

AGRICULTURE IN UKRAINE: PRE-WAR, STATUS QUO AND A LOOK AHEAD

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Photo: Ukrainian Grain Association



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**Agriculture in Ukraine:
pre-war, status quo
and a look ahead**

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This Outlook report is a collaborative effort that brings together a team of authors of KSE Agrocenter: Head of the KSE Agrocenter – Dr. Mariia Bogonos, Associated Member of KSE Agrocenter – Dr. Oleg Nivievskyi, Researchers of KSE Agrocenter – Pavlo Martyshev, Roman Neyter, Ivan Kolodiazhnyi, Valentyn Litvinov, Igor Piddubnyi and Hryhorii Stolnikovich.

Using the collective experience of such authors and various elaborations made in partnership with the WB, UN FAO (see <https://agrocenter.kse.ua>) the Outlook report offers a comprehensive and authoritative analysis of the topic under consideration.

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INTRODUCTION

Throughout its history, Ukraine served as a “breadbasket” for the neighbour and more distant regions. In 1940-50s it produced over 25% of the Soviet Union’s grains. In 1991-1996, Ukrainian wheat exports rose from 0.8 to 1.8 million tonnes, and in 2013-2016 from 8 to 14 million tonnes. Over the recent years, Ukraine has become a significant player on the world agricultural markets. In 2021 it accounted for 10% of world wheat, 15% of corn and barley, and 50% of sunflower oil exports.

On February 24th, 2022, only four days after the Winter Olympics in Beijing, where 91 countries including RF and Belarus celebrated peace and human dignity, Ukraine was covered with missile attacks from RF and Belarus. Today, more than 3 months past the RF’s invasion, dozens of Ukrainian cities, towns and villages, hundreds of cultural heritage and infrastructure objects are destroyed. RF’s soldiers maraud homes, shops and offices and terrorize civil population with murders and sexual assaults (rape) of women, teenagers and children. Ukrainian military and civilians continue defending bravely and devotedly their land, lives and values.

As no exception, agricultural producers in Ukraine strive to defend their values: feed Ukraine, feed the world and support the Ukrainian economy. Compared to February 2021, Ukraine today does not control nearly 20% of its territory¹ that translates into around 10 mio ha of total agricultural area, of which 8 mio ha are arable land. Agricultural production under the RF army’s occupation or intense battles is, clearly, impossible. Food security in Ukraine is challenged. Severe drop in nominal wages, weakened national currency and increased food prices reduced the affordability of basic food commodities by 38%². Although significant food shortages are not expected, undernutrition of more sensitive population groups has been observed.

The Black Sea is a critical export supply route for Ukraine, and Black Sea ports were immediately blocked by the Russian naval fleet. Ukraine’s inability to export through traditional channels forced grains and vegetable oil to remain in Ukraine’s ports and in inland elevators. Concerns regarding agricultural commodity shortages arose as global stocks were at historic lows and markets were tight before the war began in Ukraine. Agricultural producers and exporters employed alternative but more costly

¹Authors’ estimations based on (i) Order of the Ministry of Reintegration of the Provisionally Occupied Territories of Ukraine N 104, Registered with the Ministry of Justice of Ukraine on May 31, 2022 under N 587/37923 About modification of the order of the Ministry concerning reintegration of the temporarily occupied territories of Ukraine from April 25, 2022 N 75 (Наказ Міністерства з питань реінтеграції тимчасово окупованих територій України Зареєстровано в Міністерстві юстиції України 31 травня 2022 р. за N 587/37923 Про внесення змін до наказу Міністерства з питань реінтеграції тимчасово окупованих територій України від 25 квітня 2022 року N 75), (ii) <https://decentralization.gov.ua/areas> and (iii) <https://mailchi.mp/latifundistmedia/zemelyniy-dovidnyk-ukrainy-2020>

²KSE C4FLUR Food Security and Policy Review in Ukraine, issue 1, https://kse.ua/wp-content/uploads/2022/05/Food-security-and-policy-in-Ukraine_issue-1_merged-1.pdf

trade routes, including transport overland via trucks and rail across Ukraine's western borders, and through Danube River ports. However, export capacity could not accommodate export supply. The Black Sea Grain Initiative (BSGI) was implemented in the summer of 2022 and allowed for much larger volumes of agricultural exports from Ukraine from August 2022 to July 2023. However, termination of the BSGI in July 2023 again limited Ukraine's export capacity to the Danube River and more costly European Solidarity Lanes (ESL). Concurrently, intensified shelling of the Danube River ports (NYT, 2023) and continued trade tensions between Ukraine and neighboring countries over Ukraine's increased grain exports into the European Union (EU) substantially weakens the transship capacities of the ESL. The complexities of continued war and concerns regarding Ukraine's export potential elevates uncertainty and food security concerns around the world with developing nations especially vulnerable.

This report reviews the current state of the agricultural sector of Ukraine, describes the development of policy and economic environment that impacted the development of Ukraine's agriculture, provides with projections for the agrifood sector development post-war and informs about the role of the agricultural land market which was launched 7 months prior to the unfold of the war.

PRE-WAR DEVELOPMENT OF THE AGRICULTURAL SECTOR

Throughout its history, Ukraine served as a “breadbasket” for the neighbour and more distant regions. In 1940-50s, after the devastating famine of 1932-33 and despite difficult relationship with the Soviet Government, it produced over 25% of the Soviet Union’s grains (Panchenko et al. 1996). In 1992, a year after Ukraine gained its state back, total production of wheat, corn, barley and rye amounted for 35.6 million (further, mil) tons and export for 1.2 mil tons. By 2020 the production doubled, and export increased 42.3 times (State Statistics Service of Ukraine, further, SSSU, 2022) – Ukraine has become one of the major players on the world agricultural market. In the last years, 10% of world wheat, 15% of corn and barley, and 50% of sunflower oil in global exports were from Ukraine (FAOSTAT 2022).

Abundance of black soils (27.8 mil hectares) and landscape characteristics that allow for higher yields and larger fields, play one of the key roles in the development of agricultural production. Around 80% of the total utilized agricultural area (further, UAA) in Ukraine are used for cultivation of cereals, oilseeds, vegetables and other annual crops (WBD 2021, SSSU 2020a). In 2021, agriculture contributed almost 10% to the country’s GDP, around 18% to employment, and 44% to its export value.

The current section highlights policy and economic milestones which impacted the formation of the agricultural sector of Ukraine as it has been by 2021.

POLICY AND ECONOMIC MILESTONES IN DEVELOPMENT OF UKRAINE'S AGRICULTURE



1

Agricultural Land Market

1991 - 2020

USSR leaves Ukraine with state monopoly on agricultural land. Before July 2021 Ukrainian farmers, while reaching the global exports leadership in wheat, corn, barley and sunflower oil, have operated millions of ha of land as rented.

2021 - 2022

Agricultural land in Ukraine opens for sale to physical persons, despite the war.

2023

Agricultural land in Ukraine opens for sale to legal persons of Ukrainian origin, despite the war.

2

State Regulation and Crises, 1991-1999

In 1991-1999 state regulation of the economy continued and two major economic and fiscal crises took place. These led to:

- ♥ introduction of the Ukrainian national currency - Hryvnya
- 💧 drop of the agricultural production and exports by 50%



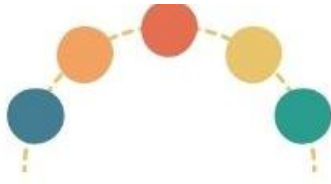
3

Liberalization and tax benefits, 2000s

Since 2000 the Government forgave the control of the economy (despite few steps back in 2003: consumer price capping and mandatory crop insurance).

Special VAT regime implied the right to withhold VAT received and reimburse it onto the production factors. These tax benefits left agriculture essentially tax-free, supporting more effective producers and economies of scale.





4

2014 The Association Agreement with the EU

2014 marked the **beginning of the end** of Ukraine's economic and cultural connection to RF. DCFTA was signed with the EU, putting Ukraine onto the path of joining the EU. The RF's invasion to the East of the country and annexation of Crimea created a minor shutter to the sector. The producers, having significant trade benefits from the EU, re-oriented their exports from RF to the EU, and retained their role as global exporters of grains.

5

2014-2021

- Introduction of the EU's technical requirements for food production, standardization, compliance assessment, surveillance, sanitary and phytosanitary measures
- Adoption of flexible exchange rate and inflation targeting policies, reforms in the banking sector and abolishing of special VAT regime for agriculture
- The national decentralization reform
- Selling rental rights for state and communal land



Figure: Major events related to agricultural policy

Source: own elaboration

1991-1994

Soviet Union left Ukraine the heritage of state monopoly on land and state regulation of the economy. One of the milestones in development of the agricultural sector was land reform. The Land Code of Ukraine of March 13, 1992, allowed transferring property rights on agricultural land (except some land in a state land reserve) from the state and collective enterprises, i.e., “kolhospy” and “radhospy”, to the collective ownership of their transformed peers – collective agricultural enterprises (CAEs). To strengthen the status of CAE members as co-owners of the collective property, the privatization of the CAEs' agricultural land began in 1994. Each CAE member was

given the right to manage and own an allotment of land of 3.6 hectares (further, ha) on average. As a result, 6.9 mil rural residents (about 16% of total population) — members of about 11 thousand (further, thsd) CAEs — received more than 27 mil ha of agricultural land (about 45% of the total territory of Ukraine) in private ownership. By 1994 more than 32 thsd of private farming entrepreneurs emerged.

State regulation of the economy, and of the agricultural sector continued until 1995. The Government controlled the supply channels, performed stock interventions, and capped the prices for agri-food commodities at around 10% of the respective world market prices. Export quotas disincentivized exporting. With the break of 1993 macroeconomic crisis, when the inflation reached 4700% and production factor prices sky-rocketed, production of agri-food commodities, especially of livestock, severely dropped (see Agricultural production 1991-2021 section). As the rest of the sectors stagnated as well, more people were attracted to engage into agricultural production activities within their own rural households. Consequently, the latter became the taskforce of agricultural production (KSE 2021, Kvasha et al. 2021).

1995-1998

Since 1995, the Ukrainian government worked on reducing fiscal deficit, financing the reforms with monetary expansion, cancelation of export quotas and privatization of public food processing plants. Neither the cancellation of the quotas nor the privatization of plants provided with the desired levels of liberalization and efficiency. Instead of the quotas, minimum export prices were introduced, and major food production enterprises were excluded from the privatization. These left Ukrainian grains and oilseeds producers with around 40% of export FOB price and inability to pay for the production factors. Consequently, by 1999 production by the agricultural enterprises dropped to 50% of the pre-independence level. Rural households continued providing the population with most of the food items.

In 1998, the crisis which originated in South-East Asia, RF and Latin America, uncovered major disbalances in the Ukrainian economy which led to the financial distress in the country: Ukrainian national currency (further, UAH) fell by 100% against the US dollar (further, USD). This, however, produced one positive effect: urge for more efficient reforms (Kvasha et al. 2021).

1999-2000

In 1999, after the end of the crisis, land ownership and the scheme of agricultural production factors purchase were changed, and tax benefits for agricultural producers provided. CAEs turned into private individual farms, corporate enterprises, limited liability companies and private enterprises. Consequently, agricultural land became

predominantly private. Out of 42.7 mil ha of it (or about 71% of Ukraine's territory), 32 mil ha comprised private ownership, 10.5 mil ha state ownership and only about 30 thsd ha were in communal ownership. Further, from now on, agricultural production factors were delivered upon immediate payment, which resolved the issue of producers' debts to the suppliers.

An important role in boosting agricultural production played tax benefits. They were accumulated from the so-called single tax of the simplified taxation system (further, STS) and a special value-added tax (further, VAT) regime. Until 2013, STS replaced about twelve other taxes and fees. Special VAT regime implied the right to withhold VAT received and reimburse it onto the production factors. These tax benefits left agriculture essentially tax-free. They implicitly provided more support to more productive and often larger agricultural producers, and thus supported large-scale agriculture.

Such decisions caused considerable optimism in Ukrainian agriculture. In 2000, as compared to the previous years, a lot more investments into the sector were made. In 2000 and 2001, for the first time since 1995, net profits of agricultural enterprises were positive, and agricultural exports doubled. Both in agriculture and food industry, employment began to fall, and wages to rise (Kvasha et al. 2021).

2001-2013

Bad harvests of 2000 and 2003, and at times occurring unfavorable conditions at the world and domestic markets, motivated the Ukrainian Government to take a few steps away from liberalization. The new policy measures included certification of grains exported, mandatory crop insurance, capping of consumer prices for bread, minimum prices for sugar, wheat-price pledging, 23% (later 17%) export tax on sunflower seeds and abolishment of VAT compensation for commodities exported. Although agricultural land could now be private, only managing and owning it applied. Selling the land was strictly prohibited, and the only legal way to assemble a larger plot was renting. In response to the tightening control, in 2011, the agricultural producers reached an agreement with the Government that each year their total exports of grains and oilseeds would not exceed 80% of the expected harvest (Kvasha et al. 2021).

Despite fluctuations in market and export controls, Ukraine has signed bi- and multilateral trade agreements since 1995. The first free trade agreements (further, FTAs) were with Turkmenistan (1995)³, Georgia (1996)⁴ and Azerbaijan (1996)⁵. FTA

³ Agreement on Free Trade between the Government of Ukraine and the Government of Turkmenistan (1995), https://www.wto.org/english/thewto_e/acc_e/ukr_e/wtaccukr52_leg_22.pdf

⁴ Agreement on Free Trade between the Government of the Republic of Georgia and the Government of Ukraine (1996), <https://www.worldtradelaw.net/document.php?id=fta/agreements/geoukrfta.pdf>

⁵ Agreement on Free Trade between the Government of Ukraine and the Government of the Republic of Azerbaijan (1996), <https://wits.worldbank.org/GPTAD/PDF/archive/Azerbaijan-Ukraine.pdf>

with the Republic of Northern Macedonia entered into force on July 5, 2001⁶.

Following the Orange Revolution of 2004, which was caused by the brutal faking of Presidential elections results, Ukraine fulfilled the World Trade Organization's (further, WTO) membership conditions, and in 2005 became its member. Import tariffs on non-sensitive foodstuffs and agricultural products as well as many specific tariffs were reduced, and Most-Favored Nations (further, MFN) tariff regime and many other tariffs unified. The country continued concluding the FTAs, and in 2012-2013 signed with the EFTA states (Iceland, Liechtenstein, Norway and Switzerland)⁷ and with Montenegro⁸. The CIS FTA among Armenia, Belarus, Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan, Moldova, and the RF became effective in 2012 as well⁹. However, as of January 1, 2016, RF and Ukraine suspended the FTA with respect to each other.

2014-2021

Starting from 2014, the reforms in agriculture of Ukraine were driven by the agenda of Association Agreement (further, AA) with European Union (further, EU). The AA entails a comprehensive program of market and institutional reforms, whereas its trade component, Deep and Comprehensive Free Trade Area (further, DCFTA), defines the stages of trade liberalization and institutional convergence between EU and Ukraine. The AA was initiated in March 2012, and it had to be concluded at the EU summit in Vilnius in November 2013. Contrary to the expectations, the former (currently, in exile) President of Ukraine, Viktor Yanukovych, refused to sign the AA at the very day of the summit. This caused the uprising of the Revolution of Dignity and fleeing of Mr. Yanukovych and his peers to RF. Shortly after, RF annexed the Crimean Peninsula and started a hybrid war in the east of Donbas region. Overcoming various obstacles, the AA was signed by the new Government, and entered into force on September 1, 2017.

