed.

Research financed by leading Ukrainian grain producer and trader Nibulon illustrates the impact of the sunn pest on Ukrainian wheat production. In 2009 in the particularly susceptible areas of the southern Ukrainian steppe region, infection was on average 5%, while in 2007, a year when climatic conditions were particularly favourable to multiplication of the pest and it reached into central Ukrainian oblasts of Vynnytsya, Cherkassy and Poltava, infected grain was estimated to be as much as 50-70% of the harvest. Reflecting this, wheat exports fell nearly 80% in 2007, from nearly five million tonnes in 2006 to a mere one million tonnes. A study by the State Crop Protection Inspectorate in 2008 showed average infection rate of 4.6% across the country, with significant regional variations from 1.6% in Vynnytsya Oblast to 46% in some deliveries tested in Kirovograd Oblast.

A further critical loss point identified by all wheat value chain representatives interviewed is the inadequate supply of harvesting equipment and road transportation to ensure an efficient and timely harvest. While the larger producers have built up modern combine harvester and grain truck fleets, medium and small producers are often entirely dependent on hired rented equipment. For this reason, demand for both harvesters and trucks to transport wheat to existing storage facilities (grain elevators) peaks in the key harvest months of July-August and strains the existing supply of equipment.

The impact of the shortage of harvest equipment is twofold. Firstly it results in the continued extensive use of old and substandard harvesters which can both damage and spill considerable quantities of grain and secondly crops are often left un-harvested in the field for want of equipment, so that when they are harvested, they have already begun to deteriorate as result of climatic conditions and pests.

On large commercial farms (agro-holdings) losses at this stage account for an estimated 80% of losses between the crop ripening and its on-sale to flour millers and amount to losses of 2.5 to 5% of annual volumes of wheat harvested. On medium-sized commercial farms, losses are larger, partly because less high quality agri-inputs are used (meaning faster degradation) and less efficient harvest equipment is available (meaning greater damage and spillage) and partly because such farmers are more likely to be growing a range of crops and in years when wheat prices are low, their harvests are delayed as a result of the shortage of equipment, they may decide not to harvest their wheat crop at all, but rather plough it back into the land. For such farmers, losses are therefore estimated to fluctuate in the range 10-40%. For Ukraine as a whole, a representative of a leading Ukrainian producer put the level of grain losses during the harvest campaign at nearly 20%.

The 20% of overall wheat produced by smallholder farmers is less subject to the high fluctuations of the medium-sized farmer, since although smallholders are perhaps most exposed to the risks posed by poor quality inputs and harvest machinery, their extremely low planted areas of wheat (often less than 1 hectare) and their use of their wheat crop primarily as animal feed for their own livestock, mean both that in all but the most extreme climatic and market conditions it is harvested and also that as a feed crop, losses are not of great relevance for the purposes of this study.

If 80% of losses by larger commercial farms are made as a result of absence of machinery at harvest, the remaining 20% (or only some 1% of the crop) are estimated to result from transport losses as well as spoilage and pilferage while in often dated storage facilities prior to export or milling. Representatives of commercial farmers and flour millers argue that even in old Soviet flour mills losses are minimal. Again, however, losses by medium sized farmers in the post-harvest handling phase are higher, given higher rejection rates on grounds of quality by independent flour mills with whom they are less likely to have firm supply agreements in advance. Transportation and storage losses in Ukraine for grain were put at nearly 8.5% by a representative of a leading grain producer.

Factors causing such losses at the post-harvest handling phase of the wheat chain include outdated and insufficient truck fleet and elevator capacity, for the most part dating back to the Soviet era. Outdated and insufficient infrastructure is also a loss factor for wheat destined for export as both rail networks, rail trucks and port infrastructure (particularly storage facilities) are insufficient for the increasing demands made by growing grain exports. While some actors, such as Nibulon have made significant investments in elevators, river barges and export terminals of their own, the state rail and

main port infrastructure in Odesa and Yuzhnyi remain antiquated and restricted in their expansion potential.

Similar issues confront Ukraine's milling and baking facilities, which while now privatised are often operating 20-30 year old machinery. Industry operators estimated that 50% of current facilities still require upgrades to technology, processes and staff qualifications. Losses therefore occur as a result of mechanical failure and human error, particularly in control of mixing proportions and baking temperature and timing. Bakeries interviewed stated that only some 2-3% of flour supplied is rejected on quality grounds (excessive moisture and low gluten levels) and that even poor quality flour, referred to as 'pancake flour' can be used in the production of ravioli (*varenniki*), pancakes and other products and so may not be lost to human consumption.

Interviews with bread retailers suggested low levels of losses in distribution, with bread being delivered to retail outlets several times a day at regular times, allowing outlets to regulate their receipt and prevent overstocking. Further they stated that bread not sold by retail outlets is taken back by bakeries and for the most part reprocessed into dry bread products for further use. As in other countries, consumer preference for bread 'fresh from the oven' is leading retailers to produce more on their own premises, which can be better controlled to respond to actual purchasing thus reducing waste. In such cases a write-off rate of 4 to 6% is applied.

Discussions with bakeries, however, revealed that up to 10% of bread supplied to larger retailers is returned as a result of over-ordering in order to have a large amount on display for consumers, with smaller outlets returning very little by comparison. They further pointed out that such returned bread can only be used for production of breadcrumbs, the cost of production of which makes it unprofitable, so that returns are generally passed on for use as animal feed.

At the consumption phase of the wheat-bread food chain, although it is taboo to throw bread away given its importance in the social culture of Ukraine, discussions with consumers revealed an estimated 5-15% discard rate (some fed to animals, domestic or wild) due to over-purchase. It is further considered that the state support to production of cheap bread also acts to support over-purchase even by poorer segments of the population.

Potato agri-food chain

Identification of critical loss points in the potato food chain requires an initial distinction between the food chains for new and old potatoes. New potatoes, which account for some 20% of overall production in Ukraine are harvested from May and throughout the summer months by hand and therefore see little damage and losses during the harvest process.

There is high demand for new potatoes from retail chains, so that a relatively higher proportion of products enter this higher technology chain, in which produce is washed by the producer, cooled, packaged (in plastic crates for loose sale and increasingly also in small plastic bags) and forwarded within three days to retailers. Thus, the relatively higher value of and demand for this product coupled with its short shelf-life mean that it is handled with care using modern technologies and that relatively few losses occur.

The vast majority of losses occur in the food chain for old (autumn harvest) potatoes primarily as a result of primitive harvesting and storage technologies. This food chain is characterised by three

distinct sub-chains depending on the scale of production and technology available to producers, wholesaler distributors and retailers.

The first two sub-chains are initiated on larger commercial farms (with over 50 hectares in production), of which it is estimated that there are approximately 50 in Ukraine. While the largest of these, such as *Mriya* in Ternopyl Oblast, may harvest over 2,000 hectares of potatoes, on average commercial potato producers work between 600 and 1,000 hectares of potatoes. On these farms harvests are either fully mechanized (using combines) or partially mechanized, with machines unearthing the crop and people following on foot to collect the harvest. Both forms of harvest result in relatively high levels of mechanical damage, which, when combined with losses to pests (primarily beetles and rats) after ripening, results in an estimated 20% loss in the pre-harvest and harvest periods and subsequent hand sorting process. Losses can be much higher, particularly when air temperatures at the time of harvest are high, leading to almost instant spoiling after unearthing and during transportation. In such circumstances farmers often resort to harvesting at night.

Given extreme drops in prices during the harvest season, most potatoes go into long-term storage immediately after harvest and preliminary sorting. It is in the level of technology of storage facilities that the main distinction between commercial producers is found, with only 30% of commercial cold storage facilities considered 'adequate' by industry experts in terms of availability of temperature and ventilation control technology. The remainder for the most part uses Soviet era facilities, which either never had temperature and ventilation control or the equipment for such controls is long defunct. The losses of potatoes stored in low-technology facilities is estimated at a further 20%, while that in more modern refrigeration is between 5 and 10 per cent, primarily as a result of natural drying of the product.

Packaging of fresh (or stored) potatoes is also minimal with the overwhelming majority of potatoes passing from storage containers to large 40 kilogram mesh sacks and direct through regional and local markets to consumers. Indeed only 10-15% of the harvest is sold through supermarkets and even there Ukrainian potatoes both new and old are for the most part sold loose, with small mesh or plastic bags only beginning to emerge as a packaging option. An additional 5% of potatoes that survive harvest and storage are estimated to be lost in the process of either processing or packaging and an additional 5% during distribution, primarily due to crush losses during transportation and handling of the heavy sacks.

In the retail phases of the commercial potato chain, rejection of product by retailers is estimated at 5-10% and retailer write off rates for horticultural produce are 3-6% in storage (with temperatures maintained at 6-8 degrees centigrade and 6-12% on shelves (where temperatures average 18 degrees centigrade depending on the season (i.e. outside temperature), with losses in potatoes likely to be at the lower end of these ranges (e.g. 1-2% rejection, 0-1% in storage and 1-4% on shelves), due to their slow deterioration relative to other fruits and vegetables.

