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Model-based risk-adjusted planning for sustainable agriculture under agricultural trade liberalization: Ukrainian case study

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Foreword

This report presents results of the research carried out by the author during the 2010 Young Scientists Summer Program. The objective of the research is to develop an integrated modeling approach to support agrarian policy recommendations in Ukraine addressing national food security goal, including economic, social and environmental aspects of the food security problem in the conditions of trade internationalization and liberalization. The author analyzes main current trends of agro production and trade development, including socio-economic-environmental consequences of trade liberalization in Ukraine. Stochastic optimization model is proposed for supporting policy decisions regarding optimal structure of production, in particular, allocation and intensification, satisfying identified goals and constraints.

Goals and constraints incorporated in the model include criteria of the national Program on sustainable rural development “State Program of Ukrainian agriculture development to 2015”, adopted in 2007. The State Program sets the following goals: increase the quality of life in rural areas; increase incomes of rural households through improved management, diversification, and financial support of domestic agrofood sector; increase employment in rural areas, including small and medium entrepreneurship development; increase competitiveness of Ukrainian farmers under liberalization; fulfill environmental norms of agrifood production and ensure their efficient monitoring. The integrated model may be a useful tool for governmental authorities and agrarian policy makers. The proposed advanced methodology integrates stochastic optimization methods with multi-criteria analysis.

Abstract

The paper summarizes development trends of the agricultural sector in Ukraine in the recent years and identifies main impacts of current trade policies, in particular, socio-economic-environmental consequences of agricultural trade internationalization and liberalization in Ukraine. We propose an integrated modeling approach to support policy recommendations that may help enhance national food security and improve economic, social and environmental standards especially in rural areas. The approach includes stochastic optimization procedure that investigates optimal robust policies regarding agricultural production portfolios, production allocation and level of intensification, processing and trade under desirable goals and constraints in the presence or risks and uncertainties. The introduced goals and constraints are coherent with the goals of the “State Program of Ukrainian agriculture development to 2015” and include such criteria as increasing rural incomes, employment, creating new entrepreneurship businesses, supporting agriculture competitiveness and ecologically safe agricultural production. The developed approach may be useful for national and regional agrarian planners.

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Model-based risk-adjusted planning for sustainable agriculture under agricultural trade liberalization: Ukrainian case study

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1. Introduction

Liberalisation of trade between Ukraine and EU is underway. It is expected that negotiations on EU-Ukraine free trade agreement (FTA) will complete in 2011. This agreement will affect current agro production trends by changing supply-demand relations and by imposing EU ecological standards. For Ukrainian agribusinesses the agreement may have positive consequences by creating effective mechanisms for sustainable ecological development, and negative, caused by necessity of substantial additional resources (financial and labour) for liquidation of discrepancies between Ukrainian and European standards. Trade liberalisation between Ukraine and EU will be the catalyst of system's reforms in agrifood sector in Ukraine.

EU-Ukraine FTA may cause a number of risks which affect domestic food security. Thus, on one hand, Ukrainian agriholdings are interested in increasing production and export of profitable cash crops, such as sunflower and rapeseeds, which are highly demanded in EU for biofuels production. On the other hand, EU is interested to export animals' products, especially milk and meat products, to Ukraine. Meat consumption in Ukraine is lower than in EU and is even lower than the recommended norm. For this reason, Ukraine is considered as a potential livestock market.

The main condition of Ukrainian WTO accession (2008) is liberalization of its agricultural market through removing protective tariffs and customs services. Meanwhile, as [15], [16] show, EU manages to preserve high protection level for most of its agricultural production, including livestock, even under free trade agreements (this will be further discussed in Section 3.3). Despite protective EU policies, some Ukrainian producers, in particular, livestock farmers, have comparative advantages with respect to international producers, what is analyzed in Section 5.

The current agricultural trend in Ukraine is towards intensification and modernization to increase competitiveness of domestic firms under trade internationalization and liberalization. Agrifood enterprises in Ukraine are being actively restructured and integrated forming large agriholdings. During 2005 and 2006 the number of the enterprises, which operate more than 10 thousand hectares of land, has increased by 27%; the average size of the total area in these enterprises has risen by 7% to more than 20 thousand hectares. I have all reasons to believe that agro-holdings will represent agricultural sector of Ukraine in the nearest 5–7 years. In 2008-2009 the trend was stimulated by Ukraine's WTO accession. Agriholdings are driven by profit maximization criterion and concentrate primarily on intensive production of cash crops (biofuels crops, grains) causing adverse socio-economic and environmental impacts in rural areas such as diversion of land and water resources from direct food production to intensive production of biofuels, which undermines food security

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and environment quality through high fertilization rates and absence of adequate crop rotations without complying to necessary agronomic standards. Rapid production intensification led to almost complete elimination of livestock sector [2], [3], [13]. Such tendencies may lead to further considerable imbalances in agrifood sector of Ukraine, land degradation, loss of fertile soils, water, air, soil pollution.

It is expected that production intensification and trade liberalization in Ukraine will bring a number of advantages, however negative implications of recent reforms increase awareness regarding the need for sustainable policies and governmental regulations. Recently adopted (2007) National Program on sustainable rural development "State Program of Ukrainian agriculture development to 2015" sets the following criteria for future agricultural polices: increase the quality of life in rural areas; increase incomes of rural households through improved management, diversification, and financial support of domestic agrifood sector; increase employment in rural areas, including small and medium entrepreneurship development; increase competitiveness of Ukrainian farmers under liberalization; set environmental norms of agrifood production and ensure their efficient monitoring.

Development of sustainable agrifood production is an important component of the overall economic development in Ukraine. Therefore, the aim of this research is to develop an integrated modeling approach to the analysis of agricultural sector in Ukraine under production intensification and trade liberalization. We identify four main tasks of the research: first, analyze impacts of the WTO's policies on Ukrainian agricultural sector; second, compare trade flows and market regulations in Ukraine and EU; third, develop an integrated model for the analysis of optimal robust production allocation and intensification under uncertainties which can be used for planning sustainable agrifood production in Ukraine; four, summarize recommendations for market regulations under EU-Ukraine FTA.

The structure of the paper is as follows: Section 2 describes main problems of agro production development under trade liberalization. Section 3 presents main drivers of Ukraine's agriculture and agrarian foreign trade under WTO accession and EU – Ukraine FTA prospects, including state regulation question. Section 4 illustrates negative consequences of current agro development trends under liberalization. They confirm our assumptions about food insecurity. Section 5 introduces integrated model for supporting decision ensuring food security and provide farmer's profitability. This section summarizes results of model application to the analysis of beef production expansion in Ukraine. Section 6 concludes the study.

2. Problem Formulation

The main idea of an ideal "free trade" is to create world market, where "sellers and buyers meet, haggle, sell and purchase goods at affordable prices for all". However, in reality there exists no "open" market, where farmers from Brazil, Ukraine, USA or elsewhere, can sell or buy at their best price. Majority of farmers sell their products to the nearest grain elevator, which is actually a monopolist in the area. Small and medium producers have no other way but to sell to the closest collector because otherwise they bear additional costs for building storage facilities, transportation, etc. Thus, only few agricultural producers may have advantages from the free trade. This is one aspect of the "free trade" dilemma. Another relates to subsidizing domestic producers (producers' domestic support) by many developed countries which adopted "free trade" principles.

In 1996 UNO members "…agreed that trade is a key element in achieving food security. Food security exists when all people, at all times, have physical and economic (at affordable prices) access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" [19]. Thus, food security definition includes three components:

- Social: food security means sufficient quantity of food for each societal group and person;
- Environmental: food produced in a sustainable way by rational use of natural resources;
- Economic: food available in sufficient amounts and variety at prices affordable for each societal group

Free trade proponents (UN members) argued that free trade automatically ensures food security, their main arguments being that in liberalized world agricultural markets will eliminate subsidies for non-efficient producers; delete bound tariffs; and eliminate practices of state support for food production. As a consequence, free market will direct food flow to where it is mostly needed. But in reality free trade is far from this ideal case. Failure of the Doha Round under WTO confirms practical impossibility of equal free trade conditions between WTO members.

It is well known that trade liberalization would allow countries to shift resources to sectors in which they have comparative advantages. Free trade theory proves increased benefit from exports. Indeed, trade liberalization leads to production specialization. Consequently, producers get additional benefits from increased exports. But on the other hand, production specialization leads to imports' increase in those spheres, which don't have comparative advantages. In long-term, this may increase country's import dependency. Thus, trade liberalization simultaneously stimulates export and import increase. As a rule, import volume raises faster. Specialization and dependency on imports affects food, social and economical security of a country and increases governmental costs to reduce these negative consequences.

Other problem of specialization and export orientation, which is typical for Ukrainian agricultural sector, is centralization. Let us clarify what centralization means in this case. A majority of producers don't export their production themselves. Agricultural products are collected from producers and then exported by trade-oriented intermediaries (traders), which get considerable share of profits. In Ukraine, only few traders control all exports of grains. Not only in Ukraine, but also in the whole world from three to five firms control more than 40% of the world market [13]. Free trade creates only illusion of farmers' profits increase. In reality, only large producers survive, while small and middle are not able to compete with large ones for scarce resources and market access. Consequently, the diversity of producers as well as production variety is controlled by few large multinational corporations (MNC), which are primarily profit oriented and are not interested in national food security goals of a country.

In these conditions, many countries try to protect their food security using international WTO regulations, which are not always advantageous for all WTO members and may not be effective at individual country level. Therefore, there is a need for state regulations in agricultural sector which would ensure national economic and food security goals.