Following the DCFTA, Ukraine began the introduction of the EU's technical requirements for food production, standardization, compliance assessment, surveillance, sanitary and phytosanitary measures. Tariff-free import quotas allowed the sector to benefit from increased exports to the EU. The reforming process has as well been enhanced by cooperation with the International Monetary Fund (further, IMF). Adoption of flexible exchange rate policy, inflation targeting policy, reforms in the banking sector and abolishing of special VAT regime played significant role in the

⁶ Agreement on Free Trade between the Republic of Macedonia and Ukraine (2001), <https://wits.worldbank.org/GPTAD/PDF/archive/FYROM%20-%20Ukraine.pdf>

⁷ Free Trade Agreement between the EFTA States and Ukraine (2012), <https://www.efta.int/sites/default/files/documents/legal-texts/free-trade-relations/ukraine/EFTA-Ukraine%20Free%20Trade%20Agreement.pdf>

⁸ The Agreement on free trade between the Government of Ukraine and the Government of Montenegro (2013), <https://mfa.gov.ua/en/about-ukraine/economic-cooperation/free-trade-agreements-fta>

⁹ CIS Free trade Agreement (2012), <https://mfa.gov.ua/en/about-ukraine/economic-cooperation/free-trade-agreements-fta>

development of the agricultural sector (Kvasha et al. 2021 and Nykolyuk et al. 2021). In 2017 and 2019, Ukraine as well signed FTAs with Canada¹⁰ and State of Israel¹¹.

The period after the Revolution of Dignity could be marked as very modest in terms of the land reform. With a launch of the national decentralization reform in 2014, about 1.68 mil ha of agricultural land were transferred from the state into a communal ownership. To increase the efficiency of land use, auctions for selling rental rights for state and communal land were introduced. Their mandatory character led to a significant increase in the land rental prices and local budget revenues. Furthermore, a minimum duration of seven years on lease contracts was introduced, thus dragging shorter term leases into informal arrangements. Transparency and access to information on land and related rights was somewhat improved by adopting the relevant normative base and infrastructure (KSE 2021).

The most common agricultural land transactions of that period included inheritance and emphyteusis (around 18% of the transactions), and long and short-term lease (around 76% of the transactions) (Nizalov et al. 2018). According to the statistical records, in 2018 the average rental price for a ha of agricultural land in Ukraine was around 50.2 EUR per year (USSGCC 2019, in current prices).

In 2019, after the presidential and parliamentary elections, the land reform got a new momentum. The land turnover law of March 31, 2020 established a design for the land sales market. The latter came in on July 1, 2021. Despite being a huge step towards market economy, some temporary exemptions were still in place. In particular, agricultural land of public property, foreign legal entities and individuals, as well as until July 2023, domestic legal entities, cannot participate in the land market. As of the time of writing this article, agricultural land may only be purchased by the citizens of Ukraine and up to the total acreage of 100 ha. From 2024 onwards, the possibility of land purchase will extend to 10 thsd ha for legal entities (as long as the beneficiaries are Ukrainian citizens that have no business abroad or offshore companies).

By the end of 2021, the total acreage of land in circulation amounted to 0.4% of the total agricultural land area. More than 60% of this land was purchased for commercial agricultural production and around 35% for individual peasant farming. The average sale price was 1100 USD, the average number of sales transactions per day 459, and the average size of the land parcel sold 2.4 ha (KSE 2022).

In the last decade, five main types of agricultural producers emerged in Ukraine: rural households, family farms, private and public agricultural enterprises and, the so-called, agricultural holdings (further, agroholdings). Rural households currently

¹⁰ Canada-Ukraine Free Trade Agreement (CUFTA) (2017), <https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/ukraine/index.aspx?lang=eng>

¹¹ Free Trade Agreement between the Government of the State of Israel and the Cabinet of Ministers of Ukraine (2019), https://www.gov.il/BlobFolder/policy/isr-ukraine-fta/he/sahar-hutz_agreements_israel-ukraine-fta-en.pdf

cultivate land parcels of around 1.3 ha. In 2019 their input to the total value (in current prices) of crop commodities was 30.1%, and of livestock commodities 48.7%. Family farms, public and private enterprises differ from each other by the type of ownership. Family farms are privately owned and run mainly by the family members (LoU 2003). The average size of a family farm is around 134 ha. Private agricultural enterprises are defined as enterprises whose main economic activity is agricultural production. Average acreage of land cultivated by such enterprises is around 1.2 thsd ha. Public enterprises are owned by the state. Along with rural households, private enterprises are the main contributors to gross agricultural output in Ukraine (Bogonos and Stepaniuk 2017, SSSU 2020b).

Agroholdings belong to a rather unique type of agricultural enterprises. They are organized around parent companies which control and manage dozens of subsidiary agricultural enterprises. Because such parent companies do not always own the subsidiary enterprises or their majority stocks, the term “holding” may be somewhat misleading (Hermans et al., 2017). Agricultural land area cultivated by one such agroholding may range from around ten to more than 600 thsd ha (Horovetska et al., 2017).

CROPS AND LIVESTOCK PRODUCTION 1991-2021

Since 1992, crops production has dominated Ukrainian agriculture. Although in 1991-2000, grains harvest and export fell, starting from 2001 they followed steadily increasing trends. Oilseeds production was on the move upwards since 1991. Production of wheat, barley, rye and oats demonstrate tremendous volatility which mainly results from their dependence on the weather. Starting from 2014, however, this volatility seems to decrease. One of the possible reasons – improvement of production technologies, i.e., improved access to fertilizers and use of more efficient machinery. Whereas production of wheat and maize continue growing, barley quantities seem to remain steady in the last ten years. Oats and rye production, supplied to the domestic market, decrease. Growth of maize production from 3.8 mil tons to 41.9 mil tons in 2000-2020 demonstrated the responsiveness of Ukrainian agricultural sector to export demand, quickly developing poultry sector and favorable for this crop climatic conditions.

Sunflower is the traditional oil crop for Ukraine. Its production has been increasing at high rate and steadily throughout the years. Starting from 2000, sunflower oil production and export stood on the way of rapid development as well. Rapeseed and soya beans, although currently occupy much smaller areas of agricultural land, follow rapid growth as well (Figure below).

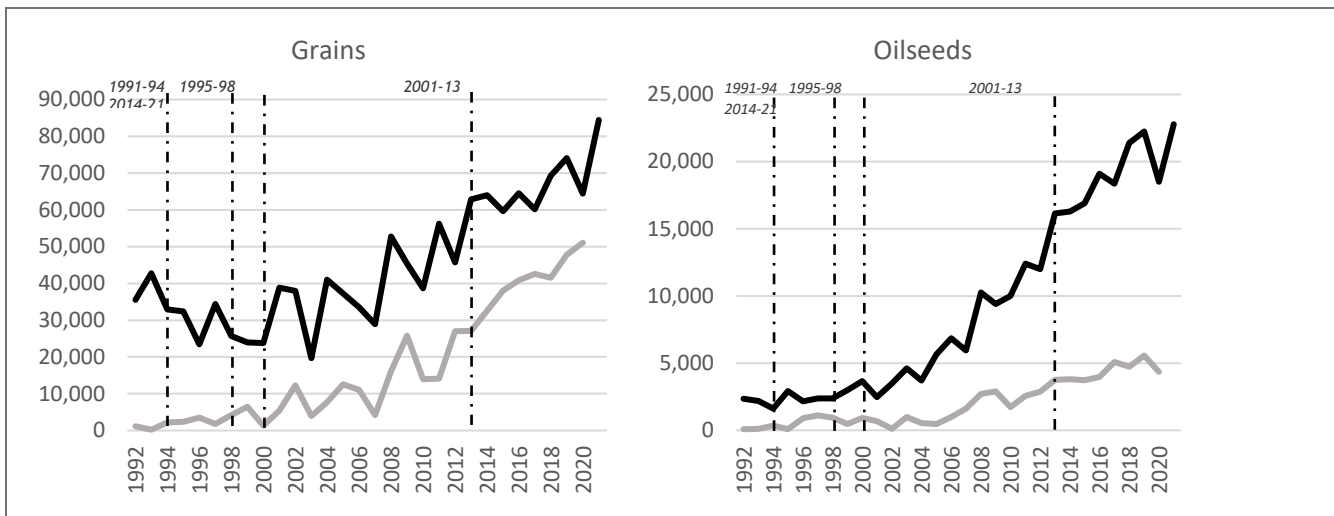


Figure Production (black curve) and export (grey curve) of grains, oilseeds and oils in Ukraine in 1992-2021, thsd tons

Source SSSU 2021

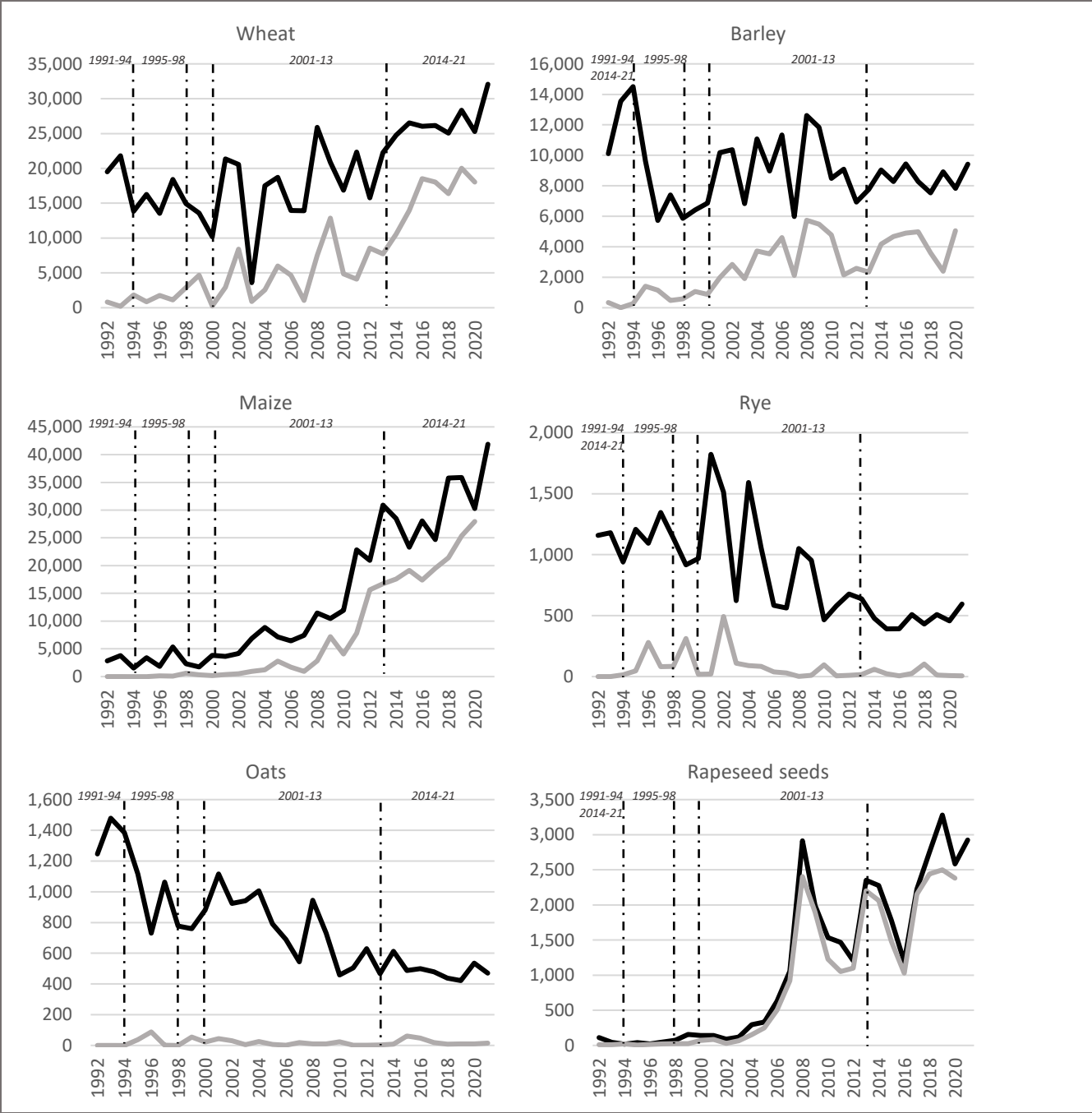


Figure Production (black curve) and export (grey curve) of grains and rapeseed seeds in Ukraine in 1992-2021, thsd tons
Source SSSU 2021

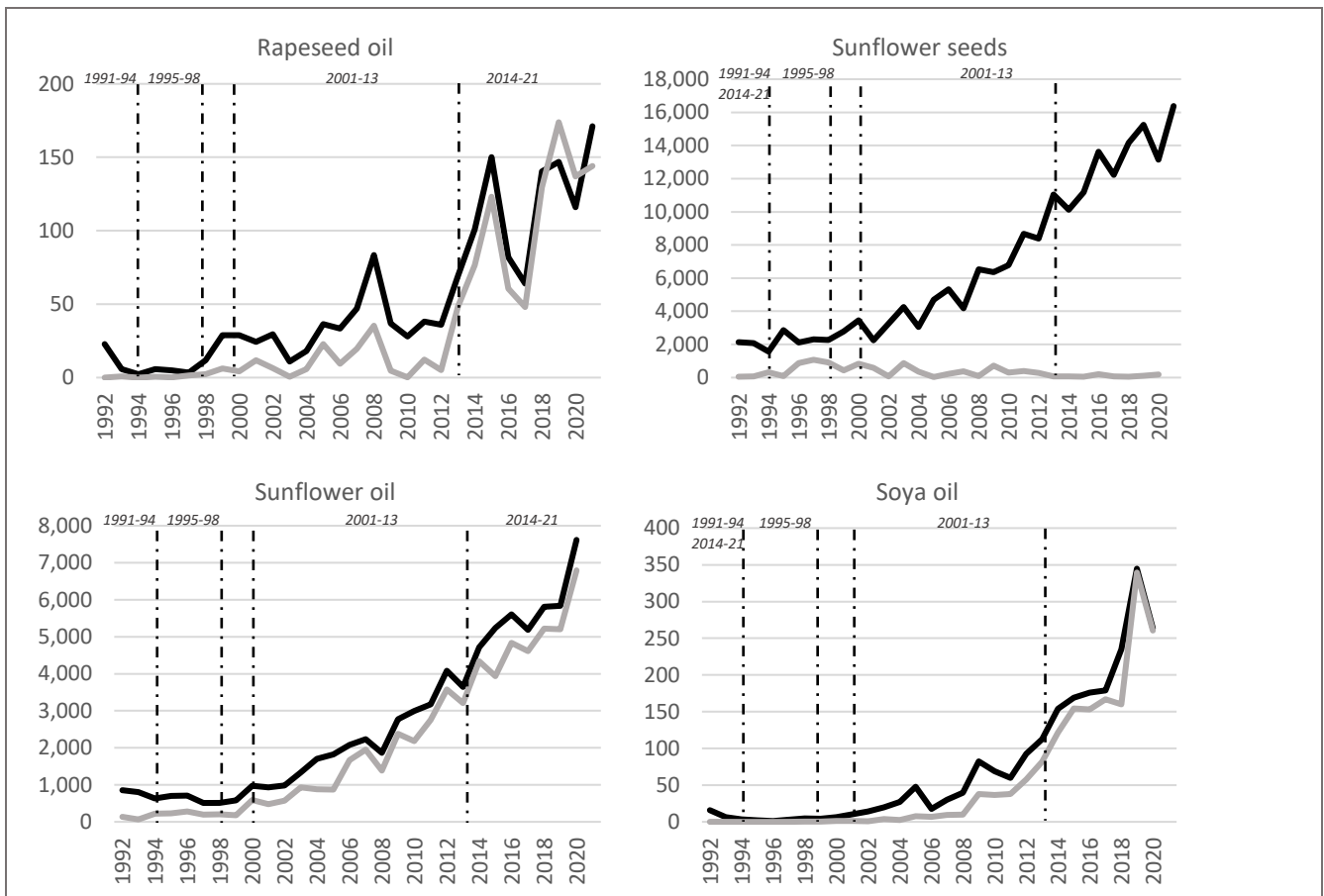


Figure Production (black curve) and export (grey curve) of rapeseed oil, sunflower seeds, sunflower oil and soya oil in Ukraine in 1992-2021, thsd tons

Source SSSU 2021

In contrast to crops production, production of livestock commodities does not follow a positive trend. Steady reduction in cattle heads since 1992 led to the decrease in beef and veal and milk production. Most of the herd decline took place at the rural households. Although in 2010-2019 cattle slaughter weight increased from 203 to 229 kilograms (further, kg), the impact of herd decline was greater (SSSU 2020b, SSSU 2020c, SSSU 2011). Similarly, milk yield at the agricultural enterprises improved from 4.1 to 6.1 thsd kg per cow and year, and at the rural households from 3.9 to 4.6 thsd kg. Nevertheless, the decline in dairy cows had considerably stronger effect on the negative trend of milk production.