As noted in previous sections, smallholders (households) dominate potato production in Ukraine, consistently accounting for over 90% of the harvest. The smallholder chain is estimated to make fewer losses (approximately 10%) during the harvest than their larger commercial counterparts given their smaller plots, hand-harvesting practises and interest in minimizing losses of own product. After initial sorting, potatoes are then stored primarily in cellars 2-5 metres underneath rural dwellings for the winter. To a lesser (and falling extent) potatoes are also stored in sack-loads for the

winter by city dwellers on covered apartment balconies and other cool, dark places. Losses primarily to rot in such primitive storage are estimated at 20-30%.

Household producers interviewed admitted that likely only 30% of their potatoes were consumed by humans (some by the producers themselves, some by extended family members and some sold on local markets), the remainder being relegated to animal feed, used as fertilizer or simply thrown away during post-harvest sorting, storage or in spring when new potatoes become available. And such levels of loss are further exacerbated by bumper harvests such as that of 2011, where production gluts, absence of storage capacity or export markets and subsequent price falls to levels below production costs, meant that up to 30% of the crop was simply left in the ground.

Consumption practises in Ukraine are such that almost all potatoes consumed, both new and old and whether they have gone through the commercial-retail chains or the smallholder consumer chain are subject to peeling before cooking and consumption. During peeling, especially when one is removing not only the skin, but also blemishes deeper into the product, particularly in the spring (March to May) period when produce has been in storage for over six months, a further 5-20% of edible or once edible potato matter can be wasted.

Apple agri-food chain

The apple agri-food chain has many similar characteristics to the potato chain, also being dominated by smallholder producers (accounting for 75% of apples produced), while commercial producers remain dichotomized in their access or lack of access to controlled temperature and ventilation storage technologies.

Unlike potatoes, apples are for the most part harvested in Ukraine by hand, which results in initial (harvest and sorting) losses at a level of some 10% of the commercial crop, including windfall losses as well as bird and other pest damage to the post-ripened fruit. With 30% of current Ukrainian storage capacity featuring controlled temperature and ventilation, with low levels of apple sorting technology (only one facility in Ukraine uses water floating) and given the higher perishability of apples, losses during storage and handling are considerably higher than those for potatoes.

Losses during winter storage are estimated by industry experts as in the range 10-20% for commercial produce stored in temperature/ventilation controlled facilities and as much as 30-40% for commercial produce stored using more primitive technologies. This compares to an anticipated loss rate of 5-10% for similar storage periods when controlled atmosphere refrigeration technology is utilized. Those with controlled storage aim to keep their stores closed until February, when prices are highest, while those without adequate refrigeration are forced to start selling from December as their produce begins to decline in quality.

Industry expert estimations range from 20-25% for the level of fresh commercially produced apples destined for Ukrainian retail chains, as against 75-80% being sold into Ukraine's wholesale/retail market networks. Produce sold to retail chains is almost exclusively stored in 500 kilogram wooden crates, then sorted and transported in reusable plastic containers (although a small amount are now bagged) and are likely to be transported by refrigerated truck, which results in relatively low levels of losses in distribution (estimated at 5%). Produce sold into markets, however, are subjected to packaging and transportation in reused banana boxes without refrigeration and a further 10-20% may thereby be lost to crushing, bruising and accelerated deterioration.

Rejection and loss levels at the level of retail distributors are higher than those for potato, likely mid-way in the average horticultural retail write-off ranges of 5-10% rejection by retailer, 3-6% in storage and 6-12% on shelves, with some seasonal fluctuation and lighter coloured varieties more prone to visible blemishes and therefore subject to higher loss levels through rejection by both retailer and consumer. Ukrainian apples reaching the growing supermarket and retail shop segment are subject to major competition from imported apples (according to retail sources as much of 95% of apples sold through supermarkets are imported), which are almost always in better condition (skin treated etc.) and better packaged.

Apple consumption by non-producers is estimated to be in the range 5-10%, due primarily to spoilage in the home. While Ukrainians, unlike more western people, tend to consume almost an entire apple, when eating it raw, consumer losses could be reduced through increasing levels of refrigeration of apples in the home and reducing the practise of cutting apples for display on the table, which results in spoil if not eaten at a single sitting.

Ukrainian apple processors interviewed, stated that some 5-7% of apples supplied are rejected for quality reasons and are thereafter likely used either for animal feed or discarded. Such losses arise as a result of poor quality inputs used by large numbers of uncoordinated smallholder suppliers. The main critical loss point, however, identified in the processing sub-chain, however, centres around outdated juice-making technologies, human error and power outages. In smaller processing facilities still using Soviet era technology approximately 10% of consumable produce is discarded as a result of spoilage during processing as a result of technical failure or mistakes made by workers. This can rise to 15% if power outages stop processes for over two hours, meaning that a whole batch can be spoiled. Once products have been processed and packed, losses fall off, with less than 1% of produce returned by distributors as a result of quality short-comings or shelf-life expiry.

In terms of smallholder apple production losses during harvesting are again likely to be less than those by commercial farmers, because of the relatively small number of apple trees and greater care taken in harvest and handling by owner-consumers. Harvest losses by household producers are therefore estimated at only 5%. Further, losses between storage (as for potatoes, in underground cellars) and consumption are estimated by industry experts to be on a par with those of commercial stores not using temperature and ventilation controls, i.e. 30-40%, but household producers state that up to 60% of the crop is lost, given to animals or discarded, despite some collection of apples by local commercial processors and cottage industry use of some produce for purees, compotes and juices.

Pork meat agri-food chain

The pork meat agri-food chain is also characterized by a predominance (albeit smaller) of production and household consumption by smallholder farmers (60% of production). Its commercial producers, an estimated 20 large farms hold between 15,000 and 100,000 head, can also be clearly divided between those employing new production technologies and practises (60%) and those still working with old Soviet era technologies and practises (40%).

The agricultural production stage of the pork supply chain is characterised by a cycle of 12-14 months from the birth of a litter to animals reaching 100-120 kilograms in live-weight and their slaughter. The cycle can be broken down into three phases, each analysed in terms of its critical loss points.

The first phase, birthing, includes the first ten days after birth, when piglets remain with their mother and are fed by her. Losses to mortality range from 5% modern farms to 7-10% on those with poorer temperature controls and unsanitary conditions.

The second phase, weaning, is between 10 and 30 days, when piglets are transferred from milk and the quality in terms of composition, consistency and nutrition of feed is critical at this stage. Commercial producers employing modern feed regimes experience losses to mortality of some 4% during this period, while one farms using outdated practises this can be 8-9% or higher. In addition losses due to poor growth as a result of damage to animals (mechanical, broken legs, goring) begin to manifest themselves in reduced weight gain. On average 1% is estimated to be lost through animal damage during the weaning phase.

The final phase, fattening, is between 1 month and 12-14 months and given the resilience of animals of this age, losses fall to only 1%, although this level would again be higher on farms employing poor feed regimes and outdated feeding technologies, if losses were calculated to include their lower rates of weight gain compared to those on farms employing good feed regimes. Weight gain losses resulting from damage to animals average 3% during the fattening phase.

In addition to the question of breed genetics, key factors driving such losses during the pork agricultural production cycle include the following:

- i) Poor maintenance, meaning absence of temperature control, unsanitary conditions and poor control of medicine and antibiotics application;
- ii) Poor feed, particularly for piglets, usually a result of absence of adequate feed production capacity and reliance on purchasing feed on volatile markets;
- iii) Poor quality of personnel, as reflected in their inability to respond to the maintenance and feed requirements of the livestock.

One commercial farm interviewed provided a compelling example of how losses can be reduced through addressing these three factors. The farm made a major investment in upgrading its facilities and practises between 2004 and 2012 and witnessed a drop in production losses from 20% to 13% over the same period.

The post-harvest handling phase of the pork supply chain results in an estimated 4% losses during transportation, over an average of 50-100 kilometres between farms and slaughterhouses. This estimate is based on the 'normative' loss rate of 3% established by the old Soviet system, increased slightly to reflect increased deaths as a result of decreasing road quality and decrepit truck fleet, although the bulk of losses during this process are in weight-loss as animals are not fed during transportation.

Losses during the slaughter process depend on factors ranging from the breed (with some producing more carcass weight relative to live-weight) to the employment of bleeding prior to slaughter, to whether if bled, blood is reused in sausage production and likewise whether innards and hooves are used or discarded with sewerage. Losses through disposal of blood, innards, hooves and head, which can be processed further for human consumption are in the range 13-16%. Post-slaughter carcasses are hung for 24 hours, during which time it loses some 1.5-2.5% of their weight through liquid losses dripping.

Losses in the slaughter process by smaller slaughterhouses were estimated at a higher 20-25% level, again primarily through the process of removing heads, hooves, innards and blood. But such slaughterhouses estimated that overall losses were reduced to levels similar to those of the larger slaughterhouses as they were able to sell a proportion of the excess body parts to the local population for food uses.