3. Production and trade drivers

Agricultural outlook for Ukraine: Major incentives for state regulations in Ukrainian are due to the fact that agricultural sector in Ukraine is an important part of the national economy. First of all, Ukraine ranks as fifth in Europe (after Germany, Italy, Great Britain and France) and the 21st in the world in population; one third of total population lives in rural areas – 14.7 million (31.7 %), out of them 3.5 million people are engaged in agriculture. Second, agricultural production share in the national GDP is nearly 8% and 16% - including food industry. The share of agrifood sector in national GDP exceeds the share of construction sector by 4.2 times, that of machines and equipment manufacturing - by 3.5, metallurgy and metal processing - by 3.5 times. During 2000-2008, the returns from agricultural sector to

state budget accounted for more than 1.2 bln. UAH (Ukrainian hrivna, 100 UAH~9.5 euro~12.6 US$). Nearly 10 bln. UAH were paid in the budget as total taxes and duties from agricultural producers and food industry.

Agricultural land in Ukraine is about 22% of agricultural land of all EU countries (27 countries). Agricultural and arable land in Ukraine comprises 0.8ha and 0.65ha per person, respectively, while in EU, the numbers are 0.37 and 0.21 only. Ukraine has rich black soils which cover about 60% of the total area.

After Ukraine acquired its independence in 1990, Ukrainian agriculture underwent three main reform periods:

- 1991-1999, characterized by the default of agriculture;
- 2000-2007, characterized by resuming agriculture production, raising budget support of agricultural production;
- 2008-present – Ukraine's WTO accession.

During 1990-1999 agricultural production in Ukraine reduced almost twice. While in 1990 agricultural share in GDP was 18.6%, in 1999 it felt down to 12%. The rise of agricultural production in Ukraine resumed only in 2000. During 2001-2005 agricultural GVP added 10%, and during 2006-2009 – 12% to national budget. During the last 19 years, agricultural production concentrated primarily in households. They contributed almost a half to total agricultural GDP. They are still important producers of main agricultural products, especially, for internal markets. Thus, households produce 82% of milk, 52% of meat, 97% of honey, 98% of potatoes, 86% of vegetables, 85% of fruits and berries in 2008, and this is without any financial state support, received by many large enterprises in agriculture. The 26% of domestic households are market-oriented, 40% are mixed (e.g., consumption-market), others produce primarily for private consumption. Apart from producing agricultural commodities, rural households carry out important social tasks, i.e., self-employment, economical basis for rural areas development, social basis for rural renovation, cultural and financial maintenance of rural areas, etc.

Trade liberalization process in Ukraine started at the beginning of 1990th. At that time, independent Ukraine created main preconditions for the first trade liberalization stage such as:

- high domestic demand for capital imports;
- high domestic production of agricultural products;
- price disparity between industrial and agricultural production.

Agricultural products comprise essential share of the foreign trade of Ukraine. Moreover, it is the only economic area, which has positive trade balance. During the last ten years, agricultural share in trade balance was estimated to be around 10-11% (17% - in 2009).

Ukraine is an important world exporter of agricultural products: it occupies the first place in world exports of oilseeds, sunflower oil, barley; second - in export of rapeseeds; fifth – in grains.

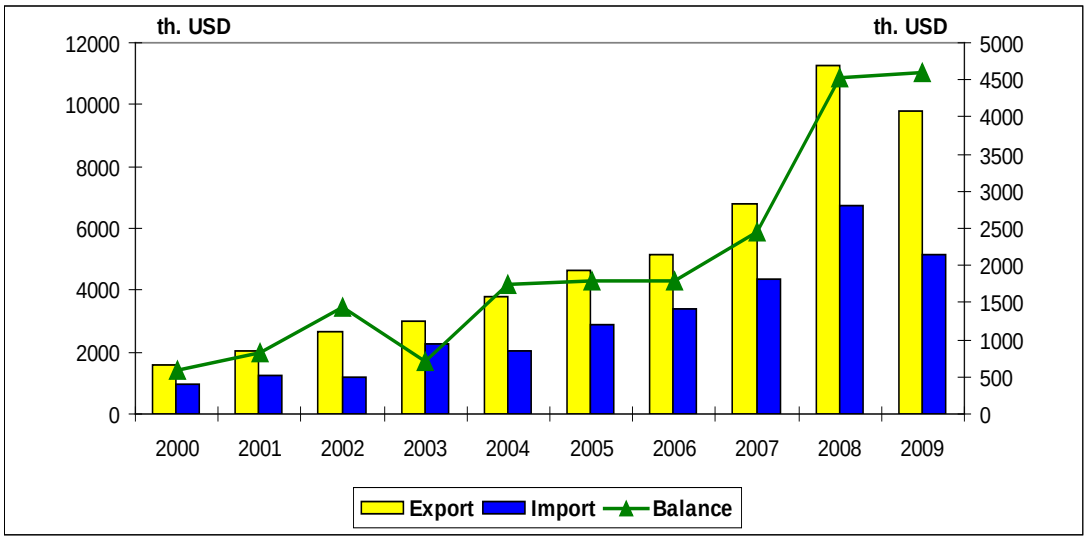

Figure 1 Dynamics of agriculture foreign trade

Source: Ministry of agricultural policy of Ukraine

During 2000-2009 Ukrainian agricultural exports raised more than four times: from 1.58 to 9.77 bln. US$ (Figure 1). In this period, export share in agricultural trade balance accounted on average for 61%. Traditionally, main Ukrainian exports are grains (22.9%), oils and oilseeds (19.7%), milk products (9.2%), meat and meat products (6.3%), chocolate (4.9%) and sugar (4.2%).

Ukrainian WTO accession: On the 16th of May, 2008, Ukraine became the 152th WTO member. In preparation for the accession, many modifications to Ukrainian legislation were implemented in order to comply with the WTO requirements.

Among positive consequences of the WTO accession foreign and Ukrainian scientists and trade experts emphasize the following:

- Ukraine's integration into global trade system;
- Stimulation of structural and production reforms;
- Enhancement of goods and services diversity;
- Investments incentives;
- Increase of production competitiveness;
- Free transit of Ukrainian goods through WTO countries;
- Opportunities for future integration of Ukraine in EU.

Apart from the positive aspects arose a number of urging threats such as:

- low competitiveness of Ukrainian products in international markets;
- inadequacy of Ukrainian production standards and, therefore, specialization in raw materials production;
- reduction of import tariffs which may decrease budget revenues;
- decrease of producers diversity as a result of their low competitiveness.

A country-member to WTO may negotiate its rights and conditions under WTO in accordance to the three main directions distinguished in agricultural sector: i) market access (export and import regulations, including tariff protection); ii) level of support to domestic agricultural producers; and iii) export subsidy.

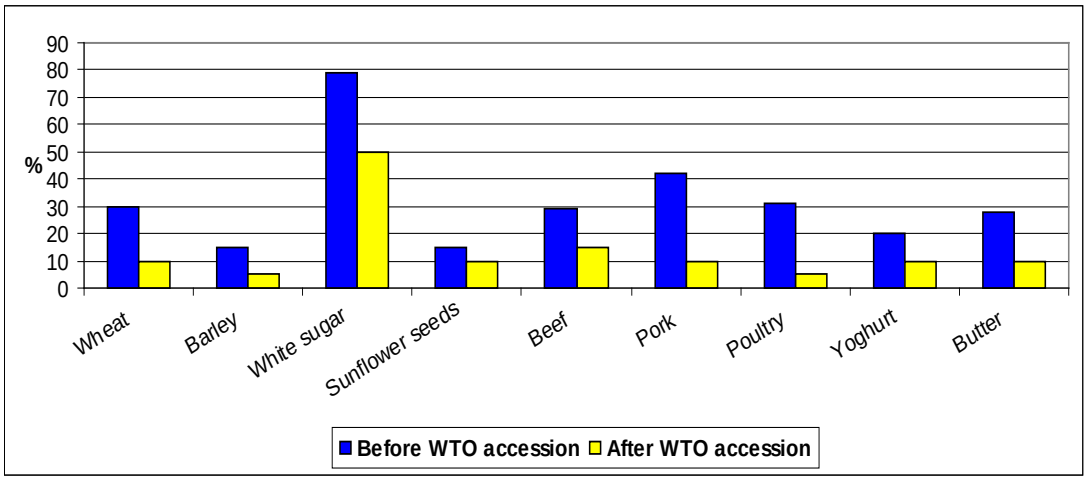

Figure 2 Ukraine's import tariffs before and after WTO accession

Source: Agricultural Policies in Emerging Economies in 2009. Monitoring and Evaluation

Market access. Prior to 2008 Ukraine maintained high tariff protection for main agricultural goods such as sugar, meat, wheat (Figure 2). After WTO accession Ukraine keeps its customs duties (tariffs) between 0% and 50% (binding rates). Some binding rates anticipate reduction phased in over the period to 2013. Ukraine's average tariff binding is 10.66% for agricultural products (4.95% for industrial goods). The highest tariffs Ukraine imposed on items such as sugar (50%) and sunflower seed oil (30%). Ukraine will introduce ad valorem import duties after WTO accession, with the exception for goods subject to excise tax (beverages, spirits and vinegar and tobacco products). Ukraine opened a tariff quota only for one agricultural good – raw cane sugar (260 000 tones annually, and increasing to 267 000 tones by 2010, at 2% tariff). The over-quota tariff is 50%.

From the date of accession, the following measures, including export licensing requirements, will be implemented in accordance with WTO agreement: Ukraine removes current export restrictions on grains; will not apply any obligatory minimum export prices; will reduce its export duties on oilseeds, live cattle and animal skins (Table 1). Before WTO accession, Ukraine used high level of export tariffs to limit the export of important commodities in food and textile industries. After WTO, these levels are reduced to average as explained below, only cattle and horse skins tariffs have higher level of protection – 20 percent.

Support of domestic agricultural producers. According to WTO rules, domestic agricultural support can be subdivided into three types: first type of support is provided to ensure public services, so called green box; second type of measures provides financial compensation to farmers for targeted reduction of their production, so called blue box; and the third type includes different measures of price or budget support of agricultural production, so called yellow box.

Measures from blue and green boxes have no impact on trade conditions and therefore they are not prohibited or limited by WTO. The yellow box measures, however, may affect trade market competitiveness, and that's why they are limited by WTO. The support level of yellow box – so called "Aggregated Measurement of Support" – was negotiated by Ukraine during 2004-2006 period to be on average 3.04 bln. UAH.