Swine sector in Ukraine is represented by two large groups of producers as well: rural households and agricultural enterprises. In 2019, the respective shares of swine reared by these producer groups were 43.5% and 56.5%. In 1991-2005 the herd decreased tremendously. Starting from 2006, however, the fall slowed down, and by 2021 reached 5.9 thsd heads. Increases in swine slaughter weight allowed to increase and, consequently, stabilize pig meat production at around 700 thsd tons (SSSU 2020b, SSSU 2020c, SSSU 2011). Numbers of sheep and goats as well as their total output (i.e., wool and milk) were declining steadily (SSSU 2020b, SSSU

2020c, SSSU 2011).

In 1991-1996, as the rest of livestock commodities, chicken meat and eggs production experienced major decline. Starting from 2000, however, production of both products resumed. Chicken meat production changed from 193 thsd tons in 2000 to 1596 thsd tons in 2021. Chicken eggs production experienced 123.9% growth in 2000-2013, and after the start of the war on the east of Ukraine in 2014, dropped by 28.2%. Agricultural enterprises take the lead in this sector. They produce around 89% of chicken meat and 56.1% of eggs. The remaining 11% and 44%, respectively, are produced by rural households (SSSU 2020c, Tarasevych 2020, SSSU 2020d).

Quantities of livestock commodities exported from and imported to Ukraine vary. 42.7 thsd tons of cattle meat were exported from, and 1.4 thousand tons imported to Ukraine in 2018. The changes in 2018 as compared to 2010 were, respectively, 221.1% and -43.13%. Quantities of pig meat exported and imported in 2018 were, respectively, 2.2 and 30 thsd tons. The growth rates from 2010 were, respectively, 584.7% and -67.7%. Meat production in Ukraine, despite decreasing and orienting mostly towards the domestic market, nevertheless has positive trade balance in terms of trade volume. Export of butter in 2018 was 28.7% of its total production, and import less than 1%, whereas export of cheese was 6.6% of its total production and import 10.9%.

Net trade of chicken meat and eggs grew rather considerably in 2010-2018. For chicken meat it turned from -96.8 to 213.4 thsd tons, and for eggs from 15.7 to 111.9 thsd tons (FAOSTAT, SSSU 2020b, SSSU 2020c, SSSU 2011).

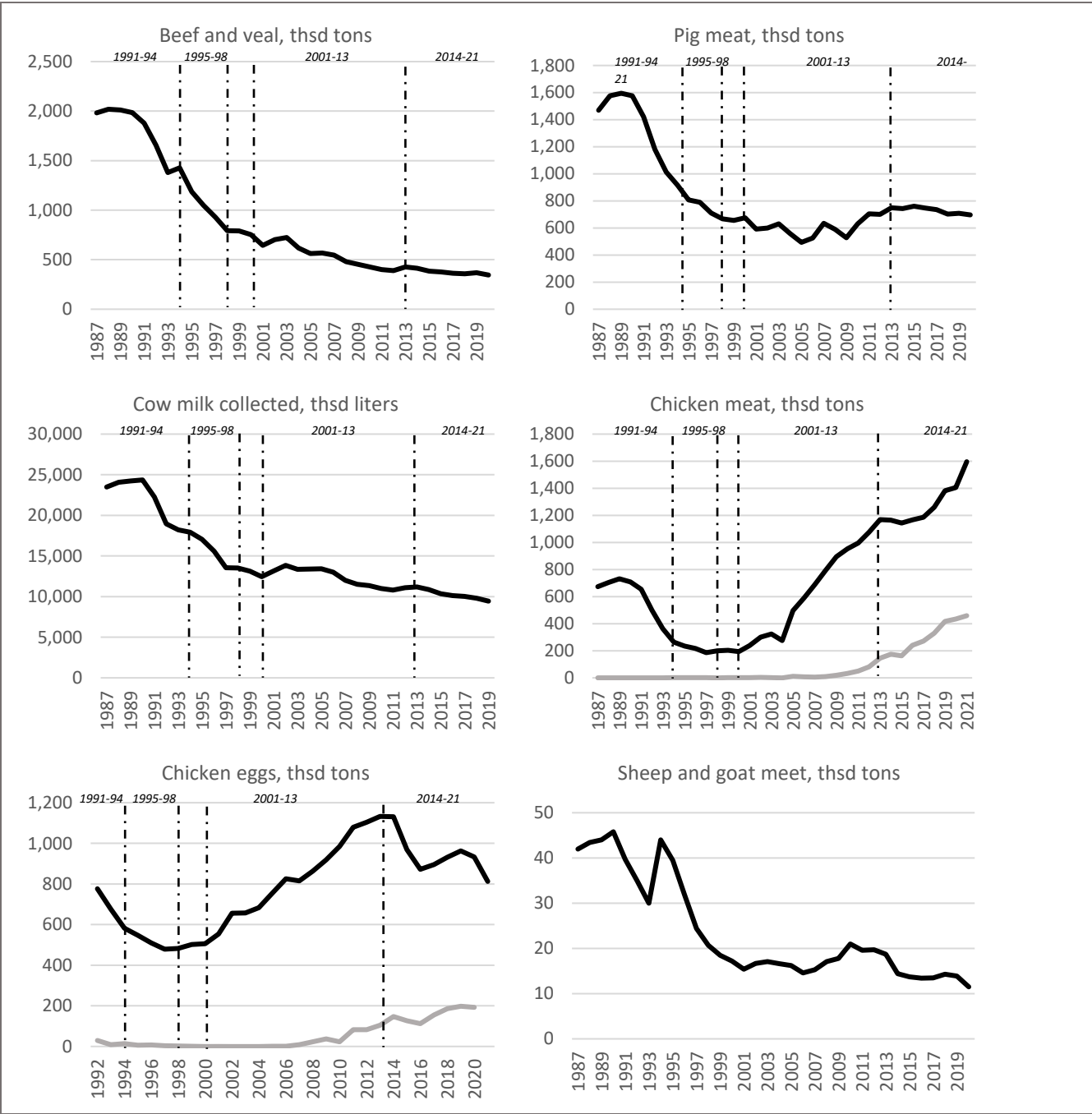


Figure Production and export of livestock products in Ukraine until 2021
Source SSSU 2021

AGRICULTURAL SECTOR IN THE TIME OF WAR

On February 24, 2022, Ukraine shuddered from explosions, and the world was shaken up by the terrible news about a new war in Europe. As of today, more than seventeen months have passed since the start of the RF's full-scale invasion of Ukraine. RF's army massacres civil population, destroys civil infrastructure, historical and national heritage buildings and places. Currently, the war has been localized to ground fighting in the East and South of Ukraine, but regional centers and especially critical energy infrastructure are suffering from missile strikes. The aggression aims at the physical and economic destruction of the country. Since 2000s, and more prominently since 2016, one of the three pillars of economic security of Ukraine is the agrifood sector. The latter accounts for 20% of the country's GDP, around 40% of foreign currency exchange and 18% of employment.

DAMAGES AND LOSSES

Based on the report prepared Roman Neyter and Anna Myslytska from the Center for Food and Land Use Research at Kyiv School of Economics (KSE Agrocenter) and Sergiy Zorya from the World Bank, with support from Dragan Angelovski, Daniele Barelli and Taras Antonyuk from the Food and Agriculture Organization of the United Nations (FAO) (<https://kse.ua/wp-content/uploads/2023/05/RDNA2.pdf>)

Data and methods

Full scale military assault by RF brought substantial damages and losses to Ukraine's economy and its agricultural sector. To estimate the impacts on agriculture, the rapid damage assessment methodology of the World Bank and FAO is used. In the core of this approach lies comparison of the pre-disaster and post-disaster conditions, and distinction between damages and losses. Damages are defined as partial or total destruction of infrastructure and physical assets in terms of number of units and their monetary value. Losses are an estimate of the changes in economic flows arising from (i) the disruption of service delivery and availability/access to goods and services, (ii) disruption of governance and social processes and (iii) increased risks and vulnerabilities (WB 2017).

For assessing the damages, the agricultural sector's assets and infrastructure are categorized in seven groups: machinery, storage facilities, livestock, perennial crops, fertilizers and fuel, stored harvest, farmland and unharvested winter crops. Their baseline quantities (number) and monetary values are calculated based on the 2020

data from SSSU, State Water Resources Agency of Ukraine and Ministry of Agrarian Policy and Food of Ukraine.

The degree of damage is estimated with regional coefficients (Table below) which vary among the assets and infrastructure groups, are regional and rely on expert opinion. For damaged machinery, excluding tractors and trucks, storage facilities, livestock, and perennial crops, the coefficients depend on the severity of battles and occupation and increase linearly with time. One year of active fire is assumed to result in 100% damage. Therefore, daily increase of the damage corresponds to 0.274% from the baseline quantity (number). Since the coefficient is regional, if active fire take place on half of the region's territory, the damage rate is halved as well. If the region is under occupation, the pace of increase in the damage is slower by 50%, i.e., 0.137%. The coefficients for tractors and trucks are 1.2 higher than for the rest of the machinery. These assets can potentially be used for military transportation and repair, and thus pose increased interest for being stolen by the occupants. For translating the damages into monetary values, the principle "build back better" is applied. It means that if the destruction covered more than 40% of an item, the latter cannot be repaired and must be replaced with the equivalent and cost-efficient option available on the market.

To estimate the coefficient for damaged and stolen fuel, assumption that the RF's army uses all the fuel available in the regions they have control of is used. Assuming equal distribution of fuel in a region, the share of damaged and stolen fuel is thus proportionate to the approximate percentage of the region occupied or at the peak of the fighting.

The coefficients for the shares of stolen grains, sunflower seeds, crop protection products and fertilizers follow the assumption that RF's army and RF's Government representatives benefit from selling and, where appropriate, using the stolen goods. However, it is further assumed that such activity starts only after at least one month of control of the territory.

The coefficients for damages related to unharvested winter crops and mining and destruction of agricultural land are defined as follows. In the previously occupied but then liberated regions of Kyiv, Sumy, Chernihiv, and Mykolaiv, the damages occurred at around 15% of the baseline sown area. In the regions which were occupied or suffered heavy fighting during the sowing season, i.e., the regions of Kharkiv and Zaporizhzhya, the damage affected 50% of areas sown with winter crops. And in Kherson, Donetsk, and Luhansk regions, the farmlands are assumed to be entirely inoperable. Furthermore, 10% of these lands need active demining, 33% need some recultivation and 3% substantial recultivation.

In the regions with little military activities and no prior occupation, the damages are assumed to be zero. Monetary values of the damages are estimated with 2021 market prices.

Table Coefficients for estimation of damages in the affected regions of Ukraine by June 1 according to the assets and infrastructure groups, % of damage from the baseline quantity (number)

	Donetsk	Zaporizhya	Kyiv	Luhansk	Mykolayiv	Sumy	Kharkiv	Kherson	Chernihiv
Mining	100	50	15	100	15	15	50	100	15
pollution of agricultural land									
Recultivation of agricultural land	33.3	16.7	5	33.3	5	5	13.3	33.3	5
Unharvested winter crops	100	50	15	100	15	15	50	100	15
Agricultural machinery and equipment	26.6	13.3	10	26.6	5	10	13.3	13.3	10
Agricultural machinery – trucks and tractors	31.9	16	12	31.9	6	12	16	16	12
Storage facilities	26.6	13.3	5	26.6	5	5	13.3	13.3	5
Livestock	26.6	13.3	10	26.6	15	10	13.3	13.3	10
Perennial crops	100	50	15	100	15	15	50	100	15
Crop protection products and fertilizers	26.6	13.3	5	26.6	5	5	13.3	13.3	5
Fuel	100	66	40	100	33	80	50	100	80
Stored agricultural produce	26.6	21.5	0	26.6	0	0	13.3	26.6	0

Source Own estimation

For estimation of losses in agriculture the baseline quantities of crops and livestock production were set at the levels of 2021. Area-specific losses coefficients which were

based on the expected severity of production decrease (according to data and experts' opinion) are then applied to these baseline quantities. Monetary values of the losses are estimated with 2021 market prices. For territories previously occupied/attacked and then liberated from the RF's army, i.e., Kyiv, Sumy, Chernihiv, and Mykolaiv regions, 15% decrease in annual crops and livestock production is used. It is based on the share of agricultural land under mining pollution. For regions that were occupied or under heavy fighting during the sowing season, we impose a loss coefficient that reflects the share of the occupied territories or share of the region with active fighting, i.e., 50% for Zaporizhzhya and Kharkiv regions and 100% for Kherson, Donetsk, and Luhansk regions. The loss coefficient for perennial crops reflects the damage coefficient for this category. We also assume that the yields would be 10% lower than in the baseline scenario. The productivity decrease is expected primarily due to the logistics disruptions. Such disruptions are caused by fuel shortages and the inability to get the required spare parts for the machinery and other agricultural inputs in time. They result in suboptimal course of the sowing campaign, fertilization, and crop protection products application.

Results

The impact of Russia's invasion of Ukraine on the agricultural sector after one year of the full-scale conflict is immense. Direct damages amount to **\$8.7 billion** (\$2.1 billion more than in the November 2022 Review) and indirect losses, including lower production of crops and livestock, as well as logistics disruptions and higher production costs, amount to additional **\$31.5 billion** (\$2.76 billion less than in the November Review). The lower value is due to the introduction of regional coefficients instead of using the national average. To cover the needs for reconstruction and recovery, **\$29.7 billion** is required. Considering the colossal damages and losses, it is vital to continue supporting Ukraine's agriculture financially for it to perform at least on a pre-war level. This way one of the most important sectors of the Ukrainian economy will be on its way to prosperity, growth and modernization, contributing to Ukraine's post-war recovery and the global food and nutrition security.