The processing and packaging phase of the pork supply chain includes both the butchery of porcine carcasses and the processing per se of meat and animal parts into pork products. The first step is the trimming of skin (used for sausages) and *salo* (under-skin fat, a delicacy in its own right in Ukraine), followed by the removal of bones (which can be processed into flour and used in animal feed). Skilled butchers will lose only 0.2% of edible meat during this process, after which meat is hung at two degrees centigrade for a further day during which it may lose a further 1% of its weight through liquid dripping.

The distribution phase of the pork supply chain for pork destined for retail outlets is swift, given regulations limiting shelf life to five days after slaughter. Storage prior to sale, primarily in supermarkets and meat outlets therefore averages three to four days. While vacuum packing of fresh meat can extend its shelf-life to 10 days, it is used minimally in Ukraine given its perceived cost. While transportation of pork to retail outlets results in approximately 1-1.5% losses, levels of waste of pork at the level of shops and supermarkets are harder to estimate, given shelf-life extension practises such as blending fresh meat with spices to be sold as mince or marinade, using meat that has used its sell-by date in *pelmeni* (meat dumplings) or sausages, cooking meat that has reached its sell-by date for sale hot or cold (and in salads) and simply selling fresh meat after its sell-by date. It is even credibly rumoured that there is an active market for 'old' meat, which is then cooked and made 'good'.

Such practises result from the fact that losses of waste meat, unlike losses of fresh horticultural products, are not passed back to their suppliers through the return of unsold produce, but carried by the retailer itself. Retailers reduce losses by buying only a few days in advance of anticipated sales. Ukrainian food retailers, like their counterparts in some other countries, are notoriously sensitive to photography (particularly documentary film-making) on their premises.

Only an estimated 30% of fresh pork meat is currently sold through supermarkets, however, and even medium-sized producers are put off by delayed payment regimes and the need to provide transport if dealing with supermarkets, preferring to sell to traders and on to local markets. Such meat supply is subject to substandard refrigeration, packaging and sanitation in both transportation and storage at local markets. Fresh meat sold by smallholder producers, who have slaughtered the animals themselves is even more at risk as it is stored without refrigeration prior to collection by traders. Nevertheless, as with meat destined for supermarkets only 5-10% is estimated by industry experts as lost to human consumption (discarded or fed to dogs) in the distribution phase as even meat rejected by market inspectors can find use in sausages or ravioli (*pelmeni*).

Interviews with smallholder (household) pig producers resulted in professions of zero loss or waste, almost a reverse on their open admission of extensive losses and waste of potatoes and apples. Industry experts agree that losses in production (at the farm level) would be minimal compared to those on commercial farms, given the care shown to 'own' animals by households, with the exception of their ability to respond promptly and successfully to disease. As a result, if modern commercial farm losses are 13% and those employing poor or outdated practises 20%, it is likely that

smallholder farmer losses are in the range 5-10%, as a result of mortality rates in the birthing and weaning phases and disease at any stage.

Smallholder producers traditionally slaughter pigs three times a year, particularly for the major holidays of Christmas and Easter. In terms of slaughter and butchery an estimated 3-8% of edible meat is lost to human consumption, through trimming and deboning. The major losses in the commercial slaughter and butchery processes, i.e. non-meat body parts, are not discarded by smallholder butchers, offal is consumed, blood is used for *krovyanka* (blood sausage), the intestines are boiled in the animal's stomach to produce *saltsison*, the head and hooves are used for *kholodets* (jellied meat) the skin is left on the *salo* for human consumption. Sausages are also produced and bones and other inedible matter fed to dogs.

Traditional storage of pork meat is in sealed five litre jars in cellars, where it can be kept for months without spoiling. Fridges are now widespread even in remote rural areas and while larger chest freezers allow for the storage of large quantities of unconserved meat, more often meat is conserved in jars, which once opened are kept in fridges. An estimated 5-10% of meat and meat products are estimated to be lost in the conservation and storage process, primarily due to breakage of jars or poor sealing, uncontrolled temperature rises and vermin.

While processed meat is subject to additional losses resulting from technological failure and human error during processing (estimated in the range 10-15%), processed products enjoy a longer shelf life than fresh meat and their levels of waste during the distribution phase are therefore considered to be lower.

In terms of waste at the household level, even urban consumers practise freezing of fresh meat for use on an as-needed basis and are able to smell whether meat is edible irrespective of its formal 'use by' date. In addition, Ukrainian cuisine includes recipes including soups and dumplings, where meat can be used even if not entirely fresh. While such features inevitably result in less waste than in higher income countries, the growing urban middle class and increasing market penetration of supermarkets and continued use of local markets which have no 'shelf' refrigeration capacity, invariably leads to overbuying and reduced shelf life and waste, estimated at 5% of pork and pork products sold.

Milk and dairy products agri-food chain

The agricultural production stage of the milk and dairy food chain can be divided between four groups of producer. First are the rural households, which hold one or two cows, and account for an impressive 70-80% of milk produced. Such milk is of relatively low quality due to poor genetics, feeding regimes, medication and antibiotic use and milking/pre-cooling processes and the proportion of overall Ukrainian milk supply produced by households is gradually falling as larger dairy farms develop. Secondly are the dairy cooperatives, which unite 5-50 household producers in milk collection and provision of other services. While the proportion of production accounted for by cooperatives is insignificant at present, support to their development by the Government of Ukraine as well as leading dairies, such as Danone and Milkiland, will likely result in an increase in their role over time.

The third group of producers are medium-sized dairy farms, usually using former Soviet state and collective farm premises and therefore relatively outdated technology and practises. These account for some 20-25% of milk production. And finally some five large modern dairy farms have been

established since independence in 1991. These are linked through ownership or long-term supply contract to the major dairies in Ukraine and between them account for some 5-10% of overall milk production in the country.

A key feature of dairy production in Ukraine is the wide fluctuations between levels of milk production in summer and winter. Levels of milk produced by households can rise and fall by 30% between summer and winter, while on larger more farms the fluctuation is in the range 5-15%. Given the overall shortage of supply, however, such fluctuations do not lead to milk wastage due to over-supply during the summer months. Indeed, it is during the summer months when the increased supply and higher spoilage rates as a result of higher temperatures lead to increased proportions of milk being sold to dairies. Independent dairy cooperatives stated that during the summer months 70% of their produce was sold to dairies as against 30% through local markets or direct to clients, while during the winter months these proportions reversed.

Sector experts including small and commercial producers, dairies and cheese processors estimate a 25-35% loss during the production stage of the milk supply chain, as a result of limited use of milk substitutes for calves and therefore delayed weaning, sickness, maintenance and feed regimes and poor sanitation, primitive milking technologies and refrigeration prior to collection by dairies. And while the smaller farmers are more subject to losses at the stage of milking, the larger farms are worse hit by maintenance issues such as leg and hoof damage and mastitis.

Large dairies estimate that 70-80% of milk produced in Ukraine is purchased by dairies, the remainder primarily being consumed by household producers either fresh or after processing by cottage industry. Only a small amount of milk not purchased by dairies finds its way onto local markets. Dairies either collect milk themselves, with industry leader Danone using its own truck fleet to collect approximately 50% of its supply, or through middlemen who either buy and sell milk or provide transport services to the dairies, using truck fleets with generally obsolete cooling capacity and sanitation.

Despite this and again given the shortage of supply generally, dairies are forced to accept substandard milk, which may have low levels of fat and protein, may soured or have high levels of antibiotics. Experts estimate that less than 1% of milk arriving at a dairy is rejected. Rather dairies use substandard milk for milk products based on sour milk such as *kefir* (fermented milk), *smetana* (sour cream) and yoghurts.

Ukrainian dairies can be divided between approximately 10 large companies, which accounting for 60-65% of dairy output and some 200 medium to small processing facilities. Critical loss points inside dairies include technology failure, often as a result of outdated equipment and refrigeration capacity, which can result in entire batches of produce being lost. Losses to such technology failure are lower for milk and butter (1%) given simpler processes involved and relatively higher for sour milk products (5%), allowing an estimated average of 3% losses to machinery breakdowns etc. It is worth noting that losses of processed milk result in proportionally higher losses of raw milk. As 7 litres of milk are used to produce one kilogram of sour cream, 10 litres of milk are used to produce one kilogram of cottage cheese and 20 litres of milk to produce one kilogram of hard cheese, the loss of one kilogram of such products equates to much higher losses of milk.

Perhaps more significant than losses as a result of mechanical failure in dairies are those resulting from overcapacity, particularly of the larger dairies. An example of such losses is the introduction of

a new product, for which demand will only grow slowly, but for which a dairy is forced to use a large, six tonne, milk tank. Insufficient marketing of new products and failure to reduce prices to increase sales act to exacerbate related losses. Experts estimate that some 10-13% of milk is lost overall in milk and milk products (excluding cheese) processing facilities.

Cheese accounts for some 50% of processed dairy products in Ukraine by volume and production is dominated by five large specialized cheese producers, for the most part modernized facilities first established during the Soviet era. Cheese is generally produced during the summer months, when milk output is high and then stored for sale through the rest of the year.