Production	Bound tariffs before accession, %	Bound tariffs after accession, %	Final bound tariffs, %	Liberalization period, years	Reduction level, %
Seeds of sunflower, flax and	17	16	10	6	41
Cattle, goat	75	50	10	8	87
Sheep	50	50	10	8	80
Cattle and hoses skins	30	30	20	10	33
Other skins	30	30	10	10	67

Source: http://zakon1.rada.gov.ua/signal/981_c69.doc

Table 1 Ukrainian export tariffs changers under WTO conditions

Export subsidy. During WTO accession Ukraine abandoned all export subsidies for agricultural products to fulfill criteria of world's trade liberalization.

Trade Flows and Regulations between EU-Ukraine: The Partnership and Cooperation Agreement between Ukraine and European Union and its member-states is the legal framework of Ukraine and EU relations. Cooperation between the Ministry of Agrarian Policy and the Euro Commission Board of Directors on "Agriculture and Rural Locality Development" has effect within the frames of Memorandum of Understanding for the dialog on agrarian issues signed on October 18, 2006, which is the component of Ukraine - EU Action Plan implementation.

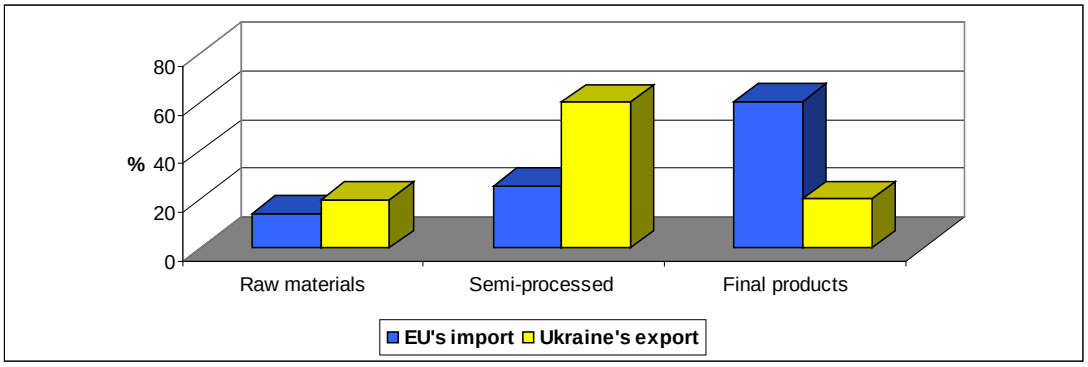

Figure 3 Structure of Ukraine's trade with EU

EU is currently one of the biggest trade partners of Ukraine – one third of total Ukrainian exports go to EU, while for EU, Ukraine is a rather small trade partner with only 0.9% of total EU trade. Main Ukrainian exports are iron and steel, agricultural products, energy products, chemicals, textiles and clothing, and transport equipment to EU. Main imports are chemicals, transport equipment, power/non-electronically machinery, office- and telecommunications equipment, and textiles and clothing from EU. Because of intra-industry trade patterns, Ukraine has positive trade balance only in iron and steel, agricultural products and the

energy sector. Overall trade balance between Ukraine and EU is negative. The structure of Ukrainian trade with EU is characterized by exports of raw materials and semi-processed goods, and imports of final products, primarily investment goods (Figure 3).

Agricultural exports of Ukraine to EU are the most important after the exports of metallurgy products. However, EU market is still limited for agricultural products from Ukraine because many of them do not confirm EU quality and safeguard standards (indicators). The quality of Ukrainian agricultural products is not the only reason for limited exports to EU. Another important economic aspect is a system of protection tariffs which exists in EU and protects EU internal agricultural market. EU has one of most developed system of tariffs (boundary) and governmental protection in the world.

EU agrifood market is export-oriented. EU exports to many countries at rather high prices for most of food products. Despite trade growth in Asian (Chine and India) and Latin American (Brazil, Argentina, Chili) countries, the EU share in total volume of world trade is around 30 percent.

High internal agrifood prices in EU are maintained by state financial support of agricultural producers and high level of protection on imports. Only 3% of the EU population is employed in agriculture, but it receives 60% of total EU budget as governmental support. In Ukraine, agricultural employment is about 13% of the total population, and they receive only 3-4% support. Below are the main differences between the existing EU and Ukrainian agricultural support systems:

- different level of governmental support;
- different institutional environment;
- difference of measures and mechanisms of market protection.

According to OECD estimates, total EU agricultural producers‘ support over the last 5 years accounted for 80-90 bln. Euro, including 30-40 bln. of governmental support (budget) and 35-50 bln. of price support, which is generated by the difference between world and EU prices [18]. Ukraine has no financial and legislative opportunities to support its agrifood sector. For example, production support of EU’s agriproducers is 0.31 euro per unit of total production or 190 euro in per capita terms, while the same indicators in Ukraine are only 0.05 and 20 euro respectively [18]. All these support measures are included in the yellow box (as explained before). The yellow box measures, in general, may affect foreign trade conditions and, therefore, are limited by WTO. But apart from these measures, EU applies a lot of other measures from green and blue boxes. In percentage terms, limited and non-limited measures are 35:65 in EU and 70:30 in Ukraine. Thus, EU supports its producers by non-limited measures, which Ukrainian producers don’t have opportunity to use. Most of developing countries (Brazil, Argentina etc.) protest against EU’s application of blue box measures. For example in 2007, EU provided 30 bln. euro to domestic agricultural producers, what was classified as blue box measure. But from economic and trade view points, these measures help to safeguard agricultural production in EU, what reduces EU imports dependency. That’s why, according to Kern countries, it will be correct to classify these measures as yellow box and limit them. All these measures are nearly 65% of total agricultural producer support in EU (OECD estimation). Another 35% is price support. In the absence of support, the prices would be equal. The difference between internal and world prices is classified as price support. The prices for most of agrifood products in EU are higher than world prices, thus consumers pay additional value to their domestic producers. Therefore, in general, high producer’s incomes in EU are supported by governmental budget transfers (indirect payments from consumers/taxpayers) and by direct consumers’ expenditures for food.

Internal EU market is very solvent, what makes it so attractive to different traders. There is a system of tariffs developed in EU to limit “cheap” imports and protect its domestic producers. Under WTO, most of agricultural commodities have higher import tariff in EU than in Ukraine

(Table 2). It is clear that products with high level of domestic support in EU have also high import tariff protection. These are, first of all, dairy products, other livestock products, sugar and confectionery, etc. EU in contrast to Ukraine imposes many import quotas (Ukraine has only one quota for refined sugar). The advantage of quotas is that they permit only a predefined volume of product to be imported in a country with specified import tariff. Beyond the defined volume, imports may be imported at the maximal level of import tariff.

Production group	Average, %		Duty-free in %		Maximum, %	
	Ukraine	EU	Ukraine	EU	Ukraine	EU
Animal products	13,0	28,7	0	20,6	20	236
Dairy products	10,0	67,8	0	0	10	225
Fruit, vegetable, plants	13,1	10,8	10,2	22,8	20	233
Coffee, tea	5,8	7,2	35,4	27,1	20	99
Cereals and preparations	12,7	27,0	3,3	6,3	20	124
Oilseeds, fats and oils	10,8	6,0	11,1	48,2	30	180
Sugar and confectionery	17,5	31,3	0,6	0	50	143
Beverages and tobacco	8,9	24,3	25,7	23,4	94	239
Cotton	1,4	0	40,0	100	5	0
Other agricultural products	7,6	5,2	23,9	66,4	20	133

Source: http://stat.wto.org/

Table 2 Final bound duties by agriculture product groups under WTO accession

Therefore, the EU has a complex two-stage system of agricultural producers' protection, what provides high price competitiveness for European in comparison with Ukrainian agrifood products. This difference of conditions for agriproduction between EU and Ukraine should be taken into consideration in future joint free trade agreements.

Until now, gained experience of conducting FTA (free trade agreements) between EU and Ukraine shows that future agreements will likely have same protective conditions for EU. For example, EU adopts the following types of protective measures, which, in fact, do not confirm with free trade concept:

- *low quotas for grain and other important products for import to EU from Ukraine*;
- *abatement of export tariffs on sunflower seeds in Ukraine*. This tariff limits gross export and provides the development of food industry in Ukraine. As a result, there are lower prices for oil-contained food products (for example, mayonnaise) and cheap feed for livestock production. Export tariff reduction may lead to rapid increase of sunflower seeds export to EU (in response to high demand of biofuel industry), what would impact domestic price of all product line: seeds-oils-feed-different food.
- *limit on animal products export to EU (dairy products, meat);*
- *export subsidies in EU;*
- *use of special protection measures under WTO by EU.*

These measures contradict free trade principles, and the EU will further prejudice the advantages of free trade for Ukraine. In particular, the EU tariff quotas and other protective measures don't create additional incentives for agricultural growth in Ukraine (except rapeseeds and sunflower production), but create a lot of prerequisites for agricultural import increase from the EU to Ukraine.

4. Trade Liberalization Consequences vs. Food Insecurity

Economic security. During the last 10 years world demand for agricultural production increased after several natural catastrophes, energy and financial crisis. Ukraine, as a country with large share of agriculture, gained high profits from its exports and higher food prices. Ukraine's WTO accession in 2008 stimulated foreign trade through reducing customs duties and import tariffs. During the last 10 years agricultural export of Ukraine raised from 1.6 to 9.8 bln. doll. In particular, crops export raised 6 times while livestock – only 2 times.