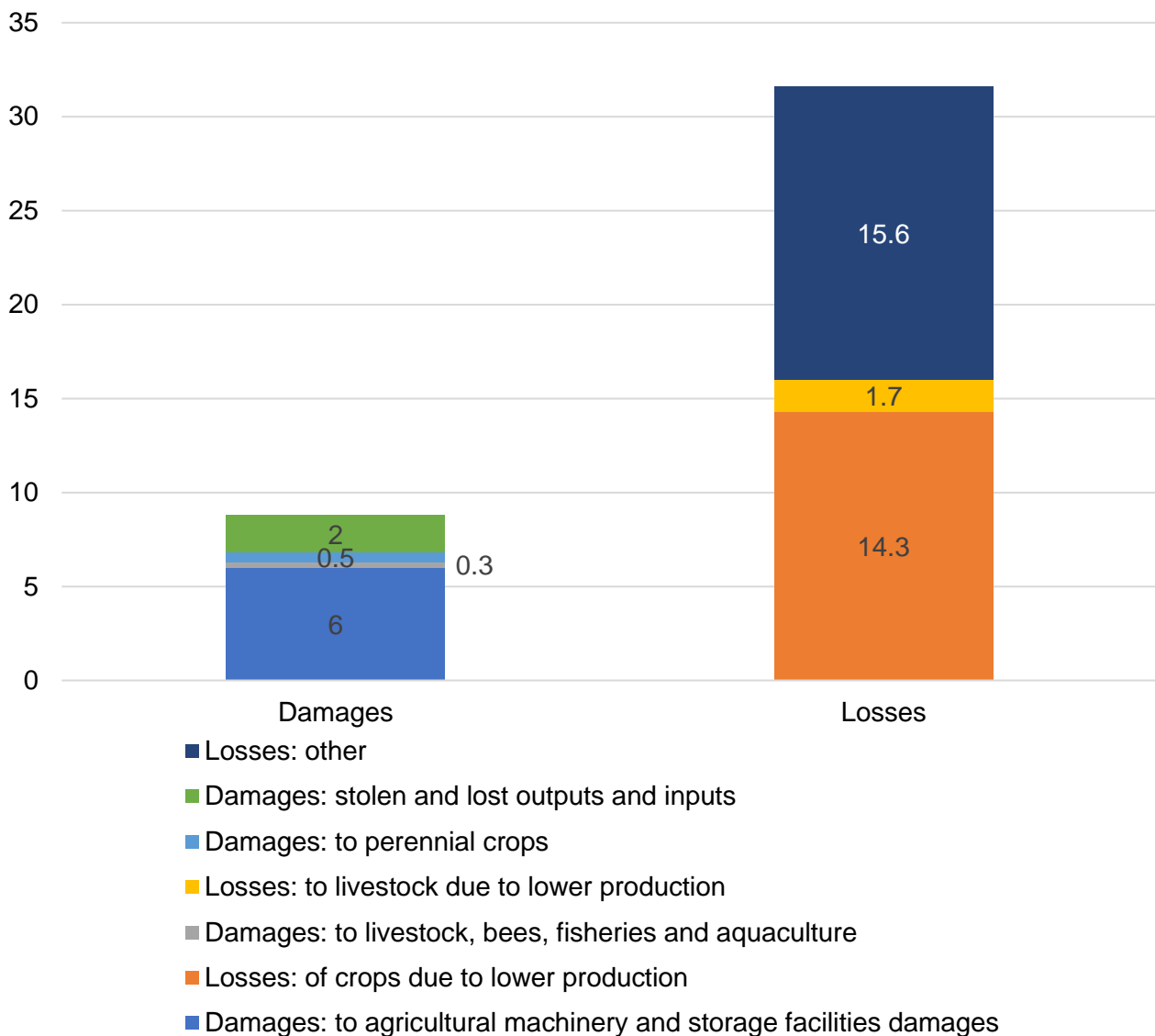


Figure: Damages and losses as of February 2023

Source: own elaboration

AGRICULTURAL MACHINERY AND STORAGE FACILITIES DAMAGES: \$6.0 BILLION

The largest category of damages is destroyed or partially damaged agricultural machinery and special equipment, which accounts for \$4.7 billion or almost half of the total agricultural war damages. Tractors are the biggest type of damaged machinery when converting to monetary value and are estimated to make up \$2.0 billion, followed by seeders (excluding fertilizer seeders) at \$646.9 million and harrows at \$442.1 million respectively. Moreover, many storage facilities for grains, food or other agricultural commodities were totally or partially damaged. The value of the damages for this sub-category is \$1.3 billion. Together with the agricultural machinery and equipment damages, the damages reached \$6.0 billion, which is \$1.2 billion more

than in the November 2022 issue of the Review.

Using the baseline of 2019, **more than 17% of all agricultural machinery and equipment in Ukraine are estimated to be severely damaged and destroyed.** Overall, it will take a lot of time, costs and efforts to repair or completely replace agricultural machinery at least to the baseline level. The approximate reconstruction costs can be found in the Agricultural War Needs section below.

DAMAGES TO LIVESTOCK, BEES, FISHERIES & AQUACULTURE: \$277.6 MILLION

Farm animals are dying both, directly because of the hostilities, and because the farmers cannot access the farm or provide animals with feed and veterinary services. In total, 2,230 cows, pigs, goats, sheep, poultry and approximately 87 thousand bee colonies died because of the war, without considering other injuries or harms. The damages to livestock and bees are estimated to be worth of \$265.6 million, while the fisheries and aquaculture were damaged to the extent of \$12.0 million.

DAMAGES TO PERENNIAL CROPS: \$489.8 MILLION

This category of damages is related to berries and stone and pome fruits. The estimates were made based on the hectares of land where these perennial crops had been cultivated. The damages to stone fruits add up to \$232.1 million, to pome fruits to \$206.7 million, and to berries to \$51.0 million. The total amount of damages to these crops is \$489.8 million, which is \$141 million more than in the November 2022 Review.

STOLEN AND LOST OUTPUTS AND INPUTS: \$2.0 BILLION

Agricultural inputs are being damaged and stolen, although the exact figures are hard to make. Using the indirect estimates and the information from the media, there were approximately 124 thousand tons of fertilizers lost or stolen during one year of the war, which translates into \$67.4 million of damages. Additionally, the amount of lost and stolen fuel and crop protection items is estimated to be worth more than \$21.2 million and almost \$6.7 million, respectively. About \$1.9 billion of crops, especially grains and sunflower seeds, were lost and stolen. Overall, the monetary value of stolen and lost inputs and outputs estimates to \$2.0 billion.

AGRICULTURAL LOSSES: \$31.5 BILLION

Besides direct damages, Russia's invasion of Ukraine has had indirect effects on the agricultural sector, resulting in losses of approximately \$31.5 billion after one year of war. These losses encompass the foregone revenue due to lower quantities of goods produced and additional costs that producers bear due to the war, such as losses of farmland due to soil damage, decreases in annual and perennial crop production, livestock, fisheries and aquaculture production, and decreases in producers' revenues due to logistics disruptions, lower prices for export-oriented commodities, and higher

production costs.

CROP LOSSES DUE TO LOWER PRODUCTION: \$14.3 BILLION

The production of crops has been significantly impacted by Russia's invasion, with losses estimated at astonishing \$14.3 billion or nearly half of all agricultural losses estimated. The most substantial production losses are for wheat, which accounts for \$2.9 billion, followed by sunflower at \$2.5 billion, and corn at \$1.7 billion. Together with perennial and other crops, this category makes up almost \$11.0 billion, which is \$0.2 billion less than in the previous Review issued in November 2022.

Winter crops and their harvest of 2023 have also been affected, with wheat having the highest level of losses – \$2.7 billion. While the decrease in production of other winter crops, such as barley, rye, and rapeseed, are not as dramatic, they are still significant. The overall approximate production loss of winter crops has increased by \$0.3 billion compared to the November 2022 Review and now amounts to \$3.3 billion.

LIVESTOCK LOSSES DUE TO LOWER PRODUCTION: \$1.7 BILLION

The livestock losses are estimated at \$1.7 billion, which is \$1.3 higher than in November 2022 Review. This is because in the current estimation the regional coefficients are used as opposed to the national average in the previous issue.

The most significant losses due to decreased herd are in milk and egg production. They amount to \$254.2 million and \$159.7 million, respectively. The losses for other livestock and animal products due to the decrease in herd, including pigs, cattle, poultry, sheep, goats, beeswax, and honey, account for \$210.5 million. The losses due to the decrease in livestock productivity account for \$1.1 billion, with milk, poultry, and eggs having the highest value of losses. The exceptionally high numbers of livestock killed, stolen, and harmed in any way have resulted in shortages of some animal products. Eggs and milk alone add up to \$732.4 million.

OTHER LOSSES: \$15.6 BILLION

In the previous Review it was noted that Russia's invasion of Ukraine had a significant impact on the farm-gate prices of export-oriented commodities. This was primarily caused by Russia's naval forces' blockade of Ukrainian ports, leading to a decrease in domestic prices. Although the Grain Deal allowed the export of some portion of the commodities since August 2022, the exporting volumes remain low and the shipment costs high. Other logistics disruptions have also contributed to the decrease in the prices for export-oriented commodities, which in total was estimated to induce \$14.5 billion of losses.

Another consequence of the invasion is inflation and a global rise in prices, particularly for essential agricultural inputs such as fuel and fertilizers. This has led to increased production costs for Ukrainian agricultural producers, with fertilizers costing \$377.1

million and fuel costing an extra \$467.4 million. The cost of recultivation of the land affected by battles and missiles is also taken into consideration as it directly affects the amount produced. Consequently, the losses resulting from higher input prices and land recultivation together are evaluated to cost more than \$1 billion.

Furthermore, the fisheries and aquaculture sector, which was not evaluated in the previous issue of the Review, has also suffered losses due to lower income, higher input prices, and additional costs. The total losses in this sector are estimated at \$53.8 million.

Table Losses in agriculture as of February 24, 2023, mil USD

Item	Value of losses
<i>... due to production decrease</i>	
Wheat	2,835.
Corn	1,701
Barley	823
Sunflower	2,467.01
Pome fruits	79.48
Stone fruits	250.1
Berries	120.4
Other crops	2,667.3
Cattle	64.67
Pigs	147.5
Sheep and goats	2.2
Poultry	285.6
Milk	800.1
Eggs (mil. pcs)	346.2
<i>... due to logistics disruption and lower prices for export-oriented commodities</i>	14,480.2
<i>... due to higher production costs</i>	1,028.4
Total	31,496.64

Source Own estimation

Box: Drastic increase in expenses on fertilizers

As mentioned above, another consequence of the invasion is severe problems in fertilizers markets. One of the major fertilizers producers in Ukraine – Ostchem, due to a lack of necessary inputs and with losing one of the factories in the temporarily occupied territory of Severodonetsk in Luhansk region, decreased its production by more than 66%, from 5.3 mln t. in 2021 to 1.76 mln t. at the end of 2022¹². Even though world prices of fertilizers decreased 1.5 times in some countries, urea FOB prices in Black Sea region as of 23.02.23 were 370-385 \$/t, and ammonia nitrate – 380-410 \$/t

¹² <https://superagronom.com/news/16552-cherez-viynu-ostchem-vigotoviv-na-669-menshe-mindobriv-v-2022-rotsi>

(according to the data of Derzhovshininform (UCAB 2023). In Ukraine, prices remain at a fairly high level: the price of urea at customs clearance reaches 750 \$/t¹³. According to the estimates of the Ukrainian Club of Agricultural Business (UCAB after), in 2022, the **average expenditures of agricultural producers on the purchase of fertilizers increased 2.4 times.**

DOMESTIC FOOD SECURITY

Data and methods

Another consequence of the war is that food security in Ukraine is challenged. The respective changes are estimated with Food affordability index (FAI). FAI is the ratio of average consumer income to the regional daily consumer prices for 21 critical food products in Ukraine weighted by the standard consumption pattern of each of these products. The food items are wheat bread, rye and rye-wheat bread, wheat flour, pasta of soft wheat, millet, buckwheat, oats, beef, pork, chicken meat, chicken eggs C1 category, milk pasteurized <2.6% fat, sour cream <15% fat, butter <72- 82.5% fat, sunflower oil, white sugar, cabbage, onion, beetroot, potato and carrot. The food consumption pattern is the recognized by the Government of Ukraine standard average consumption quantities of these food products. Price data are collected from SSSU. If for some observations price information is not available, weekly average price of food products using only the days for which food price information is available is applied. In case prices are missing for the entire region, the national average price for a given period is used. A region with no price information for at least one basic food item for at least one day in a week is considered having unstable physical food access.

A proxy for consumer income is salaries. In March-April 2022, Gradus and Kyiv School of Economics conducted a survey on changes in salaries as compared to the pre-war period. According to this study, average earnings of people who were employed before the invasion decreased to 10,155 UAH per month, or by over a third (34% decrease in average nominal earnings, including the unemployment benefits for those who lost their jobs) (Gradus 2022).

Results

We consider four different scenarios of income change in Ukraine. In the first scenario, income data is based on survey of CEO's by KSE¹⁴. The second scenario uses average salary estimated from the data web-scraped from the Ukrainian job search website¹⁵. On average, this salary is 40% higher than the one of the first scenario,

¹³ <https://dzi.gov.ua/press-centre/news/svitovi-tsiny-na-dobryva-strimko-padayut-ale-ne-v-ukrayini/>

¹⁴ Food Security and Policy Review in Ukraine. Foreword to the series & methodology. https://kse.ua/wp-content/uploads/2022/07/Foreword-to-the-series-and-methodology_eng.pdf

¹⁵ Since the last date for which the salary data is available is June 30, we use the last available salary estimates for July-September as well.

because it does not include unemployment. The third scenario adjusts the average salary of scenario 2 to the war-caused unemployment and the consequent social security payments estimated by Gradus¹⁶. The fourth scenario is scenario three with the addition of the coefficient of income change due to people switching to part-time employment or paid leave with lower compensation.

Before the RF's full-scale invasion, the FAI score was 12.8, implying that the person with an average salary could buy 12.8 months' worth of food products from our food basket. After February 24, FAI decreased significantly, because both, consumer prices and income, declined. The prices for food grew by 4-26% depending on the month, and average monthly consumer's income decreased by 6.0-39.1% depending on the income scenario.

Monthly changes of FAI reflect seasonality of prices and war-related developments. In April, when FAI was first estimated, the change in the latter ranged from at least -11.24% (income scenario 2) to the maximum of -49.16% (for income scenario 4). With liberation of the northern regions and the firefights stabilizing at the south-east of Ukraine, FAI improved. In June, however, seasonal factors brought vegetable prices up which decreased FAI: lower range of the estimate was -25.1%, and upper range -50.9%. In July, this year's vegetables harvest arrived at the stores, and the respective prices dropped. This led to the improvement of FAI. As of September 9, FAI reached the May level: -14.68% at the upper range and -43.42% at the lower range.

Table FAI and consumer price changes compared to the pre-war period, %

	FAI		Change in FAI		Change in prices
	Lower value	Upper value	Lower range	Upper range	
21.02	12.80	12.80	0.00%	0.00%	0%
22.04	6.51	11.36	-49.16%	-11.24%	+5.8%
13.05	7.55	11.39	-41.02%	-11.04%	+4.4%
27.05	7.43	11.22	-41.91%	-12.33%	+7%
17.06	7.13	10.96	-44.32%	-14.41%	+10.6%
01.07	6.28	9.59	-50.93%	-25.09%	+25.7%
15.07	6.57	10.09	-48.70%	-21.17%	+19.4%
29.07	6.78	10.52	-47.03%	-17.82%	+14.5%
26.07	7.02	10.67	-45.17%	-16.61%	+12.9%
09.09	7.24	10.92	-43.42%	-14.68%	+10.3%

Source Own estimation

¹⁶ Міграція та соціально-політичні настрої під час повномасштабної війни Росії проти України.
https://gradus.app/documents/295/Gradus_EU_wave_9_UA.pdf

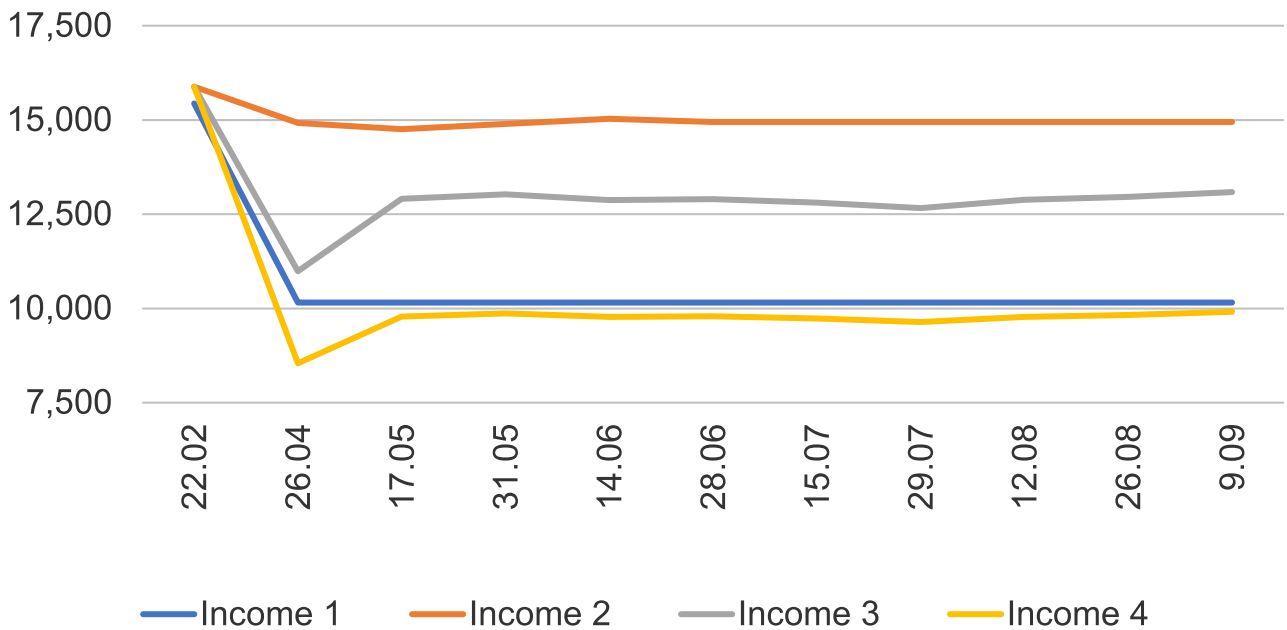


Figure Changes in consumer income depending on the data source , UAH

Note Vertical axis indicates the value of income, UAH

Source Own estimations, based on data from State Statistics Service of Ukraine, surveys by Gradus and KSE, and web-scraped data from Ukrainian job-search website

In 1.5 years of the war, Ukrainian manufacturers adapted to challenges, including the Russian attack on the power system of Ukraine in autumn 2022 - winter 2023. Many different enterprises and businesses bought electricity generators and adjusted production to the hours when electricity was available. All this undoubtedly affected the price of manufactured products.