Cheese production is a more complex process and is more input intensive, meaning that mechanical failures or mistakes by personnel are likely more common and losses, particularly when translated into raw milk equivalent are much higher than in dairies focused on milk and sour milk products. Losses in cheese processing facilities are therefore estimated to fall within the range 10-20%, with fluctuations depending on export market availability and process errors and failures.

While household processing of milk and milk products is proportionally smaller than that by commercial dairies and they are able to regulate their supply by selling any excess milk to dairies, primitive technology, lack of sanitation and lack of refrigeration result in estimated losses in the range 15-35%.

As in the meat supply chain, the distribution phase of the milk/dairy supply chain is characterised by relatively low levels of losses during logistics (estimated at up to 1%), i.e. spoilage or damage in transit. Given the size of Ukraine, the long distances, the poor road conditions (it can take three days to transport produce between Ukraine's two main population centres of Kyiv and Donetsk) and the predominance of aged European trucks whose refrigeration capacity is reduced and falling, one would expect losses at this stage to be higher. Low recorded losses mask significant reduction in the shelf life of all fresh Ukrainian produce and therefore increased waste at the level of retail and consumption.

Much higher recorded levels of waste during the distribution phase arise from produce failing to sell in retail outlets prior to its 'sell-by' date. Such losses are estimated at between 2% and 10% industry wide, with most dairies falling into the 5-7% bracket and clearly dairies using modern technology and processes falling at the lower end of this scale. As with horticultural products, unsold dairy products in Ukraine are returned by retailers to their suppliers. Generally dairies simply discard such returned produce, although, as with meat there is likely a secondary market supplied by less scrupulous dairies.

Losses of milk and milk products produced and sold by cottage industries on local markets are significantly higher (an estimated 10-20% of produce is lost) at the distribution stage due to primitive packaging and almost total absence of cold storage.

As is other commodity groupings, waste at the consumption phase has reduced from an estimated 10-15% prior to the 2008 onset of the financial crisis to an estimated 5%, as consumers reduce their purchase volumes of dairy produce and consume more of what they purchase. Losses at this stage are primarily of milk rather than milk products, given its relatively shorter storage period.

Nevertheless, the consumer practise of cutting excessive amounts of cheese (as with pork sausage and apples) for on-table display, results in waste through spoilage of produce that is not consumed at the first or second sitting. Food services account for an estimated 10-15 of all dairy sales in

Ukraine, but tend to purchase long-life (UHT) milk, which acts significantly to reduce their waste levels relative to households, which tend to purchase more fresh milk.

4.5 Summary assessment and weight percentages of food losses and waste

This section provides a summary assessment of overall losses and waste in the priority food chains, by stage of the food chain, according to the estimated weight percentages analysed in depth in the preceding section and summarized in the following table.

Weight percentages of food losses and waste (% of what enters each step)

Commodity Grouping (product)	Producer Category	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals (wheat)	Large Producer	2.5-5%	0.5-1.25%	5-10%	4-10%	5-15%
	Medium Producer	10-40%	5-10%			
Roots & Tubers (potato)	Modern Producer	20%	5-10%	2-5%	2-7%	5-10%
	Former Collective	20%	20%	5%	5-10%	10-15%
	Smallholder	10%	20-30%	5%	5-10%	10-20%
Fruits & Vegetables (apple)	Modern Producer	10%	10-20%	5%	5%	5-10%
	Former Collective	10%	30-40%	5%	10-20%	5-10%
	Smallholder	5-10%	30-40%	5%	10-20%	5-10%
	Processed fruit			15-22	1-5%	5%
Meat (pork)	Modern Producer	10-15%	15-22%	1-5%	5-10%	5%
	Former Collective	20-25%	15-22%	1-5%	5-15%	5%
	Smallholder	5-10%	0-5%	5-15%	10-20%	5%
	Processed meat			10-15%	2-5%	2-5%
Milk	Milk/yoghurt	10-30%	see previous / next column	3-15%	8-11%	5-10%
	Cheese	15-35%		10-20%	5-10%	5-10%
	Home processing	15-35%		15-30%	10-20%	10-15%

Agricultural production

For all but the most perishable commodity groups analysed and those that are subject to extended periods of storage (apples and potatoes), the agricultural production phase of the supply chain witnesses the greatest losses of all supply chain phases. This is the case for cereals (specifically wheat), meat (pork) and milk and dairy products.

Losses in the agricultural production phase of the supply chain range from losses of 2.5-5% of the ripened crop for large commercial wheat producers employing modern crop and harvest technology to losses as high as 25% of potential live-weight for commercial pig farmers using outdated technology and poor livestock maintenance practises. Small milk producers are also estimated to lose or waste up to 35% of their potential sales as a result of poor weaning and maintenance practises, spillage and spoilage between milking and collection.

Between these extremes, losses of apples and potatoes in the agricultural production phase are generally in the range of 10-20% of the ripened crop and are accountable primarily to post-ripening blight or pest, damage caused by mechanical harvesting and high temperatures and absence of cold storage and transport capacity. These losses are for the most part identified and rejected during the

post-harvest sorting process and while apples rejected from the fresh market may be forwarded for use in juice production, potatoes will be lost to human consumption, being for the most part used as animal feed.

Post-harvest handling and storage

The post-harvest handling and particularly storage phase of the food chains results in the highest losses for fruits vegetables, roots and tubers that are subject to long-term storage for use through the winter months (represented by apples and potatoes for the purposes of this study). Losses of such products is estimated in the range of 5-40%, with relatively few losses of the low levels of fruit and vegetables that are handled with modern equipment and enter temperature and ventilation controlled stores, but with extremely high levels of loss for the bulk of produce that is either stored in underground cellars by household producer/consumers or that is stored in outdated commercial facilities whose temperature and ventilation regimes are obsolete or non-existent.

The lowest levels of losses at the post-harvest handling and storage stage of the supply chain are experienced by the vast commercial cereals producers (less than 1%), who often control their own modern grain elevators. Higher levels of loss are estimated for medium-sized commercial cereal producers (5-10%), given their higher rejection rates of poorer quality grain by storage facilities and processors not owned by the producers themselves.

Relatively high losses are recorded at this stage in the pork supply chain, primarily as a result of the practise of blood sewerage and organ discard by commercial producers, products that are consumed by smallholder producers and could be processed into sausage and other pork products. Losses in the milk and dairy product supply chain in the post-harvest handling and storage stage are included in either the preceding agricultural production stage (milking and collection) or subsequent processing and packaging stage (milk treatment or processing into dairy products).

Processing and packaging

The processing and packaging stage of the food chains for the priority Ukrainian products analysed shows the lowest levels of losses among all stages of the respective food chains. This ranges from as low as 1-5% for commercial fresh pork meat producers, for whom even butchery facilities using relatively outdated technology and processes result in relatively low levels of losses of consumable product. Relatively higher levels of losses are experience by apple and potato producers producing for the fresh markets, estimated at around 5%, which result from substandard packaging processes and product damage.

Where processing takes places, losses are higher. A conservative estimate of losses in the flour milling and baking industry is 5-10% of grain delivered to mills. More pronounced are losses of dairy products during this stage, estimated at in the range of 3-15% for milk and yoghurt products and 10-15% for cheese, either as a result of process line failure leading to rejection of product batches or to overproduction of new products, particularly by larger dairies that lack the capacity to increase production of new products slowly as demand grows. Losses to household milk processors may rise to 35%.

Pork salami, sausage and cured/baked meat producers are estimated to lose 10-15% of meat supplied and apple processors interviewed estimated losses in the range 15-22%, each comprising rejection of supply on quality grounds and human and mechanical fault during processing.

Household pork producers are also estimated to lose 5-15% of edible pork products primarily as a result of primitive preservation procedures, packaging in five litre jars and a shortage of cold storage (continued use of cellar stores).

Further, the low levels of losses estimated by sector experts for this stage of the food supply chain, particularly in relation to fresh products, mask increased losses to shelf life and to waste at subsequent retail and consumption stages, which result in low levels of use of modern packaging, storage and transportation technologies.

Distribution

Losses and waste at the distribution stage of the priority food chains are estimated to be lowest for the currently relatively small quantities of potatoes and apples that are subject to proper cold storage and sold through retail chains (2-7% losses at this stage). The bulk of potatoes that survive storage are subject to a higher (5-10%) loss rate due to crush damage as a result of packaging in 40 kilogram sacks and product perishing and rejection by buyers due to lack of cold storage in Ukraine's wholesale/retail market chain. Apples, being both more easily damaged as a result of poor packaging and more perishable suffer higher distribution losses (estimated in the range 10-20%).

Losses of wheat flour, bread and other flour products are estimated to be in the relatively low 4-10% range during the distribution stage, as a result of established and controlled distribution networks, twice daily deliveries by bakeries to retailers (allowing retailers to regulate orders) and the system of bakeries taking back unsold fresh bread products for reprocessing into dried food products.