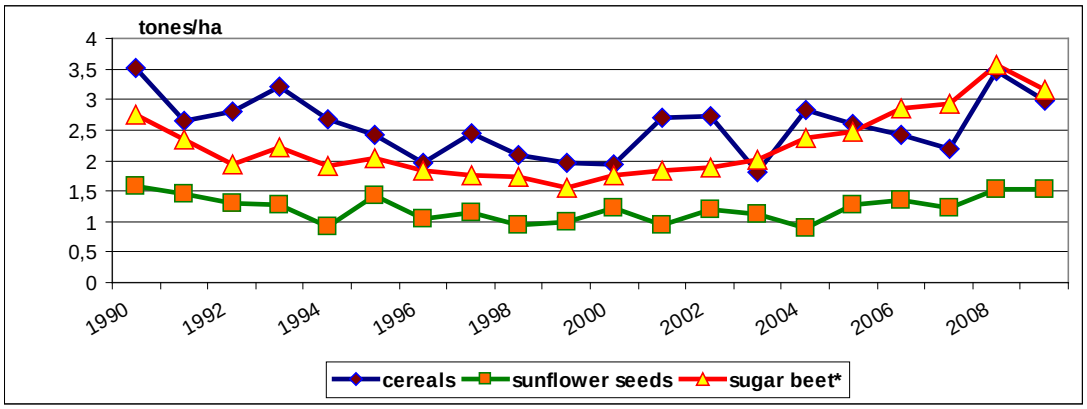

Figure 4 Yield of main agricultural products

* - 10 tones per hectare

Figure 4 shows rush increase of cereals and oils exports and imports of meat and fruits in 2008 and 2009 after WTO accession. Ukraine became net-exporter of cereals and vegetables oils and net-importer of meat and fruits. This indicates that trade liberalization deepens the specialization of country's production. From an economic view point, specialization brings additional profits from effective allocation of recourses, however in the presence of risks and without proper state regulations it can lead to increasing volatility of agrifood systems.

Instabilities of agrifood systems are caused, in particular, by imbalances between domestic crop and livestock production. For example, prior to 1990, livestock sector was among the most important agricultural activities contributing 55% to total agricultural GDP. The share decreased to 44% in 2000 and then to 39% in 2009, main reasons being increased operational costs and decreased feed production. Most of land resources are used not for producing agricultural commodities for direct consumption, including livestock feeds, but for production of cash crops such as sunflower and rapeseeds. Production of highly profitable cash crops ensures profitability of farmers and high level of currency flows into Ukraine (exports of sunflowers and rapeseeds make about 62% of all agricultural exports). Monocropping structure of agricultural production in Ukraine, which is dominated by sunflower and rapeseeds, creates problems with cereals production especially under weather uncertainties. Instable grain yields in recent years could not guarantee incomes to producers. For example, because of poor yields in 2000, 2003 and 2007 (Figure 4) cereals export was about 10-25% of the 2008-2009 years level.

Social security. Production intensification and increased cash crops production led to many adverse problems in agriculture, but most harmful are impacts on demographic and socioeconomic situation in rural areas. Foremost, this relates to increased rate of rural unemployment. Intensive large scale enterprises and agro holdings require much fewer workers than soviet-type agro businesses. This has released a rather substantial part of rural

workers and inspired rural – urban migration, what led to rural area depopulation and degradation [2]-[4]. Depopulation and deterioration of living conditions and infrastructure in rural areas are also due to the fact that unlike the Soviet times when almost all expenses on the development, social security, health and fiscal provision of rural areas were taken by the state and local collective agrarian enterprises, during and after the reform "market" rules were introduced, i.e. agrarian enterprises make profits while local communities have to develop rural areas. It should be noted that a majority of large scale producers are registered in cities and rarely pay taxes into local budgets.

Figure 5 Employment in agriculture of Ukraine

The number of people employed in Ukrainian agriculture equals about 30% of total rural population. This includes also self-employed households. Figure 5 shows the trend of agricultural employment: the number of hired workers decreased two-fold from 2000 to 2008 (Figure 5). The problem of declining agricultural workers is typical for most of the countries with high agricultural share [11]. Considering rash emergence of large agriholdings and the risks they cause to rural areas development, new approaches for organization and planning need to be properly designed in order to enable agriculture and rural development with a multitude of farming activities. Ukrainian government may impose regulations that provide equal and transparent financial support for doing business by all forms of enterprises in agricultural production and service sectors. In fact, 20 years ago many EU countries faced similar problem. Special state programs were implemented then to increase the rural livelihood and employment by investing into agricultural and non-agriculture production and services.

Food Security. Food security is a flexible concept which has been defined and redefined according to research and policy usage. The latest definition is "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life." Thus food security enfolds three important notions:

- Sufficient food production;
- Affordable food prices;
- Food diversity and quality.

Food security regulation in developed countries requires that 80-85% of the demand is covered from domestic production. To determine food security level in Ukraine we rely on the following 7 indicators:

- Calorie content of foods;
- Diversity of food products;
- Adequacy of grains production;
- Economic affordability of foods;
- Food expenditures by social groups;
- Internal agricultural market capacity;
- Import dependency.

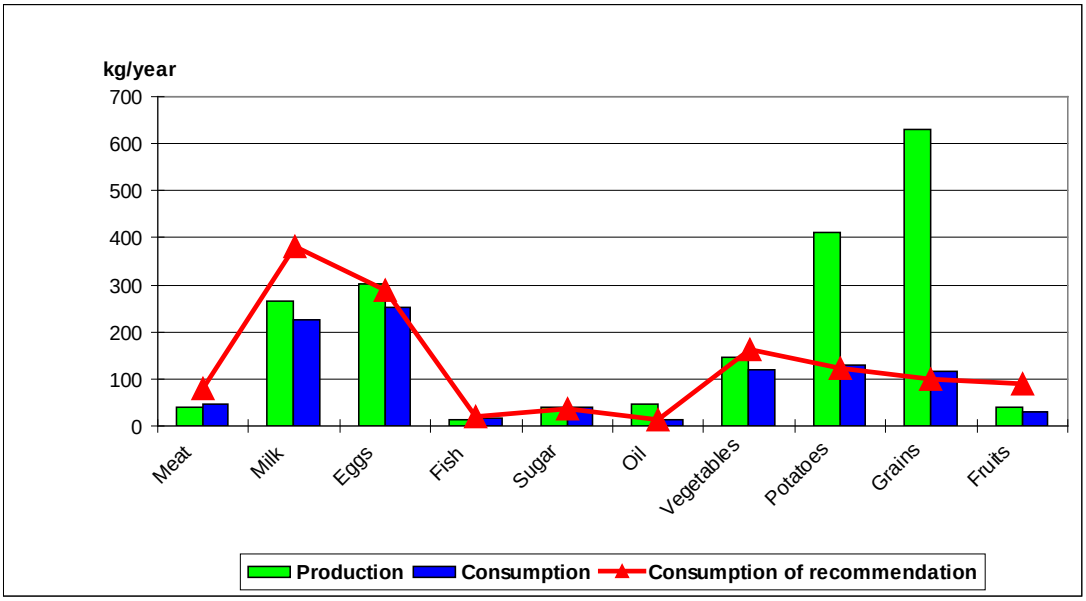

Figure 6. Food self-sufficiency of main agricultural products

During 2000-2009 calorie content of foods consumed by Ukrainians increased slowly, however, consumption of animals' proteins still stays at rather low level. Figure 6 compares Ukrainian consumption rates with consumption norms (medical recommendation) by main agricultural commodities.

Consumption of livestock products is almost twice lower than recommended level. In Figure 6, milk production is higher than consumption, but large share of produced milk is processed (dry and condensed milk). Insufficient meat production creates incentives for production increase. Government must be directly interested to help domestic producers to win internal livestock market because it is likely that under trade liberalization imports of livestock products to Ukraine will increase every year.

Ukrainians spend a rather high share of their income on food, i.e., 50.8% in comparison to 20-25% spent by average EU citizen, which indicates to an imbalance between incomes and food prices. In Ukraine, the share of expenditures on food differentiates across the regions varying, for example, from 45% in Kiev to 59.9% in the Odessa region. It is also true that potatoes and cereals dominate the diets of a Ukrainian citizen.

One of the most important indicators of state food security is import dependency (Figure 7). There are four main groups of products such as oils, fish, fruits, and meat, which have high import dependency. High dependence on oils imports is determined by high demands of food industry for exotic oils, like palm, soybeans etc., which are not produced in Ukraine. Dependence on fruits imports increased considerably after Ukraine's WTO accession. Fruits (apples, peaches, etc.) are no longer considered as profitable commodity and therefore are

not preferred by current profit driven producers. As a result, fruit import dependency of Ukraine increased to 61.4 %.

As a conclusion, if measured in terms of seven indicators, food security in Ukraine improved in the period from 2000 to 2008. However, there are urgent questions related for example to raising import dependency and increasing food prices, which are driven by production specialization, trade liberalization and globalization. These implications of new trade policies require additional attention and governmental regulations.

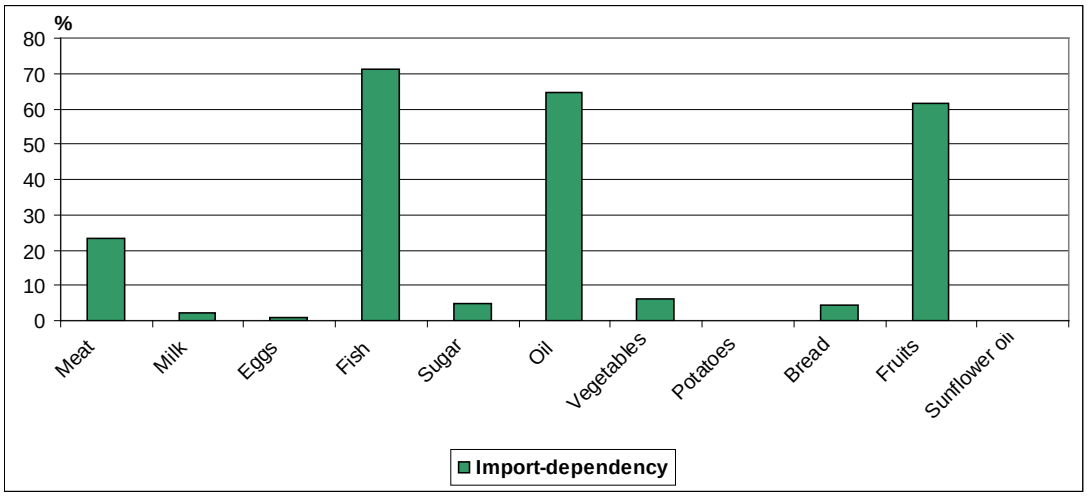

Figure 7 Import-dependency of the main agricultural products

Environmental security. The territory of Ukraine is about 60.4 million hectares. The area of agricultural lands is about 67% of the total area. In other countries, this index does not exceed 27%. Ukraine has extremely fertile black soils (chernozems) especially in the central and southern parts, totaling to more than a half of the territory.