IMPACTS OF THE WAR ON AGRICULTURAL PRODUCERS <250 HA

The full-scale war in Ukraine has brought about significant challenges and hardships for small agricultural enterprises, impacting the overall landscape of Ukrainian agriculture. Although representing a smaller portion in terms of size, these enterprises played a crucial role in the country's agricultural sector. Prior to the invasion, they accounted for more than 8 percent of the total harvested grain and leguminous crops, highlighting their importance and contribution to the agricultural output of Ukraine. Moreover, small agricultural enterprises that produce core crops for Ukraine constitute over 68 percent of all agricultural producers. However, the conflict has inflicted severe consequences on these small-scale farmers, disrupting their operations and jeopardizing their sustainability.

The ramifications of the war on small agricultural enterprises have been extensively documented by the Food and Agriculture Organization (FAO)¹⁷, providing valuable insights into the quantitative impacts faced by these farmers. The FAO findings reveal the profound challenges and hardships experienced by micro farmers in Ukraine, underscoring the urgent need for support and intervention to alleviate their distress.

The full-scale war forced farmers to significant operational changes. According to the study, there has been a nearly 8 percent decrease in the total number of enterprises involved in crop production. Extrapolating this rate from the survey data to the 2021 figures on the number of agricultural enterprises, the implications are highly concerning: approximately 1.7 thousand small farms were forced to close as a direct consequence of the war.

The conflict has compelled the remaining agricultural enterprises to adapt and survive in the face of immense challenges. The FAO study reveals that almost 40 percent of all agricultural enterprises have made changes to their farm operations in response to the war. In front-line oblasts, where the impact of the conflict is most acute, this percentage increases to around 45 percent. These enterprises have been resilient in their pursuit of alternative strategies to sustain their operations.

The adoption of limited use of agricultural inputs, such as seeds, pesticides, and fertilizers, suggests a pragmatic approach to managing costs and preserving resources amidst the challenges imposed by the war. Additionally, the shift towards changes in output markets indicates a strategic response to market disruptions, as

¹⁷ FAO. 2023. *Ukraine: Impact of the war on agricultural enterprises – Findings of a nationwide survey of agricultural enterprises with land up to 250 hectares, January–February 2023*. Rome. <https://doi.org/10.4060/cc5755en>

agricultural enterprises seek alternative buyers and explore new avenues to sell their products in order to sustain their operations and generate income in a volatile environment, or even switch to other, non-agricultural activities.

The financial burden of increased costs has been substantial. The disruptions in supply chains inside the country, national currency devaluation, consequently led to a price increase for most of the agricultural inputs, including fertilizers, seeds, feed, fuel, and spare parts for agricultural equipment. FAO revealed that over 80 percent of crop-producing micro enterprises recorded significant or drastic increases in input prices of more than 25 percent since the war began. Similarly, over half of livestock-producing enterprises (60 percent) faced significant or drastic production cost increases.

Active combat battles lead to a large-scale farmland contamination. In addition to financial challenges, micro farmers have had to contend with land contamination by unexploded ordnance. Oblasts along the front-line regions prior to the full-scale war accounted for above 47 percent of grains and legumes harvested area¹⁸. Now, active combat battles lead to an unprecedented land contamination with unexploded mines, artillery ammunition, rockets, etc. FAO survey showed, that in these areas approximately 12 percent of small agricultural enterprises' land is potentially contaminated.

Increased production costs, land contamination, ongoing battles and highly insecure and unpredicted future decreased the areas of sown and harvested areas. The FAO found that the producers decreased the size of cultivated areas for grain and oil crops by 9 percent compared to the pre-war period, with those located in the front-line areas witnessing an appalling 20 percent reduction in the size of cultivated areas for grains and oil crops since the invasion. The problem is even worsened by the decreased yield on the area harvested as in the areas of active combat-battles micro farmers obtained yield over 10 percent below the pre-war levels¹⁹.

War-induced obstacles resulted into decreased revenues of small agricultural enterprises. The blockade imposed by the Russian naval forces on Ukrainian ports caused a notable decline in farm-gate prices for key export-oriented commodities like wheat, corn, barley, and sunflower. This necessitated a redirection of export supply lines from maritime routes to alternative modes of transportation such as railways, river ports, and trucks. This shift resulted in a substantial increase in shipment prices, soaring from approximately \$30 per tonne to as high as \$200 per tonne.

¹⁸ Statistical Yearbook "Agriculture of Ukraine" for 2021.

¹⁹ FAO. 2023. *Ukraine: Impact of the war on agricultural enterprises – Findings of a nationwide survey of agricultural enterprises with land up to 250 hectares, January–February 2023*. Rome. <https://doi.org/10.4060/cc5755en>

Consequently, the demand for these commodities plummeted due to reduced export capacity. As a result, there was a weighted average decrease of 33.7% in domestic prices during November 2022.

Following that, a grain deal with the UN and Turkey²⁰ was initiated, which served to expand Ukraine's export capacity. However, this development coincided with the commencement of the harvesting campaign, leading to a significant increase in the supply of agricultural commodities in the domestic market. Despite these efforts, exporting capacities continue to fall short, and shipment costs remain elevated. As a result, coupled with the surge in supply from the new harvest, domestic prices for export-oriented commodities continue to experience a pronounced downward trend.

As a result of these, nearly 90 percent of crop-producing enterprises reported a decrease in revenues, with over 70 percent of them recording a significant or drastic decrease²¹. Coupled with increased costs, land unharvested, yield decrease these led to substantial financial losses for micro farmers, which are estimated by the FAO at the level of nearly \$3.5 billion after almost one year of the full-scale invasion, most of which are attributed to crop producers.

The Russian Federation's aggression has left a trail of destruction that has had far-reaching consequences. As a result of long-lasting and massive attacks, shelling, missile strikes, and occupation, the Russian army destructed vital components of Ukraine's agricultural sector. Agricultural machinery and inputs, storage facilities, crops, and livestock were all subjected to a deliberate devastation.

²⁰ Grain deal – informal name of the “Black Sea Grain Initiative” – the two sets of agreements signed by Ukraine, Turkey, and the UN as well as the RF, Turkey, and the UN. The goal of the initiative is to establish a humanitarian maritime corridor to allow ships to export grain and other foodstuffs from Ukraine.

²¹ FAO 2023. *Ukraine: Impact of the war on agricultural enterprises - Findings of a nationwide survey of agricultural enterprises with land up to 250 hectares, January-February 2023*. Rome. <https://doi.org/10.4060/cc5755en>

IMPACTS OF IMPORTS BAN BY THE WESTERN NEIGHBOURS

Starting from April 19, Warsaw imposed a ban on the import of Ukrainian grain and various other food items from Ukraine into Poland followed by similar bans in Hungary, Slovakia and Bulgaria. In late April, the EU Commission retroactively legalized²² this ban, which has now also been extended to include Romania and covers wheat, corn, rapeseed, sunflower seeds and sunflower oil.²³ As a result, of this bans and limitations numerous trucks, cars, and wagons carrying these products were left to stand and wait. The extended phytosanitary inspections imposed unforeseen expenses on the contractors, as they were not prepared for the lengthy process, leading to delayed deliveries and additional costs due to idle time.²⁴ Simultaneously, the EU Commission emphasized that the transportation of Ukrainian grain through these countries to other nations continues to be authorized. Since these countries were not the main exporters of Ukrainian grain but rather performed the functions of transit countries, these restrictions should not cause large losses to farmers and Ukrainian grain exporters, while increased idle time and grain inspections on the borders have negative effects.

In the summer 2022, Ukraine, under the Solidarity Lanes initiative launched by the EU²⁵ was able to increase its railway's agricultural export shipments only to about 1 mln tons per month. Poland, Romania, Hungary, Slovakia, and Bulgaria were the main countries through which Ukrainian grain could be exported.

Launching the Grain Initiative or Grain Deal and establishing a so-called grain corridor from the three deep-water Black Sea ports (Odesa, Chornomorsk, and Pivdennyi) (UN 2022) allowed increasing agricultural exports from Ukraine substantially, with, however, only marginal effect on domestic prices, i.e. it improved farmers' incomes only marginally. The Grain Deal (Glauber and Laborde 2022) between Ukraine and Russia, moderated by the UN and Turkey, came into force in August, when the 2022 harvest already started. Therefore, despite monthly grains exports returned to the pre-war levels, the supply pressure on the domestic market was not eliminated, export costs remained almost at the pre-corridor high level and the domestic prices stayed depressed and low, without any noticeable sign to close the gap with respect to the world market prices. Moreover, after the shipment peak in September 2022 (more than 4 million of tons), exports of agricultural products from Ukraine never reached the September's level till today. Continued accusation and questioning (UkrAgroConsult 2022) of the Grain Deal from the Russian side undermined the security, volumes, and costs of the grain corridor shipments.

²² <https://www.dw.com/en/whats-behind-eu-gripes-over-ukrainian-grain/a-65412876>

²³ <https://www.dw.com/en/eu-import-bans-for-ukraine-grain-shock-embattled-farmers/a-65540084>

²⁴ [Ban on grain import and transit](#)

²⁵ https://transport.ec.europa.eu/news-events/news/european-commission-establish-solidarity-lanes-help-ukraine-export-agricultural-goods-2022-05-12_en

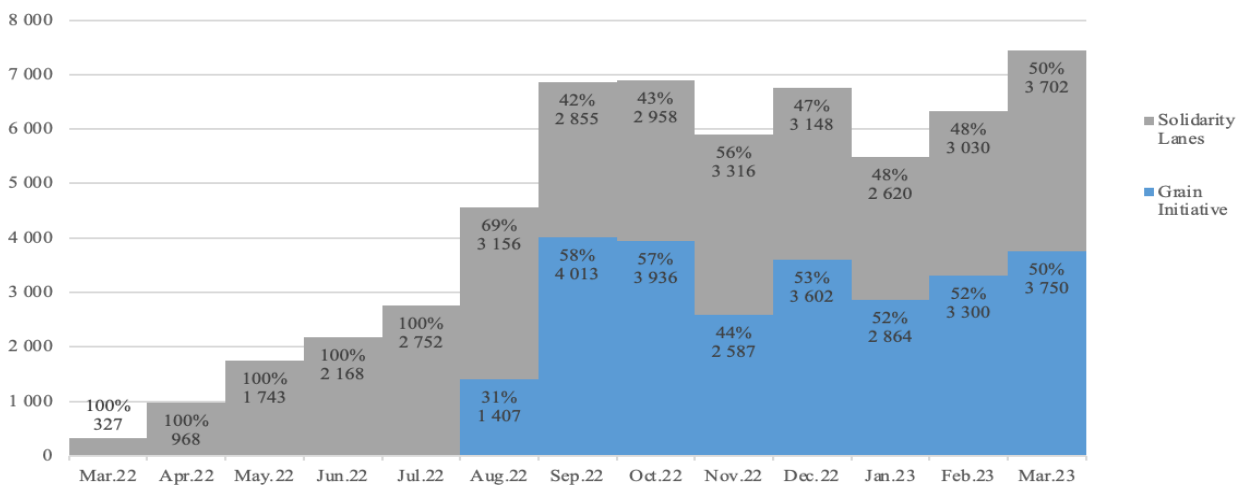


Figure Wartime Exports in Logistics Breakdown, % of total and thsd tons

Source Ministry of Agrarian Policy and Food of Ukraine 2023

For more than 15 months of the war, 84.8 mln t of Ukrainian grain were exported. In fact, roughly 44.8 million tons of Ukraine's total grain exports were shipped off to other countries, according to the Grain Deal agreement. Through Romania exported about 24.3 million tons of grain, Poland approximately 8.4 million tons, and Hungary just over 5.3 million tons. In comparison, only 1.4 and 0.6 million tons reached Moldova and Slovakia, respectively (export to some countries includes direct export to this country as a final destination and export as a transit country to the next destination and ports for future loading on a ship).

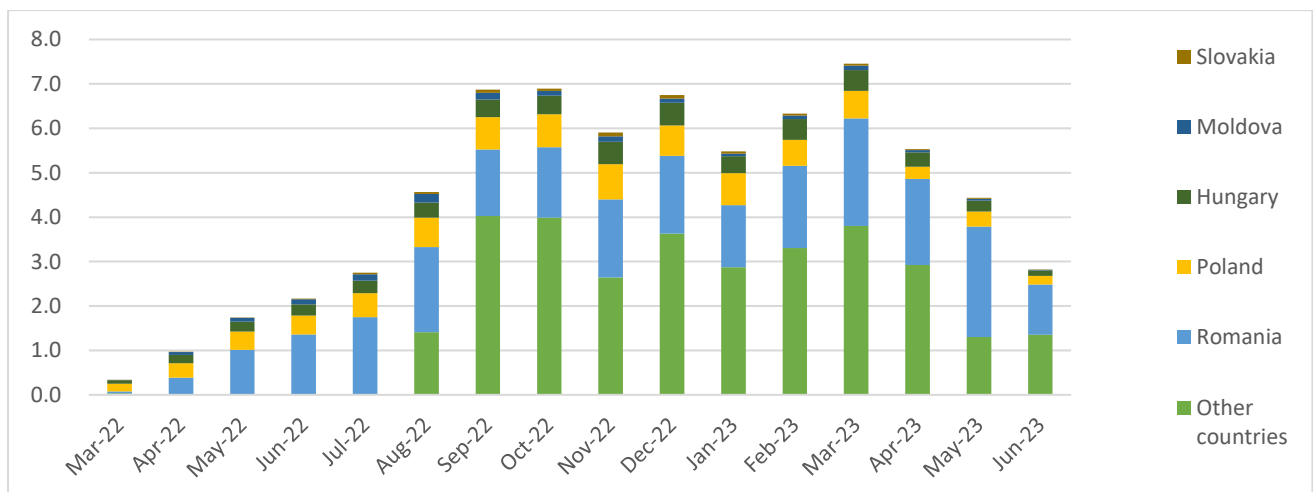


Figure Wartime Exports in Countries Breakdown, mln tons

Source Ministry of Agrarian Policy and Food of Ukraine 2023

IMPACTS OF THE DESTRUCTION OF THE KAKHOVSKA DAM

Based Neyter Roman et al. 2023 estimations

The total damage and loss for the primary agriculture are estimated at US\$1,180.2 million. The loss is estimated at US\$1,154.5 million, accounting for 98 percent of total damage and loss. The damage is assessed at US\$25.7 million.

Damages

The **damage** from the destruction of Kakhovka dam for agriculture is estimated at **US\$25.7 million**. The damage consists of the destruction of planted crops, livestock animals, and fish. Ninety seven percent of the damages were due to the death of fish.

Table Damages for primary agriculture, US\$ million

Damage categories	US\$ million
Crops	0.43
Livestock animals	0.71
Fish	24.52
Total Damages	25.66

Source Based on KSE calculation

Crops

According to Ukrainian Hydrometeorological Institute the total area affected by floods in Kherson region is 30.9 square kilometers. Flooded agricultural areas are estimated at 1,500 hectares, including 150 hectares of irrigated areas. Furthermore, it is important to note that a significant majority of the damaged area was either occupied during the dam destruction or located near the frontline, which hindered the possibility of carrying out regular crop planting activities. The directly affected farm area with planted crops, therefore, was assumed to be only half of the affected farm area, i.e., **775 ha**.