Fresh and processed pork products, which are estimated to be subject to 5-10% loss rates during distribution may be considered to be relatively low, particularly for fresh meat given its short shelf life, the absence of vacuum packaging and long delivery distances and the fact that retailers cannot return unsold product to producers. It is considered that larger levels of pork should actually be written off by retailers, but are either spiced, processed or cooked and sold. Indeed, loss rates, in the range of 10-20% are conservatively estimated for the meat supplied by medium and small producers' pork that reaches local/farmers markets via traders, given extremely low levels of cold storage and sanitation.

For milk and dairy products loss rates during the distribution stage for milk distributed through supermarkets of 8-11% primarily reflecting unsold produce that is returned by retailers to dairies and discarded by the latter and while waste of cheese is lower (5-10%) given its longer shelf life and durability, waste in the range 10-20% is anticipated for milk and home processed produce sold by smallholders through local markets, given an absence of refrigeration and sanitation in this section of the sub-chain.

Consumption

At the consumption stage of the priority food chains analysed for Ukraine, again wheat flour products (primarily bread) are considered wasted (in the range 5-15%) despite a cultural taboo on bread waste. Pork and pork products, also parts of the traditional Ukrainian diet, are subject to low (estimated 5%) levels of consumer waste as a result of storage and use patterns and a range of dishes allowing conservation.

Dairy products (particularly fresh milk) and apples are considered subject to higher levels of household waste, the former due to short use-by terms, the latter because of low levels of refrigerated storage in the home and, as with bread and pork sausage, the practise of cutting of excessive quantities of apples for table display.

The highest levels of household waste are those of fresh winter potatoes, which due to peeling and removal of blemishes caused by substandard storage through the winter range from 5-10% for produce subject to temperature and ventilation controlled storage and distribution; to 10-15% for produce sold through Ukrainian wholesale/retail markets; to 10-20% for potatoes stored by smallholder producers in cellars, who continue to feed deteriorating produce to livestock and often discard large quantities with the arrival of the new potato crop in spring.

5. KEY FACTORS FOR FOOD LOSSES & WASTE

Key factors impacting the magnitude of losses and waste in the five priority agri-food chains identified for Ukraine are analysed below, by category of factor.

5.1 Resources and technologies

As noted in the afore-going section, the bulk of losses in the priority agri-food chains are evidenced at the agricultural production and post-harvest handling and storage stages of the chains. These result in large part from an insufficient supply of modern harvest, post-harvest and storage machinery and equipment.

In the grain sector, this applies to the combine and grain truck fleets, as well as to grain elevators, for which outdated and substandard technology continues to be used as a result of the shortage of supply of more efficient machinery and facilities. Industry leaders stated that although the number has fallen considerably in recent years, Soviet era combine harvesters that can lose up to 30% of a standing crop are still in use in Ukraine. Overall industry representatives complained of a 25% shortage of combines leading to overworking of the existing fleet and slow northward progress of the harvest from earlier harvest regions in the south of the country. Research conducted by the Ukrainian Academy of Agrarian Sciences shows that loss rates through delays to harvest can rise to 30% of wheat harvests, if crops are left standing between 17-20 days in the field.

The most significant pre-harvest loss factor in terms of both quantity and quality of wheat was identified as the Sunn bug *Eurygaster Integriceps*, whose numbers vary enormously from year to year and a significant attack may occur about once in every seven years, potentially causing yield losses estimated at 50–90% of wheat harvests. While feeding, this pest injects enzymes into wheat causing breakdown of gluten which reduces the quality of the flour resulting in the production of inferior dough. The impact on potential food grain exports, as illustrated by a representative of the Ukrainian Grain Association is that Ukrainian wheat can have up to 22% infection, while key import markets such as Egypt allow a maximum of 1%, leading to entire shipments being relegated to feed or waste.

The insufficient supply of modern harvest, post-harvest and storage machinery and equipment is particularly pronounced in fruit and vegetable (including potato) harvest, sorting and storage technologies and capacity and the availability of modern holding facilities on commercial livestock (meat and dairy) farms.

Further, markets do exist for Ukrainian potatoes and apples, if they can be properly stored. Indeed, retail outlets complain that during the March-May period they are forced to import large amounts of potato, particularly from Egypt, when prices in Ukraine start to rise as a result of lack of decent eating potato and before the first young potato harvests in May. Representatives of leading Ukrainian supermarkets complain that after the New Year there are only five Ukrainian suppliers able to offer quality potato. Supermarket apple sales are even more dominated by imported produce (one retail source suggested that 95% of apples sold by Ukrainian supermarkets are imported) due to the poor quality of mechanically harvested and non-refrigerated local produce.

The absence of adequate cold storage capacity impacts not only the fresh horticultural agri-food chains of apple and potato, but also results in one of the larger loss points in the pork chain, in that

installation of freezer capacity at slaughterhouses would allow storage of blood, organs and other by-products that can be used for processed pork products, thus reducing the substantial dressing percentages currently wasted. The dairy sector also suffers from a lack of investment in modern technology on large modern farms, in improved sanitary regimes and equipment at dairies, in upgraded refrigerated transportation and higher levels of refrigeration at retail outlets.

Exacerbating this absence of investment in technological upgrades are the overall investment climate and difficulty of doing business in Ukraine, compounded by discouragingly high rates of interest (over 20% per annum) charged by commercial lenders to commercial value chain actors and the prohibitively high levels (up to 50% per annum) charged by commercial lenders and credit unions to small producers and SME actors and market entrants.

5.2 Management, marketing, product development

Management, marketing and product development were also emphasized by key informants interviewed, who pointed out poorly qualified management and labour responsibility for major losses, particularly in (on-farm) livestock production, through poor and outdated maintenance and feed regimes.

With the exception of a very few industry leaders in each agri-food chain, an absence of good management processes, which impacts labour practises generally, is apparent throughout the cold chains through which fresh horticultural, meat and dairy products pass as well as in the wheat-flour-bread chain, where staff turnover, pilfering and unsanitary practises result in increased levels of losses right up to the level of retail and the 'fast profit' approach to business management encourages a 'don't care' attitude among workers.

Investment in management training and subsequently staff training by newly trained management is therefore required as part of any drive to reduce losses and human resources and staff motivation policies as well as work-flow processes require analysis and improvement. Management training should also include training in business development and investment, in order for managers to calculate the benefit to their businesses of investing in the new technologies, such as those listed in the afore-going section, as well as vacuum packaging to extend the shelf life of fresh pork.

In the sphere of product development, Ukraine is hampered in the potato and apple agri-food chains by the lack of information on optimal potato varieties and the continued production of apple varieties that cannot compete with today's European produce on retail shelves, resulting in retail and consumer rejection of Ukrainian produce and ultimately its relegation to waste.

As noted above, dairy product development often results in over production during the early months of introduction of a new product, which leads to unnecessary waste, as does the extreme competition in a non-consolidated market characterised by multiple dairies and trade marks (for example for fresh milk), which leads to overstocking of milk and products on retail shelves in order to hold shelf space against competition.

5.3 Value chain coordination and supply logistics

The fragmented nature of agri-food production in Ukraine caused by the breakup of former state and collective farms during the 1990s and the slow pace of consolidation into commercial farms leads to major challenges in value chain coordination as a result of the huge numbers of small producers.

The cereals commodity grouping leads the way in terms of consolidation of production, with the emergence of large and vertically-integrated agri-holdings which employ modern production techniques and machinery as well as post-harvest handling, storage and primary processing capacity. Nevertheless, considerable coordination will be required particularly between government and private sector producers to establish best practises and the type of early warning and response system required to combat the Sunn bug threat. Similarly, if Ukraine is to reach governmental targets under its 'Grain – 2015' program of 80 million tonnes of grain harvested, of which 45 million tonnes exported, industry experts estimate that public-private investment in certified grain storage capacities will be required for a total of 45.5 million tonnes, as well as 8,000 specialized road carriers of over 30 tonne capacity, 12,000 rail carriers, barge capacity to transport some 5.6 million tonnes of bulk cargos by rivers to sea ports as well as improved logistics connections and storage infrastructure at the main Odesa and Yuzhnyi port terminals.

Meat production, at least of meat sold through wholesale/retail networks is also increasingly characterized by larger producers, with households that rear poultry, pigs or cattle for meat distributing little such produce beyond their extended families. The commodity groupings where smallholder producers still dominate and therefore where coordination is most challenging and leads to the greatest losses to marketable food products is in the horticultural (including apple and potato) chains and in dairy production.

The apple and potato agri-food chains are characterised by wholesalers contacting individual farmers at the time of harvest and collecting un-chilled produce in non-refrigerated vehicles for transportation to wholesale markets or storage facilities. The lack of producer organization in order to standardize production in order to engage directly with processors or retailers or to develop joint pre-cooling and storage capacity not only causes negative impacts on rural incomes, but also on levels of losses and waste due both to spoilage immediately after the harvest and also to shortened shelf life and higher levels of consumer waste. On a positive note, representatives of leading Ukrainian supermarket chains state that 35% of Ukrainian potatoes are currently go to retail outlets and that this level is growing, reflecting improvements in storage and transportation practises.