In many Ukrainian regions, increasing production intensification causes acute problems of imbalanced land utilization, soil/water/air contamination, worsening physio-chemical properties of soils. In accordance with the data on land use, in recent years the quantity of eroded (washed away) agricultural land in Ukraine expanded to 13.3 million hectares (about 32% of the total agricultural area), including slightly eroded - 66.5%; and medium- and strongly eroded, 33.5%. Degraded land extended by 19.4 million hectares (46.2% of total agricultural land). Main hot spots of degraded land concentrate in southern (41.7%) and northern and central Steppe (33.1%) parts of Ukraine.

Main reasons for worsening land/soil quality:

- high production level of arable land;
- erratic cropland utilization, imbalanced cropland utilization by regions;
- fast land degradation, uncertainty about land degraded areas;
- new types of land tenure characterized by instabilities and small areas which are chaotically emerging in response to changing/liberalization of market conditions
- insufficiency of special purpose areas such as managed forests, natural parks, historical and preserved (sanitation) land areas;
- absence of ecological and environmental regulations against anthropogenic intrusions into land resources.

Production intensification and specialization substantially expanded land utilization. Figure 8 shows that utilization share of arable lands in southern and central regions exceeds

country's average, which is about 53%. Nine regions have very high utilization share (nearly 60%) and 7 regions have extremely high share (more than 70%).

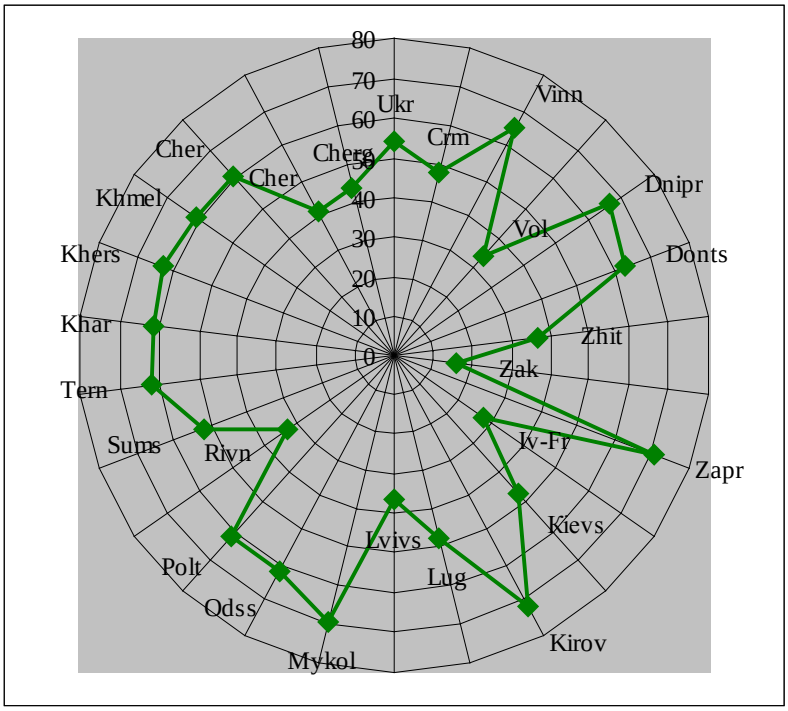

Figure 8 Regional arable land in Ukraine, %

The decrease of livestock production during 1993-2009 led to rapid decline of organic fertilizes application. Application of organic fertilizers decreased from 8.6 tons per ha in 1990 to 1.3 tons per ha in 2000. During 2001-2009, this level decreased further twofold. Currently, only 2.5% of total arable lands in Ukraine are nourished by organic fertilizes.

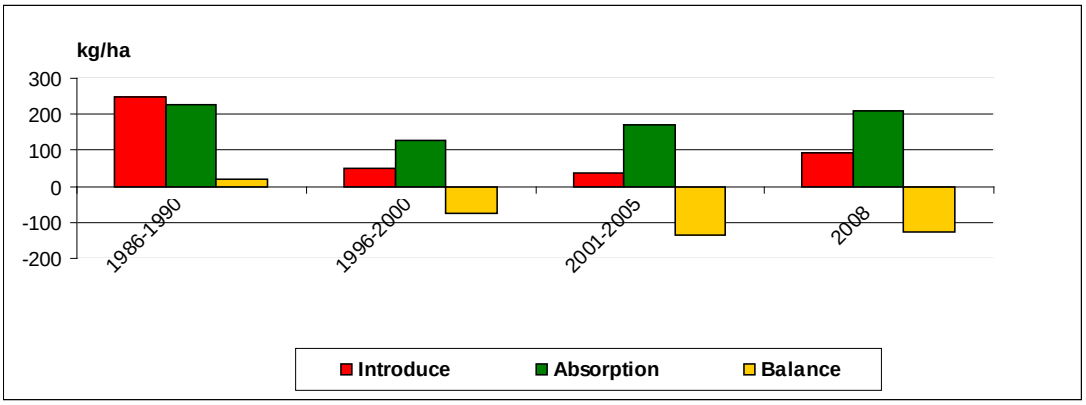

Figure 9 Dynamics of nutrients content (NPK) in agricultural soils of Ukraine

Profit maximization principle in agriculture led to monocropping. Intensive producers apply primarily one type (with high nitrogen content) of mineral fertilizers, which ensures high yields. Consequently, nutrients content in soils changes. Figure 9 illustrates the decrease of "useful" nutrients content in agricultural soils during 2000-2008 (Figure 9).

Intensive production of cash crops without adequate crop rotation changes natural soil composition. In general, soils in Ukraine are characterized by high productivity, but the humus content in soils dropped from 3.5 to 3.2% in 25 years. It is estimated that agricultural land in Ukraine loses 0.65 ton humus per hectare annually. It is important to preserve soil productivity for future generations, what requires state regulations to ensure rational utilization of land resources.

Ukraine's agriculture is the second biggest user of water resources in economy. Today agriculture consumes nearly 25% of total water resources of which 13% returns to natural water sources. Ukrainian experts estimate agricultural share to total environment pollution on average around 35-40% [19].

5. Integrated Modeling Approach

5.1. Long-term priorities of agrarian policy to ensure sustainable development and food security

The years of market reforms in agricultural sector of Ukraine are characterized by essential changes: sharp reduction of agricultural production, increasing production costs, imbalanced production and processing, increasing shortage of production for food and processing industries. These changes led to many socio-economic problems including worsening conditions in rural areas, increasing prices and decreasing stability of food provision to population. Most of Ukraine's territory has favorable conditions for agricultural production. Under efficient management this may ensure increasing profits and lowering production costs. The "State Program" specifies a number of priorities for long-term agriculture development: increase rural life quality, including increase their profits; increase employment, including entrepreneurship development; support of agriculture competitiveness under liberalization; provide ecological-safety under agricultural production. The State Program identifies also several pathways of sustainable agriculture development such as: agricultural investments according to zonal and economic production potentials; implement measures to increase market volume satisfying demand and medical norm of consumption; export maximization.

Among the most important Ukrainian agricultural policies (Figure 10) are development of sustainable agro-food production and market. More than 40 percent of total governmental support will be used for their improvement. In crop production the main indicator is a balance between demand and production. In livestock production the main indicator (purpose) is the rate of animals (including 1.7-1.9 mln. herds of cows in the agricultural enterprises) and meat production increase.

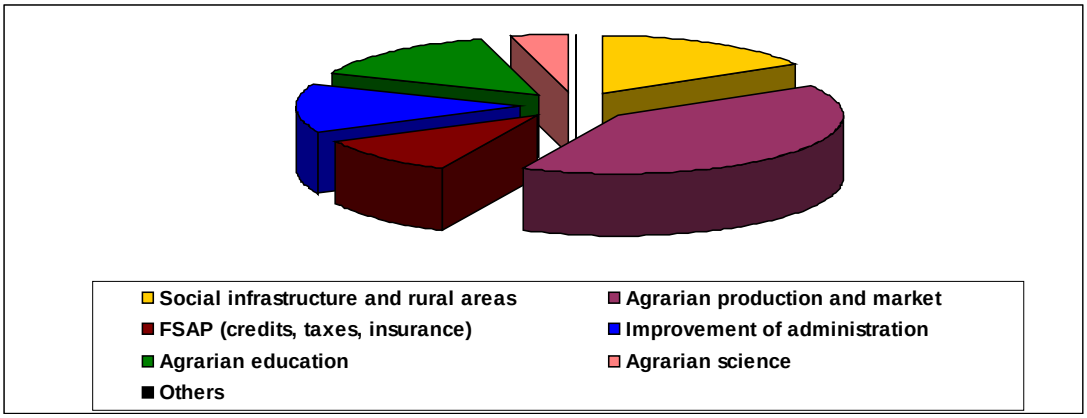

Figure 10 Priorities of long-term Ukrainian agrarian policy

Primary goal of agriculture development in Ukraine is to enhance food security. Under trade liberalization (practically no limits for trade flows between different countries and regions) and increasing risks and instability of agro-food production due to weather variability, financial and economic shocks, food security becomes a main problem.

To fulfill food security problem, the Ukrainian State Program wants to ensure the increase of agro-food production to 2015. For example, grains yield is expected to be 50 mln. tones; sugar beet – 25 mln. tones; vegetables – 8 mln. tones; potatoes – 18 mln. tones; oils crops – 15 mln. tones; meat – 5.1 mln. tones; milk – 20 mln. tones; eggs – 17 bl. pcs.