Livestock

The overall financial loss incurred due to animal deaths in livestock production was estimated to be US\$710,000. This estimation is based on the assumption that the number of affected and deceased animals, including cattle, pigs, poultry, sheep, and goats, did not exceed 2 percent. To determine this estimate, the baseline was established by considering the number of animals remaining in Kherson oblast in 2023, while taking into account the adjustments made to the 2001 baseline due to damages caused by the war (using the RDNA2 estimates).

Fishery

The aquaculture and river-based fishing industry have suffered significant damage,

amounting to US\$24.52 million, which represents 97 percent of the total damages in the primary agriculture sector. This substantial loss can be attributed to various factors, including a drastic reduction in water volumes, a rapid decline in oxygen levels, fish spills over the dam, and the contamination of water with oils and other toxic substances. These combined factors have not only endangered the current fish stocks in the Kakhovka dam but also rendered the remaining fish unsuitable for human consumption.

Farm assets

The damage of farm assets was not included in the total damage estimate. It is unlikely that any of the functional farm machinery and equipment were on the occupied territory of Kherson oblast and destroyed by floods. By now, a vast majority of farm mobile assets were stolen or expropriated by Russia. In addition, there are 11 grain silos on the area affected by floods, but most of them were empty, without grain stocks.

Losses

The **losses** for agriculture from the destruction of Kakhovka dam are much higher than the damages, estimated at **US\$1,154.5 million**. The losses are calculated for 5-year period, which is assumed to be needed at minimum for restoration of Kakhovka dam and irrigation infrastructure, and include foregone benefits for the production of crops, livestock production, and fishery. The losses also include the cost of recovery/recultivation of the agricultural soils/land damaged by floods.

Crops

According to the MAPF, the Kakhovka water storage system was used to provide water for irrigation systems, covering the total area of 584,000 ha. Most of the irrigated areas were in Kherson, followed by Zaporizhya and Dnipropetrovsk oblasts. Prior to the war, however, in 2020, the actual irrigated area was 253,753 ha, according to the State Statistics Committee of Ukraine and 261,812 ha over 2017-2022, according to the 2023 ICEYE SAR imagery. This latter actually irrigated area is used for the calculation of economic losses from the lack of irrigation. The loss is valued at US\$909.9 million, capturing the difference between crop yields on irrigated versus rainfed soils in south of Ukraine, which is prone to droughts and needs (at least) supplementary irrigation to achieve a full agricultural potential. It also reflects the reality that not all previously irrigated area could switch to rainfed production and no production would be possible there in the next 5 years. The share of this area will be at least 50 percent.

The restoration of agricultural land can take years, and in addition, the restoration must be carried out according to the standards of "green" technologies. And it will not be possible to grow wheat, sunflower and corn on these lands with the help of only

drip splicing.²⁶

PROCESSED FOOD INDUSTRY POTENTIAL

Based on the 2023 work by Pavlo Martyshev, Roman Neyter and Igor Piddubnyi “Food processing. What’s next?” (<https://kse.ua/wp-content/uploads/2023/06/Food-Processing.-Whats-next.pdf>)

Food processing industry is an important sector in Ukraine's national economy. The sector is focused mostly on the primary processing of agricultural commodities (especially oilseeds crushing products); its diversification is weak. By contrast, Ukraine imports a variety of processed food products. The country shows high self-sufficiency in raw materials, especially feed grains, vegetables, and oilseeds. However, the marginality of processing is limited since raw commodities are exported actively. Ukraine's food sector is highly integrated into the global value chains. The major categories of imported inputs are palm oil, tropical fruits, nuts, plastics, and packaging materials. The sector of food, beverages, and tobacco production has fiscal costs close to the national average: in the 2018-2021, the tax burden ratio was 25% versus 27% in the whole national economy. However, a large share of sector's tax revenues is generated by excise taxes for beverages and tobacco products. This means that food processing industry excluding beverages and tobacco production is undertaxed. The most perspective groups for food exports with growing international demand are vegetable oils (both refined and unrefined), oilseed meals, poultry meat, and confectionery.

Ukraine has a disproportionally high share of the agricultural sector in GDP and total exports compared to peer countries. However, the share of processed food products is lower than international benchmarks. A high proportion of agriculture in total employment implies low productivity in the sector. Meanwhile, the share of food manufacturing is low; this means that the sector is more capital-intensive than primary agriculture. Also, the high presence of processed products in Ukraine's agri-food imports shows the essential potential for the development of the local food processing industry.

The European move towards climate neutrality and shifted consumer preferences create both risks and opportunities for agricultural producers in Ukraine. The risks are mainly connected to the regulations that may limit the access for Ukrainian farmers to the EU-members' markets – both physically if some of them do not meet the requirements and financially because of operational, investment, and transaction costs to comply with environment and food safety regulations.

²⁶ <https://a7d.com.ua/novini/59499-chastkove-vidnovlennya-slskogospodarskih-zemel-pslya-znischennya-dambi-kahovskoyi-ges-koshtuvatime-blizko-45-mlyarda-yevro.html>

On the other hand, this opens additional and significant opportunities for agricultural enterprises in Ukraine. First, EU members' demand for imported food may increase in case of a reduction in their own production due to the implementation of the Farm to Fork strategy. Second, in addition to coercion, the EU also applies methods of stimulating sustainable farming, which also includes the expansion of preferential credit programs and the provision of grants for enterprises that are ready to be the locomotive of the green transformation for organic and healthy food.

However, several caveats should be noted here. Since Ukraine is on the path of integration and becoming a member of the EU, it is appropriate to understand that upon accession, the requirements applicable to members will also apply to Ukrainian enterprises. Therefore, delaying the adjustment of production standards may lead to negative effects on the country's EU membership or if EU directives are more strictly applied to importers. An example of such EU policy for maintaining its domestic competitiveness is the Carbon Border Adjustment Mechanism (CBAM) mechanism, which will at least indirectly affect the costs of agricultural enterprises through a possible change in prices for fertilizers and machinery and, perhaps, directly for agricultural products if such amendments, which have a certain political support in the EU, will be adopted as well.

Ukraine, as a major global producer and exporter of grains and sunflower oil, as well as an exporter of animal products to the EU, can increase its export potential for processed products that have a higher added value compared to the current structure of production and export of the sector. However, in this case, the competitiveness of farmers will be determined not only by the cost of production factors but also by environmental sustainability, and compliance with food safety standards – in particular, food traceability and animal welfare requirements.

CURRENT STATE OF THE AGRICULTURAL LAND MARKET

In July 2021, the first stage of the land market was implemented, namely, citizens received the right to buy up to 100 hectares of agricultural land in one hand. It was expected that in 2022-2023, the first distribution of land would take place, and interested citizens would have the opportunity and desire to purchase land for farming before, in January 2024, access to the auctions of the main players - domestic legal entities, with an increased limit of ownership per citizen up to 10 thousand hectares.²⁷

But the war made adjustments, which no one could have expected in 2019, at the beginning of the land reform. For the first few months, the sale of land plots was completely stopped, and then the state registers started working again (so that citizens' personal data were not stolen or used in some other way). The temporarily

²⁷ <https://delo.ua/economy/rinok-zemli-v-ukrayini-perebuvaie-v-stagnaciyi-shho-bude-z-cinami-ta-popitom-na-ugiddya-v-2023-roci-412183/>

occupied Luhansk region has completely fallen out of circulation, and land plots cannot be bought/sold. Moreover, investing in clearing the land of explosive substances, mines, rockets, unexploded shells, and more will be necessary.

Despite of these circumstances, land plots were indeed sold in 2022; however, the quantities were significantly reduced, both in terms of transaction numbers and total area. During the year, starting from February 24, 2022, to February 28, 2023, 52.7 transactions of land purchase and sale were made, with a total area of 99.5 thousand hectares. For comparison, in 8 months of 2021, almost twice as many transactions were conducted - 101 thousand, the total area of which was 244.5 thousand hectares.²⁸

According to the data of the State Geocadastre, as of June 2023, the average price (purchase-sale, exchange, donation, lifetime maintenance) of 1 hectare of agricultural land was UAH 39100 per hectare²⁹. Moreover, the most expensive 1 ha of land in Lviv region, Kyiv region, and Ivano-Frankivsk region, 156.5 thousand UAH/hectare, 146.2 thousand UAH/hectare and 134.7 thousand UAH/hectare, respectively. Kherson, Mykolaiv, Chernihiv, and Sumy regions have the most cheap average prices for 1 ha, prices vary from 23.1 to 25.9 thousand UAH/ha.

For 2.5 years since July 1, 2021, only individuals were allowed to operate on the land market with the size threshold of 100 ha per individual. Starting from January 1, 2024, the land market in Ukraine will be open for the operations of legal entities. They will be allowed to operate land parcels up to 10,000 hectares per entity. The impact of this change on the market and the potential increase in prices is uncertain due to the war and shocks caused to the agricultural sector. The NBU's approximate estimates suggest a reduction in consumer inflation to around 20% in 2023 (31% in 2022).³⁰ Consequently, it can be anticipated that the average price per hectare may rise by a similar range of up to 20%. However, the focus should not solely be on price increases but rather on the continuation of essential land reform. Institutional background and legal procedures practiced during the reform will make it easier to attract investments in Ukraine's agriculture after the end of the war.

²⁸ Ministry of Agrarian Policy and Food of Ukraine and State Geocadaster
https://public.tableau.com/views/vl_Land_market_1_v1/Dashboard1?:language=en-GB&:display_count=n&:origin=viz_share_link:showVizHome=no&:embed=true%22width=%221024

²⁹ <https://land.gov.ua/index.php/monitorynh-zemelnykh-vidnosyn/>

³⁰ <https://bank.gov.ua/ua/news/all/u-2023-rotsi-inflyatsiya-pochne-znijuvatisya-a-ekonomika-povernetsya-do-zrostannya--inflyatsiyniy-zvit>

OUTLOOK FOR GRAINS AND OILSEEDS MARKETS

The RF's full-scale military invasion of Ukraine has last for 1.5 years now. It has devastating impacts on the people's lives, economies and food security around the globe. **Food commodities prices are still very high.** The [FAO Food Price Index](#), which tracks monthly changes in the international prices of commonly-traded food commodities, averaged 127.2 points in April 2023, up 0.6 percent from March. At that level, the Index was 19.7 percent below its level in April 2022, but still 5.2 percent higher than in [April 2021](#), with **many countries facing high food prices inflation**: "high [food price – from the authors] inflation in almost all low- and middle-income countries, with inflation levels above 5 percent in 94.1 percent of low-income countries, 86 percent of lower-middle-income countries, and 93.0 percent of upper-middle-income countries and many [countries – from the authors] experiencing double-digit inflation. In addition, 87.3 percent of high-income countries are experiencing high food price inflation. The countries affected most are in Africa, North America, Latin America, South Asia, Europe, and Central Asia. In real terms, food price inflation exceeded overall inflation (measured as year-on-year change in the overall CPI) in 88.8 percent of the 160 countries for which food CPI and overall CPI indexes are both [available](#)". As of end 2022, however, IFPRI states that the **major food crisis has been averted** due to the Black Sea Grain Initiative, an increase in global humanitarian efforts to mitigate the impacts of the war and record wheat harvests in Canada, the European Union, and Russia.

With the world tackling the crisis by production growth in other regions and export initiative in Ukraine, the future for Ukrainian agriculture looks less pretty the longer the war lasts. According to the production experts and the producers themselves, whereas the 2022 sowing season took place with the resources accumulated in 2021, the 2023 and the following production seasons have considerably fewer means.

Since the first days of Russian invasion, the Black Sea ports of Ukraine were either occupied or blocked by Russian naval fleet. Huge mass of exportable surpluses of grains and vegoil have stuck in Ukraine's ports and in inland elevators. The land and river export routes have been more expensive and with a limited scope for toping up the shipments. Respectively, the total shipment capacity fell substantially short of the demand and of the pre-war monthly shipments³¹, which led to oversupplies exhausting³² the existing domestic storage capacities. Therefore, in May 2022 the

³¹ <https://www.ifpri.org/blog/suspension-black-sea-grain-initiative-what-has-deal-achieved-and-what-happens-now>

³² https://www.vox.com/23171151/ukraine-grain-wheat-russia-black-sea-odesa-food-crisis?fbclid=IwAR275N4CeFDx4h96_6PM3ryN2P5w1MxUKH2k0pAcciuaP3ANo9_FjNm9jSg

global wheat price spiked to 444.16 compared to 278.45 USD per metric ton. By April 2023, more than one year after the invasion, the global wheat price fell to **312.8 USD per metric ton** remaining nevertheless extremely high. Even with around 20% lower production volume³³ of grains compared to 2020 (compared to 2021 - production record year, the difference is around 36%) the quantities produced are considerably higher compared to the export capacities. Due to more expensive and longer alternative export routes, export costs surged³⁴ **from the pre-war 30-40 USD/t to 150-200 USD/t**, and thus severely depressed domestic grain prices. Launching the Grain Deal and establishing a so-called grain corridor from the three deep-water Black Sea ports³⁵ (Odesa, Chornomorsk, and Pivdennyi) allowed increasing agricultural exports from Ukraine substantially, with, however, only marginal effect on domestic prices, i.e. it improved farmers' incomes only marginally³⁶.

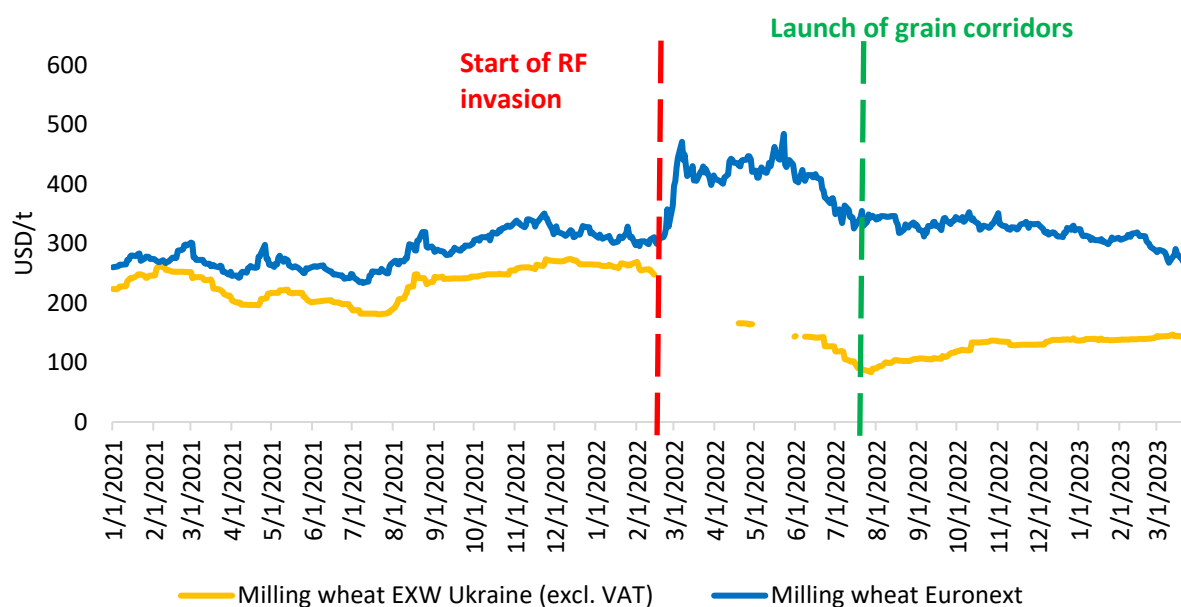


Figure Wheat prices in Ukraine and EU before and after the full-scale Russian invasion

³³ <https://kurkul.com/spetsproekty/1406-yak-viyna-vplinula-na-vrojaj-zernovih-ta-oliynih--pidsumki-sezonu-2022>

³⁴ https://www.youtube.com/watch?v=bYSv_oBAbZk&t=511s

³⁵ <https://www.un.org/en/black-sea-grain-initiative>

³⁶ See the report on the state of agricultural sector at <https://kse.ua/wp-content/uploads/2023/05/KSE-Digest-May.pdf>

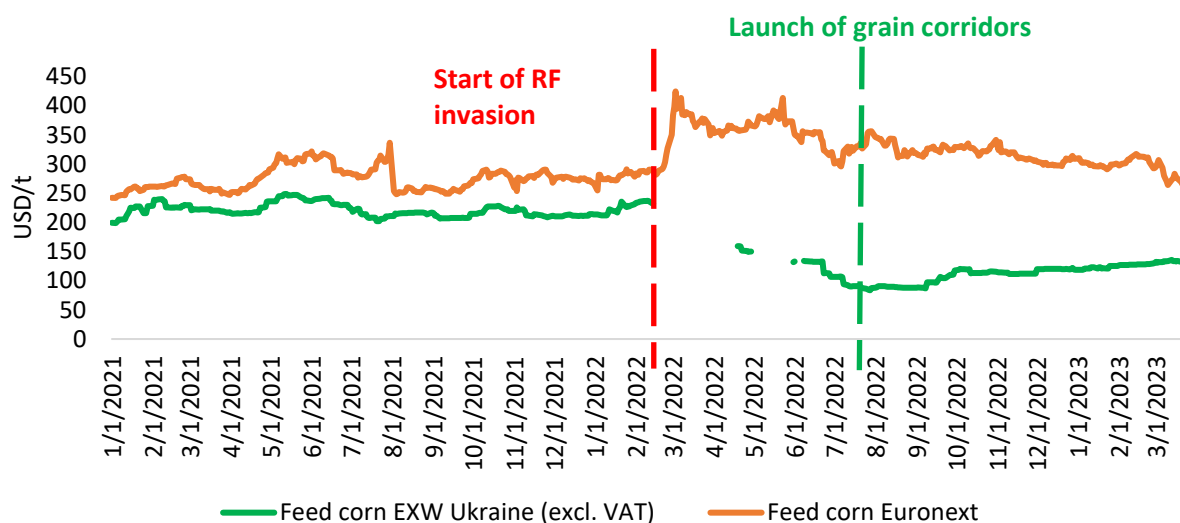


Figure Corn prices in Ukraine and EU before and after the full-scale Russian invasion

With Ukraine fighting for life in the unprecedented attack onto its independence by RF, it is important to locate the expectations about its crop production on the map of global food supply and trade. Therefore, in the current section we project the Ukrainian agricultural markets development for 2030 and beyond, i.e., up until 2050.