In the dairy sector under supply, particularly in winter means that dairies are forced to offer collection service and accept even substandard milk, but the absence of refrigerated collection points and coordination of small milk producers into cooperatives, which could be used as vehicles for improving production practises and winter feed regimes, result in major losses of potential winter supply and oversupply in summer or when trade restrictions reduce market demand.

Supply chain logistics is also a major challenge in Ukraine, again particularly for fresh produce requiring refrigeration. The potato, apple, pork and dairy food chains are all impacted by the shortage of refrigerated transport, substandard packaging and handling and storage running from the farm to retailers and consumers. As the representative of a leading Ukrainian dairy stated, improved logistics could extend the current 7 day shelf life of Ukrainian fresh milk and 10 days for yoghurt to the EU norms of 15 days for milk and 30 for yoghurt.

5.4 Trade and taxation policies

Key factors driving trade policy and its impact on loss and waste levels, particularly as it relates to exports of Ukrainian produce are driven firstly by Ukrainian government controls on exports in the grain sector, secondly by protectionist policies of its CIS neighbours, especially the largest CIS

market, Russia, in the dairy and meat sectors and thirdly by EU import quotas and certifications in the horticultural sector.

In the grain sector, Ukrainian government attempts to control grain exports through the imposition and control of a quota system in 2011 led to great consternation among producers and reduced levels of wheat available on international markets. Not only, given the shortage of adequate long-term storage, did such policies result in considerable losses of grain, but the impact of such intervention both on food security in Ukraine's export markets in Asia and Africa, on the investment climate and on levels of investment in loss-reducing technology in agri-food chains in Ukraine, were certainly both negative. The government and industry, represented by the Ukrainian Agrarian Confederation have signed agreements to coordinate on such policies in the future, including maintenance of a reserve of wheat until survival rates of winter crops are established.

Bans on imports of Ukrainian cheese by Russia in 2012 also affected on levels of food loss and waste as cheese producers drastically cut back on milk purchases, resulting in a sharp reduction in prices offered to producers by dairies and smallholder farmers reacting by refusing to sell and discarding their milk and/or slaughtering dairy cows. Russia's concerns relating to Ukrainian cheese were justified by claims of excessive levels of palm oil in the cheeses, a claim denied by Ukrainian dairies and government officials. Stricter control of production processes by the private producers and monitoring by Ukrainian government would have help pre-empt such a ban and reduce its term of effect.

While small amounts of Ukrainian horticultural produce is sold into CIS markets, as shown above Ukrainian demand for many such products outstrips supply, making Ukraine a net importer, particularly of fruit. In apple and potato production, particularly in years of good harvest, Ukraine domestic supply far exceeds domestic demand and in the absence of established export markets huge amounts of produce is wasted, often not even harvested. While EU markets require strict certification for import, this is an option worth exploring particularly for leading Ukrainian producers.

Further new potential export markets in the Middle East and Africa should be identified in order to capitalize on opportunities offered by the current excess refrigerated container capacity currently leaving Odessa empty after the initiation of a new dedicated refrigerated banana import service by Maersk Sealand.

Current Ukrainian investment policy and the overall investment climate mitigate against loss-and waste reducing investments in new technologies and practises at all stages of agri-food chains. In 2012 Ukraine was ranked 137 out of 185 countries for ease of doing business and 117 for protecting investors by the IFC Doing Business study and levels of red tape for business start-ups and conduct of ongoing businesses are high and characterized by gnawing corruption and takeovers of successful companies by shady interests.

In terms of tax policy, given the central role of agriculture in the socio-economy of Ukraine, most agricultural producers are exempt from VAT and profit tax. Further in many agricultural subsectors special government support programs are available, such as subsidies for investment in orchards, special exemptions for cooperatives, credits and lease options offered for investment in the dairy sector and co-financing of regional agricultural wholesale markets and related storage and logistics infrastructure. Thus, although Ukrainian producers are at a decided disadvantage in terms of

competing with their heavily subsidized EU neighbours, they are well supported relative to other sectors of the Ukrainian economy.

The caveat expressed by many value chain actors across the priority agri-food chains analysed in this study, however, is that many potential beneficiaries, particularly the large numbers of smallholder producers lack the experience and connections to navigate the opaque and labyrinthine application procedures in order to access such support and larger and more successful businesses often politely turn down such assistance, fearing that such a partnership would expose it to predatory government monitoring of such joint investments.

5.5 Food safety and quality standards

The poor quality of Ukrainian produce plays a major role in losses and waste in all agri-food chains analysed in this study. Wheat and potatoes are relegated to animal feed on both local and international markets given their poor quality and are large quantities of potatoes simply discarded as a result of blight and degradation. Processors ranging from bakeries to meat processors, but most markedly dairies, cheese and fruit juice producers bemoan the lack of quality of inputs, resulting in large part from the fragmented nature of production on numerous small farms lacking standardized approaches to production to allow the supply of commercial quantities of inputs at basic quality standards.

Food safety and quality standards in Ukraine have been characterized since independence by overcomplicated regulation and control by three distinct agencies, resulting in confusion among private sector agri-food chain actors, rent-seeking incentives for the regulators and a broad non-conformity of practise with the rules. As we have seen above, this in some cases this has leads reductions in waste, as sub-standard products or those that have passed their sell-by dates remain in the market and are consumed, despite the hazard this poses to public health.

Further, the introduction of a streamlined and simplified system for the identification and rectification of hazard points in food safety and quality would have a major impact on the reduction of losses and waste across all agri-food chains. A new draft law On Food Production, developed with considerable input by Ukrainian experts and international organizations, if passed, will establish the principles of traceability, recall and HACCP for food products 'from field to plate' under a single phytosanitary-veterinary service.

Introduced over a two-year period, the new system would see a simplified system of checks according to standardised hygiene and manufacturing checklists and increase penalties for non-compliance. Further sampling and testing would be reduced and rather than being applied to all food companies, it would be based on risk, meaning that if a company has a good record or its food products are less potentially hazardous, such a company will be tested less frequently or rigorously. The system will also encourage companies to improve their own systems through applying principles of GlobalGAP and HACCP, which are beginning to be adopted by market leaders. Such certification programmes would in turn help reduce losses by opening export markets for excess Ukrainian production as well as increasing incomes in agri-food production and processing.

6. PRIORITY ACTIONS & POLICIES TO REDUCE FOOD LOSSES & WASTE

This section is comprised of two parts. Firstly a brief overview is provided of government agri-food policy priorities, support programs and activities in the sphere of food losses and waste. Secondly a series of recommendations are provided of potential initiatives to monitor levels of losses and waste and to reduce losses and waste at critical loss points identified early in this study

6.1 The enabling environment for agri-food chains performance

Government of Ukraine priorities in the sphere of agri-food policy, according to the Presidential Programme of Economic Reforms 2010-2014 are as follows:

1. Reform of the Agricultural Land Market, Increasing Soil Fertility and 'Grain of Ukraine'

- a) Creation of transparent schemes to regulate land relations regulation, namely:
 - elaboration of draft law simplifying procedures relating to the elaboration, agreement and ratification of documentation organising use of land;
 - decreasing the number of organizations providing permits for business;
 - abolition of land use licenses and estimation activity. Introduction of certification of these procedures.
- b) Development of mechanism of economic stimulation for increases in the productivity of agricultural areas.
- c) Realization of National Project 'Grain of Ukraine', namely:
 - development of seed-growing system for grain cultures;
 - use of resource-saving technologies in the field of soil treatment;
 - introduction of innovation/investment projects for producing of agricultural equipment (modern combines harvesters, tractors);
 - creation of additional capacities for production and storage of grain

2. Food Safety and Food Security

- a) Harmonization of normative documents with EU requirements in the field of agriculture and food standardization.
- b) Elaboration of draft law on food labelling and consumer information, harmonized to the European Parliament and Council Regulation № 1169/2011.
- c) Elaboration of draft law on novel food harmonized to EU Regulation № 258/97.
- d) Elaboration of draft law on food hygiene including products of animal origin, harmonized to Regulation № 852/2004 and 853/2004.
- e) Elaboration of draft law on animal maintenance covering requirements for animals producing food and other products to be harmonized with EC Directive 98/58/EC.
- f) Elaboration of draft law on fodder for animals kept for production of food and other products to be harmonized with to Regulation 189/2005/EC.
- g) Elaboration of draft law on food substances of animal origin and animal by-products to be harmonized with EU Regulation № 1069/2009 and 142/2011.
- h) Elaboration of draft law on corrective actions to some laws of Ukraine (harmonization of national and EU legislation in the field of permits, certificates, agreements, expert reviews required by operators on food markets.

- i) Elaboration of draft law on official control of Ukrainian legislation in the field of food safety and food quality, fodder, animal health and husbandry to be harmonized with EU Regulations № 854/2004, № 882/2004, № 669/2009 and Council Directive № 97/78/EC.
- j) Elaboration of legal documents in the field of identification of agricultural animals with the purpose of harmonization to international standards.