As described in the third section, trade liberalization impacts self-sufficiency of agro-food products and food security in Ukraine. For planning domestic agricultural productions, we develop an integrated model that permits to identify optimal production portfolios, allocation and intensification by locations/regions under foreign trade competition (WTO, Ukraine-EU FTA).

5.2. Integrated model

The goal of the integrated production planning model is to analyze optimal agricultural production portfolios, production allocation and intensification in the presence of systemic agricultural risks that emerge in Ukraine after internationalization and trade liberalization. The model incorporates variables responsible for international trade and trade policies, such as tariffs and quotas to provide insights into potential effects of changing these variables on domestic production portfolios and food security. The model is spatially and temporally explicit. Currently, it involves only two time intervals, current and future. The model operates on the level of Ukrainian regions. We introduce EU as additional 26th region to study trade policies. Each region is characterized by production of and demand for different agricultural commodities.

The model permits to derive optimal region-specific production portfolios satisfying demands by minimizing production costs and maximizing profits. The model incorporates insurance variables, what permits to investigate the role of agricultural insurance for enhancing food security. In the absence of insurance, farmers either take very conservative risk averse decisions or increase crop specialization (e.g. cash crops) to ensure guaranteed yields. Increased monocropping, which is the case for Ukraine, does not fulfill demands in other essential agricultural commodities, in particular, cannot ensure sufficient feeds for livestock sector. To hedge risks, insurance permits farmers to diversify their portfolios in a better way. We show how in the presence of insurance, crop farmers may become risk-takers with more diversified portfolios fulfilling food security goals.

Formally the structure of the model is as follows. Production of main agricultural commodities is allocated by regions. Food security targets include direct demand for food and feeds and indirect demand, e.g., international export obligations and inter-regional trades. Let $x_{ij} \geq 0$ denote potential production of commodity i in region j to meet demand d_i in product i. The model in [2]-[4] investigates production planning for livestock producers only. In this paper, we extend the model to include main crops such as wheat, barley, sugar beet, sunflower, rapeseeds, corn. To identify the role of agricultural insurance for enhancing food security in Ukrainian, the production function of farmers incorporates variables responsible for insurance policies, i.e., premiums and coverage. In the model, we assume that farmers want to guarantee stable incomes. Stability of incomes may be increased by buying insurance. Production function of an "aggregate" farmer in location j is represented as follows:

$$
\begin{aligned}
I_j = & \sum_{i=1}^{n} P_{ij} a_{ij}(\omega) x_{ij} - \sum_{i=1}^{n} c_{ij} x_{ij} - \sum_{i=1}^{n} \pi_{ij} + \\
& \sum_{i=1}^{n} l_{ij} x_{ij} \max\{0, a_{ij}^{*} - a_{ij}(\omega)\} P_{ij} + \\
& \sum_{k} P_{ki} z(\omega)_{kij} - \sum_{k} P_j z(\omega)_{ijk},
\end{aligned}
\qquad (1)
$$

where i indexes crop/livestock type, j - farmers (regions/oblast), k denotes import or export between regions, $j = \overline{1:n}$ ($n = 25$ or $n = 26$ if foreign region is included). In (1), farmers' profits are defined as a difference between total incomes (revenues) and total expenditures. The incomes consist of revenues from crop sales $\sum_{i=1}^{n} P_{ij} a_{ij}(\omega) x_{ij}$ and insurance compensations $\sum_{i=1}^{n} l_{ij} x_{ij} \max\{0, a_{ij}^{*} - a_{ij}(\omega)\} P_{ij}$, while the expenditures include production costs $\sum_{i=1}^{n} c_{ij} x_{ij}$ and insurance premiums $\sum_{i=1}^{n} \pi_{ij}$. Inter-regional trade flows are included as $\sum_{k} P_{ki} z_{kij} - \sum_{k} P_j z_{ijk}$, where $\sum_{k} P_{ki} z_{kij}$ equals to value of imports purchased by region j and $\sum_{k} P_{ki} z_{kij}$ - value of exports from region j. Trades redistribute the products between producers and consumers to satisfy the required regional and national food security targets. The demand for insurance is guaranteed if farmers do not overpay to insurance. In the model, a condition regulating the demand for insurance is introduced by a fairness constraint on the level of farmer's payment to insurance company:

$$
\Pr ob\left[\sum_{i} \pi_{ij} \leq P_{ij}(\omega) l_{ij} x_{ij} \max\{0, a_{ij}^{*} - a_{ij}(\omega)\} \right] \geq p_j \qquad , \; j = \overline{1:m}, \qquad (2)
$$

where $\sum_i \pi_{ij}$ denotes total premiums paid to insurer from farmers j for crop i, $P_{ij}(\omega)$ price for crop i which farmer j would pay if his crop yield a_{ij} is below threshold level a_{ij}^{*},

Insurer's business is described by means of insurer's risk reserve or a balance between premiums from all farmers paid into the insurance fund and claims/coverage paid out to those farmers whose yields are below threshold or targeted level:

$$R = \sum_{i,j} \pi_{ij} - \sum_{i,j} l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} P_{ij}(\omega), \quad (3)$$

This condition imposes a "collective risk" or a safety constraint on insurer's performance requiring that total claims should be less then total premiums with defined safety probability level γ :

$$\Pr ob\left[\sum_{i,j} \pi_{ij} - \sum_{i,j} l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} P_{ij}(\omega) \geq 0 \right] \geq \gamma \quad (4)$$

Equation (4) guarantees also the level of insurance supply.

Food security constraint is necessary to maintain a certain level of agricultural product supply that is termed as food security level. Food security can be attained through actual agricultural production $a_{ij}(\omega)x_{ij}$, farmer compensation $l_{ij}x_{ij}\max\{0, a_{ij}^* - a_{ij}(\omega)\}$ if actual yield $a_{ij}(\omega)$ is lower than expected a_{ij}^*, or/and through trade balance between regions $\sum_k z_{kji}(\omega) - \sum_k z_{jik}(\omega)$. Therefore, food security constraint is introduced in the model as follows:

$$a_{ij}(\omega)x_{ij} + l_{ij}x_{ij}\max\{0, a_{ij}^* - a_{ij}(\omega)\} + \sum_k z_{kji}(\omega) - \sum_k z_{jik}(\omega) \geq d_j \quad (5)$$

for all ω. The overall goal of the model is to maximize expected farmers profits under constraints (2), (4), and (5):

$$\max \sum_j EI_j \quad (6)$$

s.t.

$$\Pr ob\left[\sum_i \pi_{ij} \leq P_{ij}(\omega) l_{ij} x_{ij}, \max\{0, a_{ij}^* - a_{ij}(\omega)\} \right] \geq p_j, \quad (7)$$

$$\Pr ob\left[\sum_{i,j} \pi_{ij} - \sum_{i,j} l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} P_{ij}(\omega) \geq 0 \right] \geq \gamma \quad (8)$$

$$a_{ij}(\omega)x_{ij} + l_{ij}x_{ij}\max\{0, a_{ij}^* - a_{ij}(\omega)\} + \sum_k z_{kji}(\omega) - \sum_k z_{jik}(\omega) \geq d_j \quad (9)$$

where , $\omega \in \Omega$, $\forall j = \overline{1:m}$, $\forall i = \overline{1:n}$, where i indexes crops and j - producers (regions/oblast), $\forall i = \overline{1:n}$, $\forall j = \overline{1:m}$

The problem may be rewritten as:

$$\max \sum_j \left[w_j EI_j + \alpha_j E \min\{0, \sum_i P_{ij} l_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} - \sum_i \pi_{ij}\} \right] +$$

$$\lambda E \min\{0, \sum_{ij} \pi_{ij} - \sum_{ij} l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\}\} \tag{10}$$

s.t.

$$a_{ij}(\omega) x_{ij} + l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} + \sum_k z_{kji}(\omega) - \sum_k z_{jik}(\omega) \geq d_j . \tag{11}$$

Here, in addition to expected profits EI_j, expectations

$$E \min\left\{0, \sum P_{ij} l_{ij} \max\left\{0, a_{ij}^* - a_{ij}(\omega)\right\} - \sum_i \pi_{ij}\right\} \tag{12}$$

and

$$E \min\left\{0, \sum_{ij} \pi_{ij} - \sum_{ij} P_{ij} l_{ij} \max\left\{0, a_{ij}^* - a_{ij}(\omega)\right\}\right\} \tag{13}$$

define expected overpayments by farmers and expected deficit of insurer's reserve, respectively. Coefficients α_j define import prices and λ stands for the price of reinsurance of contingent credit which insurer will buy if his reserve does not cover all claims.

Let us assume that in each location j we have N scenarios (observations) of random variable ω, i.e., ω_j^k, $k = \overline{1:N}$, which induces random yields $a_{ij}(\omega_j^k)$ of crops i. Hence, expressions (12) and (13) may be represented as empirical expectations

$$\frac{1}{N} \sum_{k=1}^{N} \min\left\{0, \sum P_{ij} l_{ij} \max\left\{0, a_{ij}^* - a_{ij}(\omega_j^k)\right\} - \sum_i \pi_{ij}\right\} \tag{14}$$

and

$$\frac{1}{N} \sum_{k=1}^{N} \min\left\{0, \sum_{ij} \pi_{ij} - \sum_{ij} P_{ij} l_{ij} \max\left\{0, a_{ij}^* - a_{ij}\right\}\right\} \tag{15}$$

In the linearized form, the problem (10)-(11) may be rewritten as follows:

$$\max \sum_{j=1}^{m} w_j \left[y_j + \beta_j \frac{1}{N} \sum_{k=1}^{N} v_k^j \right] + \sum_{j=1}^{m} \alpha_j \left(\frac{1}{N} \sum_{k=1}^{N} t_k^j \right) + \lambda \left(\frac{1}{N} \sum_{k=1}^{N} \varphi_k \right)$$

s.t.