OUTLOOK

To assess the future perspectives of the Ukrainian agricultural sector and markets, the AGMEMOD model is applied. The description of the model and the assumptions for the simulation are presented in Annex 1 of this report.

Grains and oilseeds areas

In the graph below we compare the grains (wheat, barley, rye, oats and corn) and oilseeds (sunflower, rapeseed and soya) areas harvested in 2021, 2022 and the projected in 2025, 2030 and 2050. Before the war, the total acreage of these crops was relatively stable, and therefore only 2021 is considered as a comparison year.

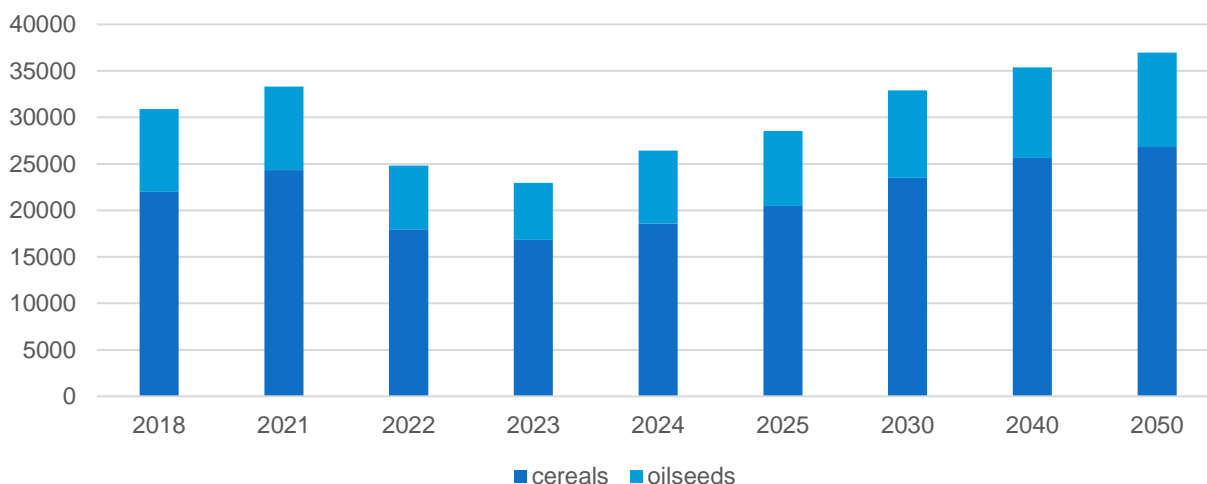


Figure Acreage of cereals and oilseeds in 2021-2050, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2050

Before the RF invasion, areas of grains and oilseeds were, respectively, around 24 and 9 million hectares. In 2022, they dropped to around 18 and 7 million ha. With the war ongoing, further drop in the areas is expected: to 17 and 6 million ha. The model estimates, that if the war ends in 2023, the areas will reach the prewar levels by 2030 and by 2050 may total 37 million hectares. The additional land for oilseeds and cereals will be reallocated from other agricultural land uses such as vegetables and industrial crops.

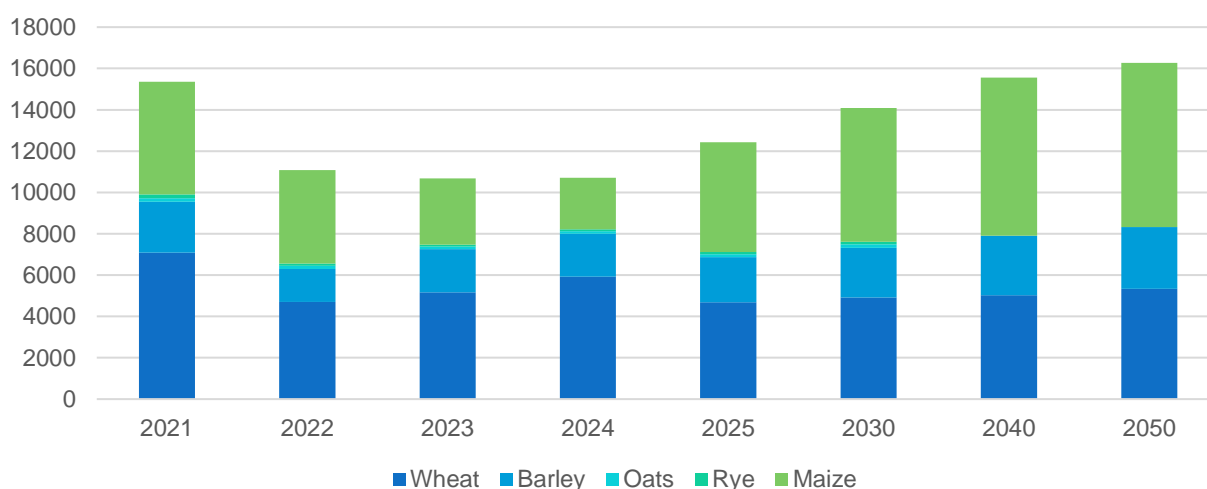


Figure Acreage of cereals crops in 2021-2050, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2050

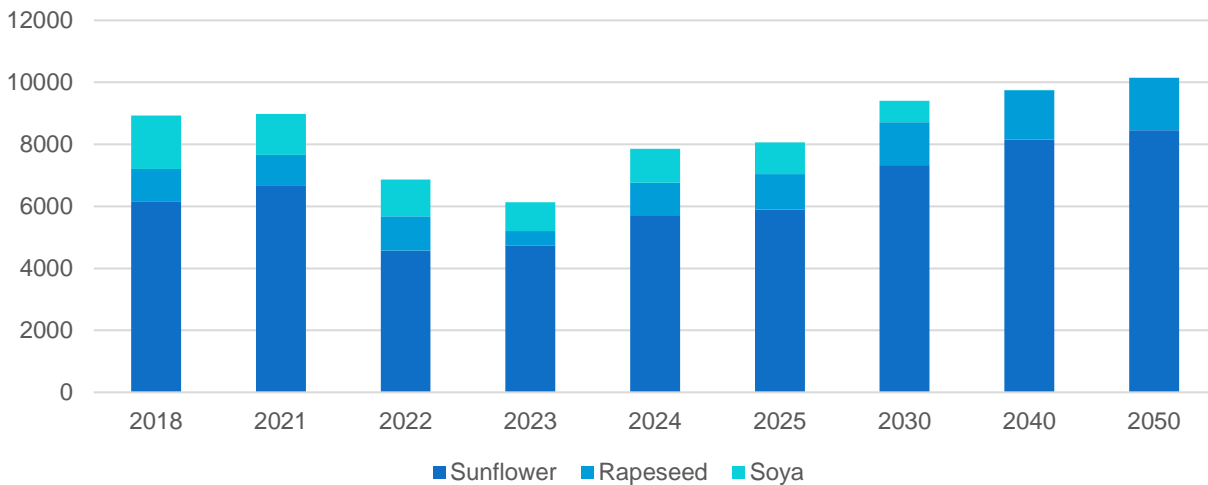


Figure Acreage of oilseeds crops in 2021-2050, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2050

Maize, wheat and barley are expected to remain the major crops during and after the war, as even reduced export possibilities will sustain these crops' relative profitability. The latter will play an important role in maize production: the producers move to wheat and barley production as the war continues and resume to corn after it ends. Maize is expected to gain a considerably greater importance by 2050 compared to wheat and barley, as it is expected to occupy 8 million hectares of land as opposed to wheat with 5.3 million hectares and barley with 3 million hectares. Changing weather conditions, the world and domestic market prices will be the major causes of such distribution.

Sunflower has been and will remain the major oilseed until 2050. Rapeseed area will grow slightly, whereas soya beans area seems to drastically reduce. Total area of oilseeds will increase at the expense of the grains, vegetables and industrial crops areas. This increase will only be reached by 2030. Area of soya will drop, and of rapeseed increase as compared to the pre-war levels. Overall, the total area harvested is expected to recover after the war by 2030 and to continue growing by 2050.

Crops production and export

During the war, in 2022-2023, the production of the cereals modelled drops. Starting from the first post-war year, assumed 2024, the production will recover but at different levels. Although acreage of maize is expected to prevail, due to the yield differences, Ukraine will produce more of wheat than of all other commodities until 2030. In 2040 and 2050 the model projects maize to be the main commodity in Ukraine. Another change will take place for oats and rye. Starting from 2024 Ukraine produce more of oats and then of rye. Overall, wheat, maize, rye, oats and barley production will grow. Export of wheat, maize and barley will the production trend, as it has been before the war. Orientation of rye and oats on the domestic market will remain, and exports will

not play such an important role in this sector.

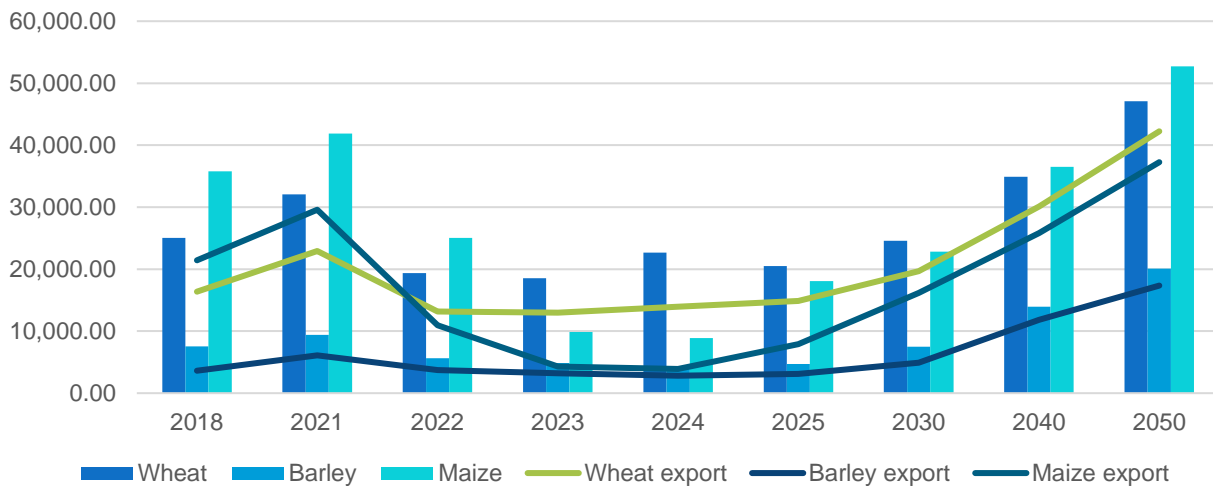


Figure Production and export of wheat, barley and maize in 2021-2050, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2050

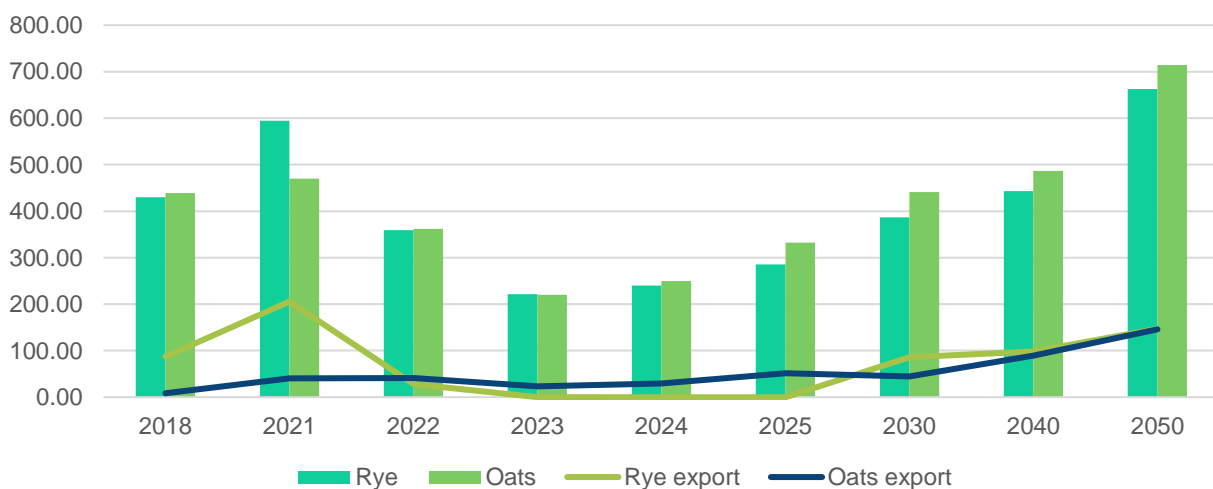


Figure Production and export of rye and oats in 2021-2050, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2050

Sunflower production is projected to reach and exceed the pre-war level by 2040, and by 2050 generate 23 million tones of volume. Severe production shock in 2023-2024 and given absence of external support (e.g., subsidies) the producers will struggle to reaccumulate the necessary resources to invest in greater oilseeds yields. Thus, sunflower production in 2030 is expected to be 18% less than in 2018. Production of rapeseed seeds and soya beans will drop by 70% and 60% in 2030, but rapeseed is expected to recover by 2050, whereas soy – not. Production of oils and meals, as well as exports of seeds, oils and meals will follow the production of the oilseed seeds.