3. Economic Growth and Improved Livelihoods in Rural Areas

- a) Introduction of new mechanisms of financial support for agricultural producers.
- b) Improvement of the system of price monitoring for the market of food products.
- c) Creation of a market information system to monitor agricultural product wholesale markets. Development of logistics infrastructure for integration of agricultural product markets into world community.

4. Rural Infrastructure Development

- a) Elaboration of a state strategy for sustainable development of rural territories, namely:
 - at the national level establishment of a Rural Development Fund and a Payment Agency;
 - at the regional level establish different models of agricultural management.
- b) Creation of a system of advisory services for rural inhabitants and commercial entities in the agro-industrial complex, using:
 - monitoring of requirements for advisory services in different fields;
 - definition of priorities for granting social services by natural and climatic zones.

5. International Technical Assistance for Livestock Sector Development within ENPARD Framework

- a) Implementation of National Project 'Raising Cattle Breeding' on the basis of:
 - monitoring the status and development of cattle-breeding;
 - elaboration of replicable projects for household and commercial farms;
 - improvement of the system of effective reproduction in dairy farming;
 - modernization of the cattle selection program;
 - creation of an information/selection centre for monitoring, control and coordination of pedigrees in cattle breeding;
 - support to investments in dairy farming.
- b) Elaboration of a program for preservation of local and disappearing breeds of livestock in Ukraine in accordance to FAO requirements (to preserve genetic resources and biodiversity).

In terms of budgetary support, the total agricultural budget for 2012 was UAH 8.2 billion or US\$ 1 billion, a 22% fall on its 2011 level. The major areas of support interventions directions of direct financial support are as follows:

Budget Line	General Fund (US\$)	Special Fund (US\$)	Total (US\$)
Preventive measures against crop diseases and livestock infections	4,250,000	-	4,250,000
Support to development of hop growing and new orchards and vineyards	6,250,000	134,375,000	140,625,000
Partial compensation of the cost of electricity for irrigation	6,250,000	-	6,250,000
Support for agricultural wholesale markets	25,000,000	-	25,000,000

Support of animal husbandry	-	91,500,000	91,500,000
Credits for private family farms	-	3,475,000	3,475,000
Support through leasing	3,125,000	628,025	3,753,025

While a number of these support interventions are likely to have a positive impact on the levels of food losses and waste, including prophylaxis against animal and crop disease, improving perennial production, market infrastructure and animal husbandry practises, the focus of support is clearly primarily focused on increasing production rather than reducing losses and waste.

When asked to provide information on the main Ministry of Agrarian Policy and Food initiatives in the sphere of reduction of losses and waste in Ukraine, the following four programs were cited by the ministry:

1. Financial Support to the Development of Wholesale Agricultural Product Markets

Under implementation since 2011 this initiative aims to establish conditions for the sale of Ukrainian agricultural produce while reducing post-harvest losses. While a ministry representative was not available for discussion, it is understood that over five regional wholesale markets have to date received official certification by the Government of Ukraine and stand to gain partial financial support in their development.

The best established regional market is that in Lviv Oblast in western Ukraine, which provides reasonable storage and sales infrastructure for wholesale trade in fruit and vegetables, meat, fish dairy produce and eggs. Other markets are still under development, with that in Kyiv having established its first pavilions and installed its first cold storage capacity and that in Donetsk still under construction. A number of others such as those in Kherson and Rivne oblasts are at still earlier phases of development.

2. Partial Compensation for Investments in Individual Milking Equipment

This initiative has, since 2012, supported improved sanitation and reduced losses in the milking process among rural households who account for over 80% of milk production in Ukraine. This is one of a number of initiatives targeting this group of producers, which also include the payment of a quarterly subsidy during the first year of rearing of heifers and the introduction of 'recommended' minimum producer prices for milk. While the latter initiative understandably riled milk processors, support to increase smallholder access to milking technology is welcome given the high loss levels during and after milking resulting from poor sanitation, spillage and a lack of refrigeration.

3. Interest Rate Support for Commercial Credit Used by Producers in Development of Greenhouse Production, including Sorting, Packaging and Storage

Recognizing not only the importance to employment and income generation of greenhouse-based horticultural production in Ukraine as well as the major losses, as discussed above, resulting from a lack of post-harvest handling technology and cold storage capacity, the government has been implementing this program since 2010.

Ministry representatives stated that some US\$ 7.5 million in state support had been successfully accessed for the development of greenhouse production to date, but that it tended to be the larger enterprises that were best placed to develop the required applications for funding. Further, while support to greenhouse production has been curtailed in the past year in favour of the livestock sector, ongoing programs continue to support orchards and berry production, as well as the all-important development of storage (currently focused on tree

fruits), for which the government provides a matching 50% subsidy to investments made by the private sector.

4. Control of Pests and Disease affecting Crops and Livestock

In addition to the substantial research and recommendatory work conducted by the State Crop Protection Inspectorate, into primary threats to Ukrainian crops such as the Sunn Pest (cereals) and Colorado beetle (potatoes), the Ukrainian Veterinary Sanitary Factory network aims to reduce losses caused by animal by-products and outdated animal food products that do not enter or cannot remain in the food market. Focusing on outdated produce supplied by supermarkets as well as on by-products from the poultry, pork and beef slaughter and butchery processes, contraband animal products slated for destruction and fish processing waste, the network of 18 factories across Ukraine produces flour for use in animal feed. As the quality of the produce is low and costs (particularly for gas-powered factories) are increasing, the network relies of government subsidisation and only the facility in Kyiv Oblast still works 24 hours.

Representatives confirmed that much animal slaughter by-products were dumped rather than transported to their factories and much outdated produce was sold on through secondary markets, with only leading supermarkets concerned enough with their own reputations to regularly supply outdated produce to them. They further argued that until fines imposed for dumping animal by-products and on-sale of outdated produce were increased and regulations more strictly enforced, there would be little incentive for market actors to comply with them.

6.2 Actions and policy proposals

The sets of actions and policy proposals outlined below can be divided into those that apply to most if not all food chains analysed in this study; those aiming to reduce losses and waste in individual food chains; and those that target specific stages of agri-food chains.

1. Multiple Food Chain Actions and Policy Proposals

This set of actions and proposals aims to address the two key obstacles to reducing losses and waste across all agri-food chains analysed in this study, i.e. (a) investment in modern technology and (b) upgrading the skill sets of and stimulation of workers.

(a) Investment in upgrading technology in production, post-harvest handling, cold chain and processing

Probably the greatest single cause of losses and waste across all agri-food chains in Ukraine over its 20 years of independence has been the shock caused by the collapse of the Soviet vertically integrated state/collective agri-food structures, their subsequent privatization and the difficulties faced primarily by their new owners in attempting to transform or replace them with modern loss and waste-reducing technologies and processes.

This applies equally to agricultural production and harvesting, whether in the sphere of livestock or crop production, to post-harvest handling (grading, storage, packing) to all linkages in cold chains for fresh meat, dairy and fruit and vegetable produce, to processing and wholesale/retail structures.

To address this, the following initiatives are recommended, to be coordinated between leading and lagging private sector enterprises, government stakeholders at central, regional and local levels and international community representatives, including technical assistance projects and international financial institutions:

- (i) Investment climate improvement and access to finance. In the sphere of improving the investment climate, the lead needs to be taken by the Government of Ukraine. Not only will

this require concrete steps in terms of broader issues of rule of law, property rights and contract enforcement, but perhaps more immediately direct threats to existing and potential investors can be addressed by individual and coordinated action by ministries and agencies on the issues of business start-up and registration and particularly on permitting and inspection regimes and overlapping authority. Certainly there is reason to be enthusiastic in relation to new draft laws on for example food inspection, but bureaucratic obstacles to doing business in Ukraine remain a severe constraint to the considerable investments required to reduce losses and waste at the production, post-harvest handling and storage phases of agri-food chains to EU levels.

In recent years there are positive examples of successes by the private sector in the attraction of international investment from both the private sector and international financial institutions into new loss-reducing facilities in cereals, fruit and vegetables, meat and milk production logistics and processing. Both potential investors and authorities and consultancies active in the sphere could coordinate more closely in the identification and pre-screening of additional investment targets among existing businesses.

Across central and eastern Europe there are also good examples of regional and local authorities attracting foreign direct investment in Greenfield sites offered for sale or long-term lease for the development of processing and logistics hubs, an area in which Ukraine has strong competitive advantage and in Ukraine could be used to support the ongoing development of regional agri-food wholesale markets.

Increased coordination between those developing and implementing government support programs aimed at reducing losses with sources of commercial credit and grant funding could also be used increase the impact and reduce the risk of such investments. Further, models for risk-sharing between commercial lenders (banks and credit unions), agri-input suppliers and agri-food wholesalers and producers can also be used to develop new products encouraging longer-term investments in loss-reducing production and post-harvest handling technologies.