$v_k^j \leq 0$,

$v_k^j \leq I_j(\omega_k^j, x, z, \pi) - y_j$,

$$t_k^j \le 0,$$

$$t_k^j \le \sum_{i=1}^{n} P_{ij} l_{ij} \xi_{ij}(\omega_k) - \sum_{i=1}^{n} \pi_{ij},$$

$$\varphi_k \le 0,$$

$$\varphi_k \le \sum_{ij=1}^{n,m} \pi_{ij} - \sum_{ij=1}^{n,m} P_{ij} l_{ij} x_{ij} \xi(\omega_{ij}).$$

$$a_{ij}(\omega) x_{ij} + l_{ij} x_{ij} \max\{0, a_{ij}^* - a_{ij}(\omega)\} + \sum_k z_{kji}(\omega) - \sum_k z_{jik}(\omega) \ge d_j,$$

for all scenarios of $\omega_k \in \Omega$, $j = \overline{1:m}$, $i = \overline{1:n}$, where i indexes crops and j - producers (regions/oblast).

5.3. Analysis of numerical application

This Section summarizes some preliminary results of the case study addressing optimal allocation of production among Ukrainian regions (oblasts). In this paper we illustrate the model application with an example of meat (beef) production only, while the role of insurance and optimal crop production allocation is studied in (Skripnichenko et. al., 2010). Price and cost of beef production vary between different regions of Ukraine. Coefficient of price variation is 34%, and cost variation is 39%. Expediency of product transportation stipulates the total transportation costs and additional costs, which are in the ranges 0.5-0.1$ tone/km. In the model, we assume that consumers price increases with increased transportation costs. Average distance between regional centers is estimated to be around 500 km. According to the model, producers (regions) with low production costs have incentives to produce more and sale surplus to regions with higher production costs.

Similar to [2]-[4], the model estimates necessary level of livestock production increase by regions to satisfy regional demands in beef. Beef demand differentiates by rural and urban consumers. It is estimated that additional ("model-based") allocation of beef production will increase total incomes of Ukrainian livestock producers by 8.4 %.

To simplify the exposition, we present the results of our studies in a schematic way. Current allocation of beef production in Ukraine (Figure 11, a) is characterized by four main production zones (Carpathian, Western, Northern and Southern zones). Within each zone there are regions with quite different levels of production costs and production potentials. Accounting for region specific financial and natural constraints for production increase, the model suggests more spatially distributed production that cover local demands better. Thus, in Figure 11.b another large production zone emerges, namely Southern zone marked with yellow color.

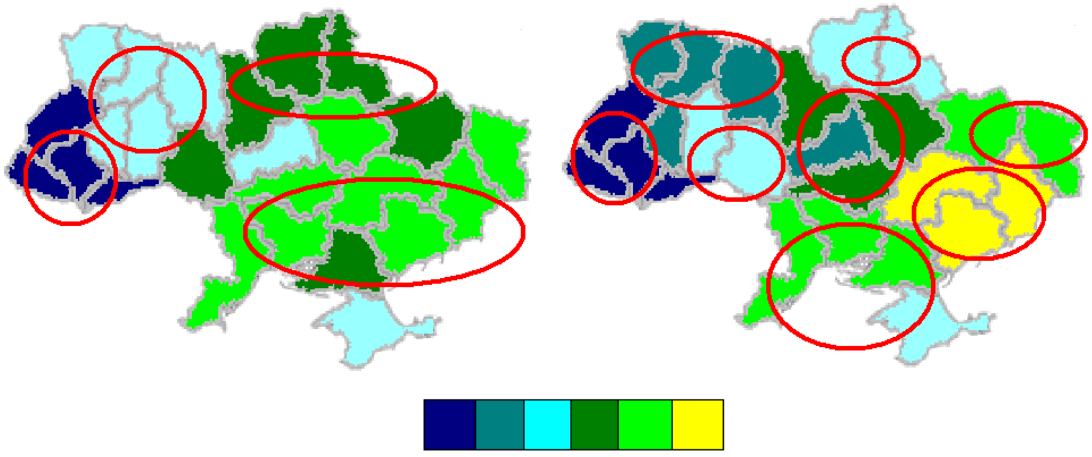

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Figure 11 Current (left) level of beef production and
model-based (right) level of beef production (tones per 100 ha agricultural land)

Model-based allocation of beef production satisfies main purposes of agrarian policy: food security and ecological safety. Allocation according this approach it helps to cut the pressure on ecology in the Carpathian zone. The model confirms that natural conditions of Carpathian zone are more suitable for small animals production, while large cattle breeding and beef production fit better into central regions with larger pastures and better access to sources of feeds. Beef cattle in Ukraine comprise nearly 40 % of total cattle herd.

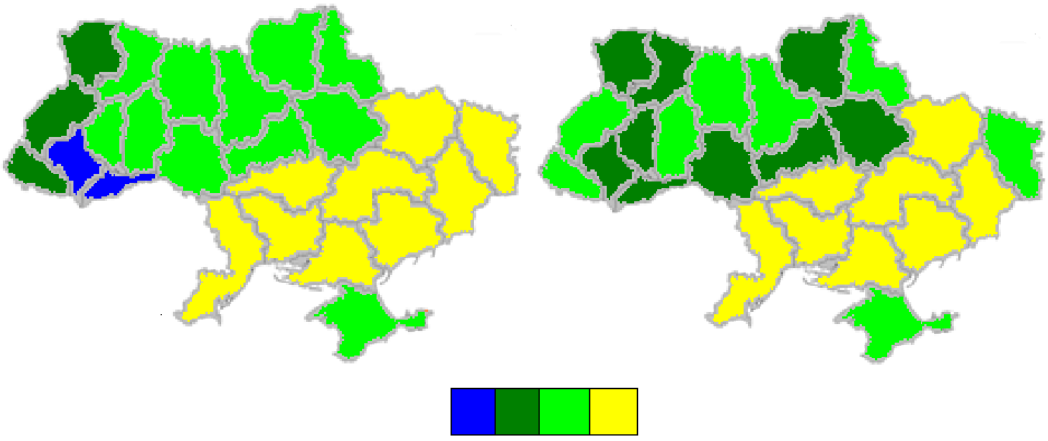

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Figure 12 Ecological situation before modeling (left)
and after modeling (right) (density of meat herds per 100 ha agricultural land)

With better spatial diversification, Ukrainian producers have good opportunities to increase their production and exports of beef to EU. Despite the fact that European external demand is only 2% of EU's own production, it is 35% of Ukrainian own production. Cost competitiveness of Ukrainian producers confirms our assumption, but for strict calculation we need to include more data on each trade partner of EU.

6. Conclusions

This paper provides an overview of agriculture development in Ukraine in the period from 1990 to 2008, which distinguishes three main stages: 1991-1999, characterized by the default of agriculture; 2000-2007, characterized by resuming agriculture production, raising budget support of agricultural production; 2008-present Ukraine's WTO accession. The paper identifies main impacts of current trade policies, in particular, socio-economic-environmental consequences of agricultural trade internationalization and liberalization in Ukraine.

The paper describes a spatially detailed production planning model which explicitly includes the goals of "State Program of Ukrainian Agriculture Development to 2015", adopted in 2007. Some of the main goals are: increase the quality of life in rural areas; increase incomes of rural households through improved management, diversification, and financial support of domestic agrifood sector; increase employment in rural areas, including small and medium entrepreneurship development; increase competitiveness of Ukrainian farmers under liberalization; fulfill environmental norms of agrifood production and ensure their efficient monitoring. With an example of beef production, we illustrate how the model may derive important policy advise regarding optimal allocation and diversification of agricultural production. We conclude that model-based planning allocation of beef production may increase total profits of Ukrainian producers by 8.4 %. By improving spatial allocation taking into account natural and financial constraints, this approach helps to cut ecological pressure from livestock production in Carpathian regions of Ukraine. Natural conditions of these regions fulfill the requirements of small animals production, while cattle-breeding fits better natural and historical conditions of central regions, which is confirmed by modeling results.

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ANNEX 1

Table 1. Dynamics of production of main agricultural products

Indicators / Product	Annual values					2009 / 2000, %
	1990	2000	2007	2008	2009	
I. Crop production, mln. UAH (against the 2005 prices)	66560	43573	49718	64899	63314	145,3
1. Grains, mln. tones	51009	24459	29295	53290	46028	188,2
2. Sugar beet, mln. tones	44262	13199	16978	13438	10067	76,5
3. Sunflower, mln. tones	2571	3457	4174	6526	6364	184,1
4. Potatoes, mln. tones	16732	19838	19102	19545	19666	99,1
5. Vegetables, mln. tones	6666	5821	6835	7965	8341	143,3
II. Livestock, mln. UAH (against the 2005 prices)	79315	34316	39051	39079	40716	118.7
1. Total meat production, th. tones	4357,8	1662,8	1911,7	1905,9	1917,4	115,3
2. Milk, th. tones	24508,3	12657,9	12262,1	11603,6	11761,3	92,9
3. Eggs, mln.	16286,7	8808,6	14062,5	15856,8	14956,5	169,8
4. Population, th.:						
- cattle	25194,8	10626,5	6175,4	4917,6	5079,0	47,8
- pigs	19946,7	10072,9	8055,0	7135,4	6526,0	64,8
- poultry, mln.	255,1	126,1	166,5	190,5	177,6	140,8
III. Total agricultural production, bln. UAH (against the 2005 prices)	145875	77889	88769	103978	104030	133,6