- (ii) Improving quality and quantity of supply. One of the key causes of losses and waste, particularly in the fresh (meat, dairy and fruit and vegetable) produce agri-food chains is the splintered nature of production and the difficulty of ensuring an adequate supply of standardised and quality produce to enter the second (post-harvest handling and storage) phase of such supply chains. Dairies are forced to collect milk from hundreds of owners of individual cows every day and supermarkets cannot find large enough suppliers of produce with whom to conclude a longer term supply contract.

Producer organization development is therefore key to consolidating supply, improving production and post-harvest processes and reducing losses in the early stage of these agri-food chains. While the Ministry of Agricultural Policy and Food, as well as leading traders and processors support such initiatives, further effort needs to be placed on showcasing successful cooperative and lead-farmer models and supporting investment by them in standardization of production, forage production and winter feed regimes, quality control, joint marketing and post-harvest handling (pre-cooling) investments. Continued work by international agencies as well as the Government of Ukraine and lead producers and processors in GlobalGAP and HACCP information and accreditation is therefore required.

(iii) Calculation and demonstration to current market players and potential investors of the benefits (savings and potential increased margins) of technological upgrades. Multiple examples can be found in each agri-food chain of successful investments in up-to-date machinery and processes that have led to tangible reductions in losses and waste. These include the example cited above of the pig farm using Soviet era facilities and practises and the reduction of nearly 10% in losses recorded after investment in new feed and maintenance technologies and staff practises as well as the substantial increases in shelf life of vacuum packing for fresh meat and of investment in improved packaging across all fresh horticultural and dairy products.

Similar examples can be found in the grain sector, with leading grain producers claiming less than 1% losses between harvest and sales. And in the apple and potato chains a mere comparison between loss levels in transport and storage between modern and outdated storage facilities speaks for itself. It is therefore recommended that such examples are showcased, supported by concrete calculations of investment levels and practise changes, resulting reductions in losses and waste, impacts on profits and timeframes required for such investments to be recouped. These can be used to invigorate investment by those already engaged in the agri-food chains as well as to attract new entrants both Ukrainian and international.

(b) Upgrading the skill sets of and stimulation of agri-food chain personnel

Ageing Soviet-trained head technical specialists and a tide of under-stimulated manual workers characterise the Ukrainian agri-food workforce. This is a sphere where it is felt that the private sector, that has most to gain in reducing losses and waste that impact its bottom line, could play a more active role.

Examples from across the region exist of successful engagement of producers and processors with local technical secondary schools in establishing apprenticeship programs under which pupils are allowed to train at local companies prior to the more promising being hired for work. Similarly companies pay scholarships for further qualification of those they consider worth the investment in return for a commitment to work for the sponsor on gaining a relevant qualification. Such initiatives benefit from flexibility of local and national authorities in allowing pilot projects and flexibility in amending curricula to reflect employer demand for new skill sets.

Additionally, inducements both in the form of performance-related pay and disciplinary procedures can be used. An innovative approach taken by one dairy farmer was to invest in housing to encourage families to commit to long-term employment opportunities in a village short on committed labour. And for higher level specialists and managers, medium-level enterprises need to follow the lead of those who have adopted international best practise in technological and personnel development by investing in skills upgrades and exposure to modern technologies and practises for their technical and business managers.

In all of these activities, close coordination of government, educational establishments and job centres, the private sector, their representative associations and international educational and technical exchange programs is required.

(c) Reducing Losses and Waste in the Distribution & Consumption Phases

The following actions and proposals aim to address food losses and waste at the final two phases of agri-food chains and involve regulatory development, enforcement and communications

initiatives that can be developed, financed and implemented jointly by private representatives, government and consumer organisations.

- (i) Levels of losses and waste during distribution phase are considered to be lower in Ukraine than in western countries, but this was explained by agri-food chain actors to be as a result of an established secondary market for sub-standard and expired produce. While such secondary markets can be viewed as positive transfer mechanisms reducing waste by offering cheaper food to poorer segments of society, they not only have considerable public health implications, but also mask wasteful practises of over-ordering by retail chains.

Potential actions to counter such activities would be for the government and/or consumer organisations to engage retail chains and their suppliers to discuss new practises such as lowering prices as products near their sell-by or best-before dates. Such initiatives could be supported by revising regulations on expiry dates and increasing fines for breaching them, at least to levels where it they exceed the cost of having produce officially destroyed, as well as cracking down on relatively open outlets for expired produce.

- (ii) Consumer awareness campaign on expiry dates, high-risk expired produce and minimising waste in the home. The aforementioned actions could be supported by a joint initiative by consumer organisations, government health and product safety authorities and industry associations to inform the general public of current systems of expiry dates, government control regulations and initiatives and related public health issues, as well as informing them of the benefits of improved buying, storage and cooking practises in relation to reducing waste, saving money and protecting family health. Monitoring of the results of the recent 'War on Bread Waste' in Turkey could also be informative in this regard.

(d) Monitoring and Reporting Mechanism for Food Losses and Waste

The optimal mechanism for monitoring and reporting food losses and waste that emerged in every agri-food chain analysed in this study is the network of associations dedicated to supporting private sector agri-food chain actors in business development and advocacy. These are both active and outspoken in Ukraine and expressed knowledge and interest in the issue of food losses and waste, as it touches their memberships directly in lost revenues and identifies key areas of infrastructure and policy for improvement.

A group of up some ten associations, representing all stages of the key agri-food chains should therefore be engaged to conduct a baseline study and thereafter annual anonymous monitoring a cross-section of members to allow benchmarking and progress reporting to a forum including government and civil society/consumer organisations and relevant international stakeholders. This forum could then identify priority interventions and coordinate their implementation using the staff of forum representatives, as well as interested stakeholders from the sector across the country.

2. Individual Food Chain Actions and Policy Proposals

This set of actions and proposals aims to address food losses and waste in the two agri-food chains analysed for which substantial quantities of potentially food-grade produce are relegated either to animal feed or simply discarded, i.e. the wheat and potato chains.

(a) The wheat agri-food chain

While this supply chain demonstrates the greatest penetration by large companies that have succeeded in investing in machinery, infrastructure and staff development to reduce losses and

waste to acceptable levels, the continued engagement of small and medium producers still dependent on outdated technologies and processes as well as the sector's potential to increase output and supply of food-grain wheat make it worthy of independent attention by policy makers and the international community.

- (i) Development of coordinated public-private program for control of *Eurygaster Integriceps* Put. Given the aforementioned impact of this pest both on quantity and quality of wheat harvests, Ukraine must make a concerted effort to coordinate its response, if it is to realise its potential and ambitions in the sphere of wheat production and particularly exports. While the Soviet state controlled system of pest and disease monitoring and control is now moribund, considerable expertise in this particular pest has been developed both by leader producers and traders and by Ukrainian authorities and researchers. A coordinated program now needs to be established in order to inform producers across prone areas on best preventative practises, as well as jointly to finance the establishment of early warning system infrastructure and to coordinate producer responses to outbreaks.
- (ii) Identify potential for public-private partnerships in addressing infrastructural obstacles to grain logistics. Further analysis by associations and consultancies of the potential for joint investment in ageing state rail, river and port infrastructure, using recent and existing support initiatives from UN/FAO and EBRD may identify opportunities for lease/management arrangements or dry port investments that over the medium term make a substantial contribution to improving transportation and increasing grain storage capacity in Ukraine's. Here again the model of governmental support to development by the private sector of wholesale agri-food market infrastructure may be informative.

(c) *The potato agri-food chain*

While the potato agri-food chain share to loss of large quantities of potentially edible produce to animal feed with the wheat chain, it unusual in that without export markets, current levels of supply can only result in huge levels of potato wastage. Indeed, research conducted by the Association of Ukrainian Potato Producers argues that Ukraine produces four times as much as is consumed by Ukrainians, meaning that, without export markets, Ukraine must use as feed or discard the bulk of its annual harvest (which it calculates account for 25% and 30% of production respectively).

- (i) Conduct of research and awareness raising among rural populations on optimal feed regimes for domestic livestock. Independent research into current feed practises and costs as well as improved feed regimes, particularly for domestic pigs and cattle, would likely show the relative high investment for low return of potato use as feed as against other readily available feed ingredients, such as low-grade wheat. This being the case, development of an awareness program for rural populations showing the benefits of changing feeding patterns would not only lead to reductions in potato waste, but would also have positive downstream implications for spurring wheat production and reducing wasted wheat and also for overall animal productivity and thereby loss reduction in the meat and dairy sectors.
- (ii) Targeted potato export market development. While Ukrainian producers have not yet received accreditation to export potatoes to EU markets, in recent years considerable opportunities have been identified when EU demand, particularly for processing potatoes

has increased and supply has been restricted by climatic or other factors. Concerted action by public and private sector stakeholders and engagement of relevant EU authorities may allow direct exports of certified produce for Ukrainian producers, which would both counteract illicit trade and allow the long-term development of an export market to act as a safety valve for excess production in the country, reducing waste in years when the EU witnesses deficits in supply.

7. ANNEXES

Annex 1. Sources

Annex 2. Key Informant Questionnaires