ANNEX 2. Ukraine's Foreign Trade of Agro Food Products

Table 1. Ukraine's agro food export

Product's groups	2000		2005		2007		2008		2009	
	tones	mln. $	tones	mln. $	tones	mln. $	tones	mln. $	tones	mln. $
01 - Live Animals	6401	6,1	936	2,8	862	3,7	964	6,5	1818	9,6
02 - Meat and edible meat offal	151280	194,3	64019	154,3	40145	105,2	25450	74,8	37891	79,1
03 – Fish and preparatios	4818	6,0	13787	19,7	21206	30,5	24212	39,6	31622	38,1
04 - Dairy produce	101559	221,4	275344	647,8	188582	663,3	202797	722,3	164253	423,6
07 - Edible vegetables, roots & tubers	33930	13,3	205956	39,3	176583	70,7	139697	81,9	485412	159,4
08 - Edible fruits & nuts	20206	19,1	76359	102,2	76179	141,5	82227	172,0	151581	176,5
09 - Coffee, tea, mate & spices	2318	1,0	1958	2,2	2299	4,7	2405	6,8	4575	7,0
10 - Cereals	1286826	122,9	12492781	1383,1	4206886	763,7	16136372	3704,2	25746031	3556,3
11 - Products of the milling industry	44694	13,9	103483	29,1	196897	73,7	379915	180,3	302514	89,7
12 - Oil seeds & oleaginous fruits	913055	150,0	479614	116,9	1639889	628,8	2709570	1390,2	2918819	996,4
15 - Animal or vegetable fats	590114	236,0	895250	573,3	2129036	1692,0	1582594	1900,0	2484367	1750,0
16 - Preparations of meat	8957	14,9	12776	13,2	2902	8,1	1152	4,1	680	2,5
17 - Sugars & sugar confectionery	168409	101,3	151840	95,9	149041	135,4	119298	150,8	133749	148,5
18 - Cocoa & cocoa preparations	52618	62,0	155900	240,1	155776	353,2	178559	503,1	181124	448,6
19 - Preps. of cereals, flour, starch, etc.	35397	21,6	94278	97,8	130936	166,7	155509	245,8	147630	205,0
20 - Preps. of vegs, fruits, nuts & plants	57814	26,7	171847	119,0	251317	250,6	165581	194,5	154518	148,3
21 - Miscellaneous edible preparations	7538	4,4	41709	49,4	50271	75,9	59420	102,8	57943	88,4
22 - Beverages, spirits & vinegar	108707	43,8	636655	425,6	774872	536,6	877025	877,0	780067	458,6
23 - Residues and waste of food industry	500481	40,7	1471631	139,6	2069592	338,6	1887077	491,2	2952721	322,1
24 - Tobacco & tobacco products	16187	77,0	14380	91,4	19133	183,1	18984	222,6	20137	214,0
Total agricultural export	-	1580	-	4669	-	6798	-	11285	-	9773

Source: data base of Ministry of agrarian policy of Ukraine

Table 2. Ukraine's agro food import

Product's groups	2000		2005		2007		2008		2009	
	tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. doll
01 - Live Animals	1026	4	15356	42,8	5373	51,5	12605	84,2	9004	74,3
02 - Meat and edible meat offal	29811	22,3	260768	166,5	207875	163,9	512188	843,7	429695	568,5
03 – Fish	234517	89,3	425847	289,9	466716	542	577949	739,5	444375	535,4
04 - Dairy produce	8405	10,2	33148	43,5	50886	91,7	43811	111,2	45862	112,1
07 - Edible vegetables, roots & tubers	15615	6,1	20357	11,8	43096	27,7	179594	91,2	128231	77,8
08 - Edible fruits & nuts	156743	55,2	651737	193,7	1001081	293,8	1036255	581,9	988481	631,9
09 - Coffee, tea, mate & spices	24405	45,6	43478	107,5	44418	52,7	52707	212,6	51063	191,5
10 - Cereals	867983	118,4	150494	57,6	166857	86,6	115197	146,5	96129	98,6
11 - Products of the milling industry	173278	35,5	71036	24,9	140483	71,1	67888	48,8	37405	20,3
12 - Oil seeds & oleaginous fruits	16961	13,1	49069	49,7	47703	95,3	53706	166,7	32104	92,0
15 - Animal or vegetable fats	54136	41,2	246627	149,3	389255	298,3	464071	492,4	313350	276,7
16 - Preparations of meat	1621	1,8	23990	33,7	18936	25,5	22243	46,9	5081	14,6
17 - Sugars & sugar confectionery	322964	74,8	226598	79,0	26437	32,0	91098	65,6	129156	87,6
18 - Cocoa & cocoa preparations	42007	70,9	212796	226,9	96992	268,5	126617	359,1	99542	302,4
19 - Preps. of cereals, flour, starch, etc.	9636	11,1	34024	52,8	54417	109,7	60806	153,7	40677	96,3
20 - Preps. of vegs, fruits, nuts & plants	14304	13,5	138368	110,3	209325	249,7	258676	314,3	143815	196,5
21 - Miscellaneous edible preparations	13993	43,4	83367	299,5	100001	432,6	122850	579,1	85813	422,1
22 - Beverages, spirits & vinegar	35527	38,6	143929	115,7	207262	279,9	226290	335,7	126832	189,1
23 - Residues and waste of food industry	44000	15,3	197761	111,7	287545	177,6	274781	243,3	208884	206,6
24 - Tobacco & tobacco products	48042	143,6	96924	357	98946	417,2	94534	457,7	82445	455,6
Total agricultural products	-	990,0	-	2870,0	-	4353,0	-	6759,0	-	5172,0

Source: data base of Ministry of agrarian policy of Ukraine

Table 3. Ukraine's agro food export to EU

Product's groups	2000		2005		2007		2008		2009	
	tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. $
01 - Live Animals	16	0,07	89	0,4	242	0,6	7	0,1	21	0,2
02 - Meat and edible meat offal	416	0,7	1	0,08	4	0,04	18	0,2	1	0,05
03 – Fish	1581	2,2	388	1,0	204	0,3	122	0,2	482	1,5
04 - Dairy produce	35583	45,2	5148	10,4	1540	5,0	177	0,5	41	0,03
07 - Edible vegetables, roots & tubers	8563	6,6	158086	27,5	61881	23,1	35374	19,4	76639	23,1
08 - Edible fruits & nuts	16212	15,4	42230	76,0	52332	100,3	26881	82,1	42544	56,6
09 - Coffee, tea, mate & spices	909	0,5	1128	0,4	1112	0,8	828	1,0	2546	2,2
10 - Cereals	301608	29,1	2870784	311,8	329414	62,4	4439392	962,4	3350670	454,3
11 - Products of the milling industry	7648	2,5	8856	2,5	20119	8,7	23338	9,6	8231	3,3
12 - Oil seeds & oleaginous fruits	1430	0,9	43281	9,8	9532	7,1	15700	18,8	23459	16,8
15 - Animal or vegetable fats	149637	52,1	386902	226,9	999390	807,5	549230	657,0	664262	468,7
16 - Preparations of meat	1	0,006	0	0	0	0	10	0,3	9	0,2
17 - Sugars & sugar confectionery	1644	1,1	12746	7,0	3217	4,4	3045	4,8	7019	9,2
18 - Cocoa & cocoa preparations	635	0,9	5757	12,8	5046	14,9	4438	14,0	7528	20,3
19 - Preps. of cereals, flour, starch, etc.	1424	1,0	7165	8,1	10959	13,9	11758	18,3	11024	15,6
20 - Preps. of vegs, fruits, nuts & plants	28224	15,2	31564	27,3	61324	99,6	14677	17,2	31471	16,8
21 - Miscellaneous edible preparations	905	0,6	3615	3,2	10217	7,6	15233	11,6	14877	12,6
22 - Beverages, spirits & vinegar	9620	7,1	7996	36,2	81242	61,0	82578	51,9	65918	45,5
23 - Residues and waste of food industry	123311	10,7	485289	45,9	806456	113,6	619748	118,9	1572830	170,3
24 - Tobacco & tobacco products	92	0,4	135	0,5	202	1,0	499	2,0	191	1,1

Source: data base of Ministry of agrarian policy of Ukraine

Table 4. Ukraine's import of agro food from EU

Product's groups	2000		2005		2007		2008		2009	
	tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. $	th. tones	mln. $
01 - Live Animals	997	3,5	15334	42,2	5241	50,9	12526	82,1	8911	73,8
02 - Meat and edible meat offal	6208	4,8	115155	62,4	33089	13,6	270352	464,2	212017	260,7
03 – Fish, preps. of fish	63535	22,2	90774	45,1	92946	78,3	109154	105,8	85367	78,9
04 - Dairy produce	4389	4,6	4003	9,1	5665	20,8	7221	34,7	6384	23,0
07 - Edible vegetables, roots & tubers	10914	4,4	9182	5,9	25162	17,6	71312	45,6	41729	28,3
08 - Edible fruits & nuts	21886	8,3	61691	18,9	227952	62,9	227659	132,5	351893	178,9
09 - Coffee, tea, mate & spices	1240	3,7	12229	24,4	11684	36,3	13247	50,0	12678	47,3
10 - Cereals	328907	48,2	12579	17,1	27449	43,6	23225	69,2	7626	27,9
11 - Products of the milling industry	57317	12,8	57002	20,4	8361	9,5	10052	10,1	15665	8,6
12 - Oil seeds & oleaginous fruits	114	0,1	2885	2,9	794	1,0	2291	4,3	435	0,7
15 - Animal or vegetable fats	24411	24,1	14491	18,7	25046	17,8	30084	17,3	17271	28,2
16 - Preparations of meat	1019	1,0	1523	4,4	7199	8,6	5585	17,4	3955	11,5
17 - Sugars & sugar confectionery	36635	10,2	27337	15,8	5398	16,5	5586	17,6	4714	14,0
18 - Cocoa & cocoa preparations	10654	14,4	60432	92,8	38641	115,9	62120	161,3	46652	132,4
19 - Preps. of cereals, flour, starch, etc.	4411	4,4	7740	15,3	16594	45,2	21424	65,3	16789	47,8
20 - Preps. of vegs, fruits, nuts & plants	5099	6,1	44642	43,4	80340	92,0	91464	115,7	60115	80,8
21 - Miscellaneous edible preparations	7413	28,9	30771	188,1	43826	272,1	57894	343,3	44440	254,5
22 - Beverages, spirits & vinegar	16804	23,2	21427	30,7	37204	86,1	62222	134,0	29129	73,7
23 - Residues and waste of food industry	17367	9,1	105214	70,9	153384	109,5	171591	165,9	146816	156,2
24 - Tobacco & tobacco products	12250	42,4	21952	97,3	26477	112,9	17819	87,6	13217	74,8

Source: data base of Ministry of agrarian policy of Ukraine