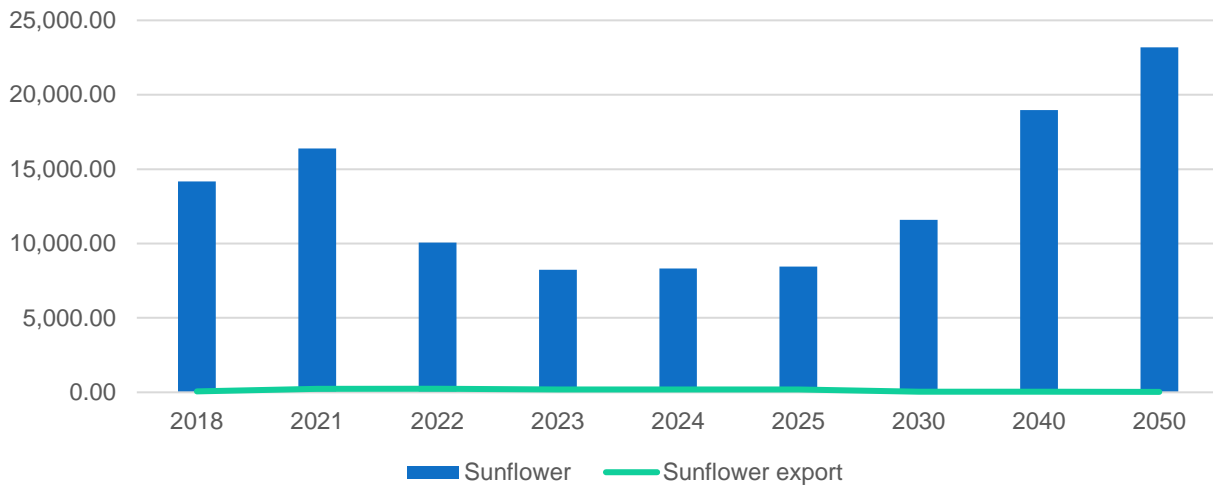


Figure Production and export of sunflower seeds in 2021-2050, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2050

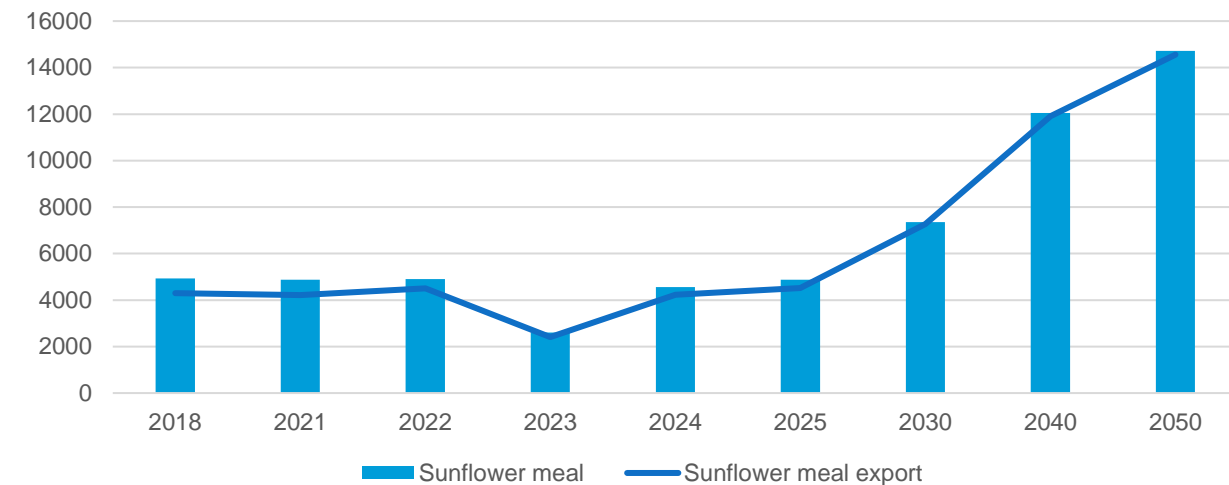
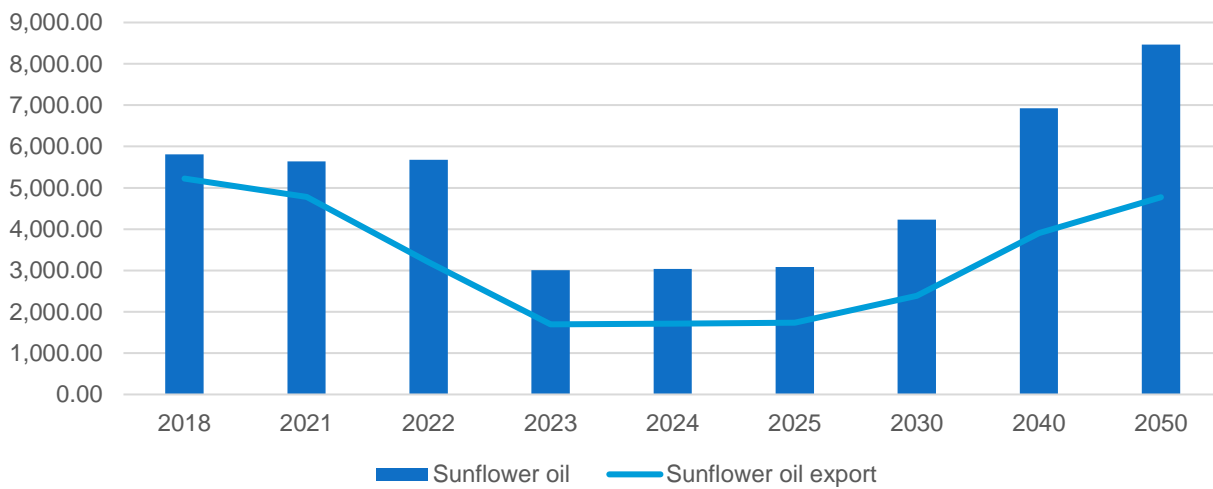


Figure Production and export of sunflower oils and meals in 2021-2050, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2050

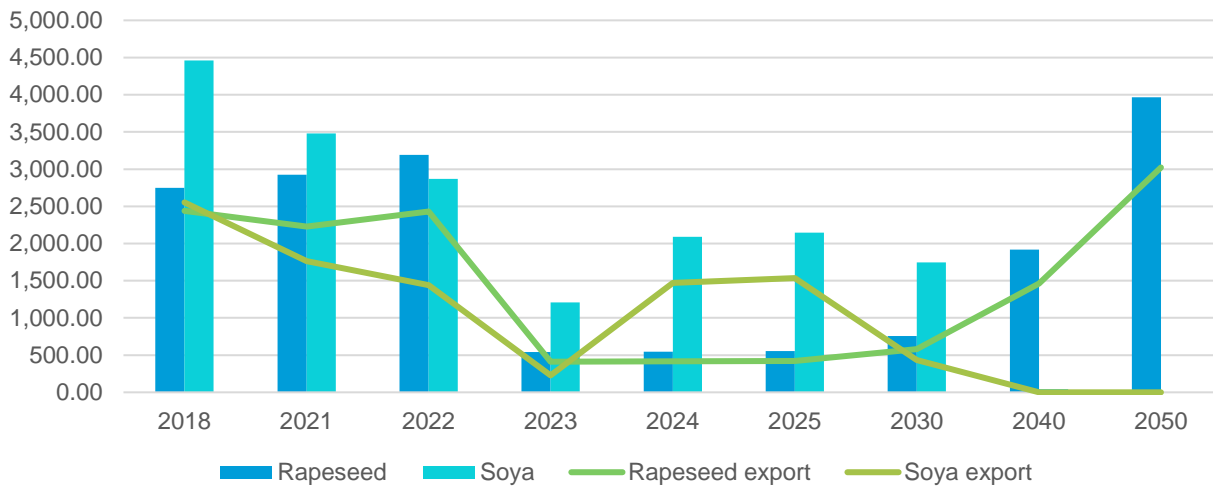


Figure Production and export of rapeseed and soya in 2021-2050, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2050

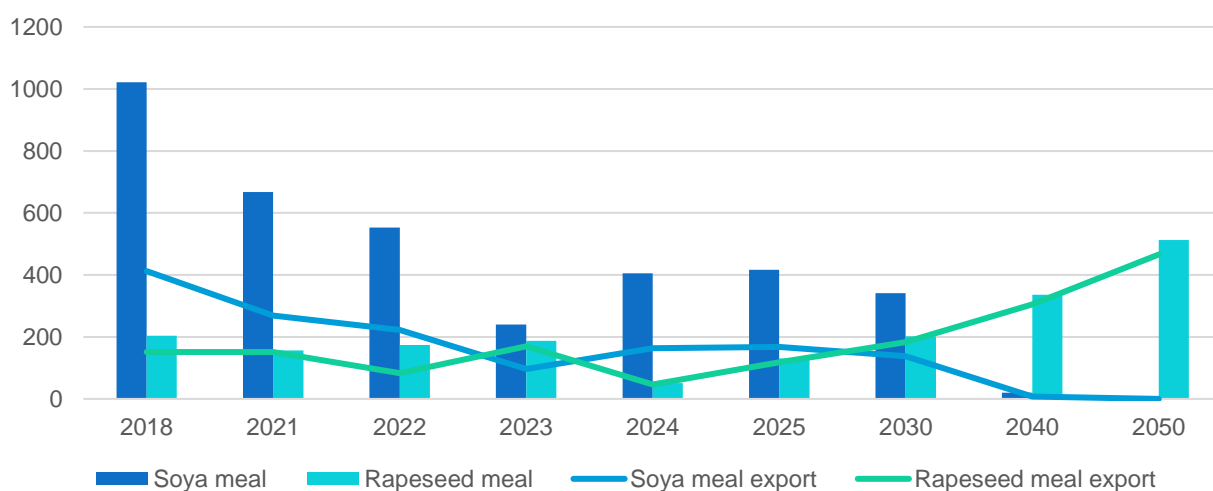
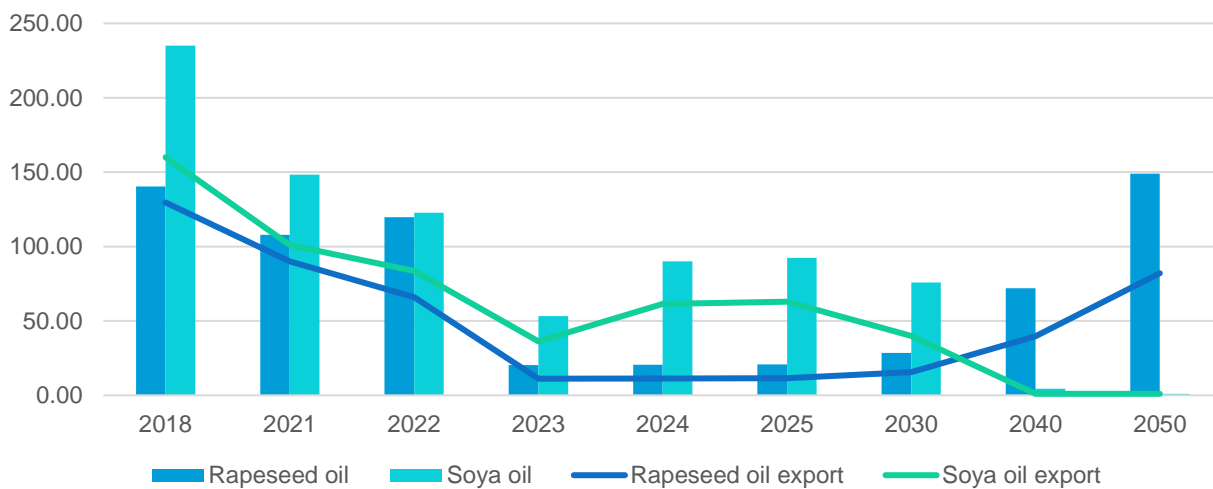


Figure Production of oilseed oils and meals in 2021-2030, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2030

Domestic prices

The price recovery stems from two factors. First, is the assumption of storage availability. It allows the producers to go on with their production plan even with the delayed export. Second, is the return of connectedness of domestic market prices to the world market prices coupled with the increased UAH/USD conversion rate (i.e., around 36 UAH per 1 USD in 2023-2030 as opposed to 29 UAH per 1 USD in 2021). Re-establishment of the price connection is based on the assumption that the producers, having available storage facilities, will not rush into selling their crops at low prices (to save the harvest and at least partially cover their production costs). Instead, they will be able to claim better market price. The model, however, does not include increased storage costs which occur due to longer storage period and increased storage capacity (i.e., investment/amortization costs).

2030 FINANCIAL AID SCENARIO

As the RF's war in Ukraine goes on, the Ukraine's agricultural sector loses the resources for recovery. The financial and labor inputs are already stretched in 2023. According. In this section we estimate the impact of financial aid to the agricultural crop producers. The financial support scenarios analyzed are two. The first one is Var. It implies that only the costs of seeds and planting materials, fertilizers and fuel are covered by the financial aid for the production of wheat, maize, rye, oats, barley, sunflower, rapeseed and soya beans. And the second scenario is All. It implies that all of the production cost categories as specified in the statistical 50-SG forms are covered by the financial aid. All of the rest of indicators are similar between the two scenarios. Moreover, the costs are covered by the financial aid without distinction between the type of crop commodity. The support is assumed to be distributed in 2023-2025, and the labor force is assumed to be available for rebuilding of the damaged facilities and infrastructure.

In the graph below we compare the impacts of the Var and All scenarios on the grains (wheat, maize, barley, rye and oats) and oilseeds (sunflower, rapeseed and soya) areas to the Baseline scenario described above. Neither covering the seeds, fuel and fertilizer costs, nor covering the total costs will significantly increase the acreage of cereals in 2023. With the support covering the total production costs until 2023 however (scenario All), the cereals area will grow to nearly 13 million hectares in 2025, and continue slow growth until 2030. The support analyzed does not seem to impact the oilseeds area. This is because production costs of oilseeds constitute a smaller share of the world market prices (considering their projected development) as compared to the cereals prices.

The development of areas of cereal crops seems to take an interesting turn with decoupled direct support. Scenario All motivates the farmers to forgo significant areas

of wheat in favor of corn, while keeping rye, barley and oats relatively stable. The explanation lies in profitability and markets. Rye and oats are domestic market-oriented crops, they are not affected severely by the world market prices. The producers stabilize and even slightly grow their acreages of these two crops, with or without the costs support, supplying the domestic market with the required quantities of these two commodities. Barley area has a slightly increasing trend as well. It is not substituted by corn or by any other crop. Although it is export-oriented commodity, the producers seem to grow it along with wheat and corn as a profitability buffer. Finally, with complete costs support, corn and wheat compete harshly for the area, leaving corn an absolute winner considering growing world demand for corn and the world market prices for it being higher relatively to the prices of wheat. The area of corn recovers to the pre-war level by 2025 already under the Var scenario.

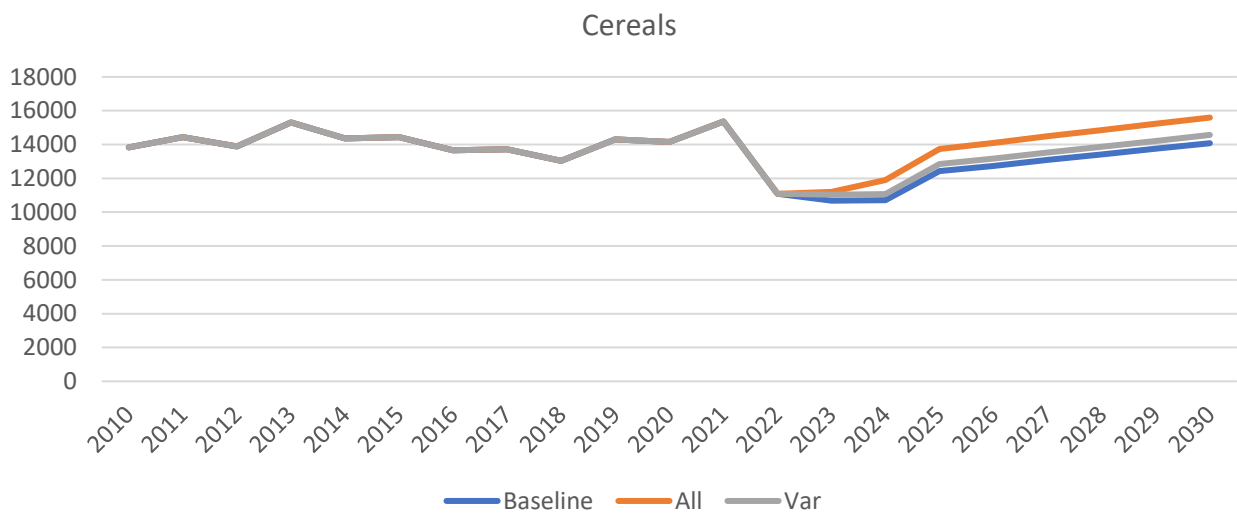


Figure Acreage of cereals in 2010-2030, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2030

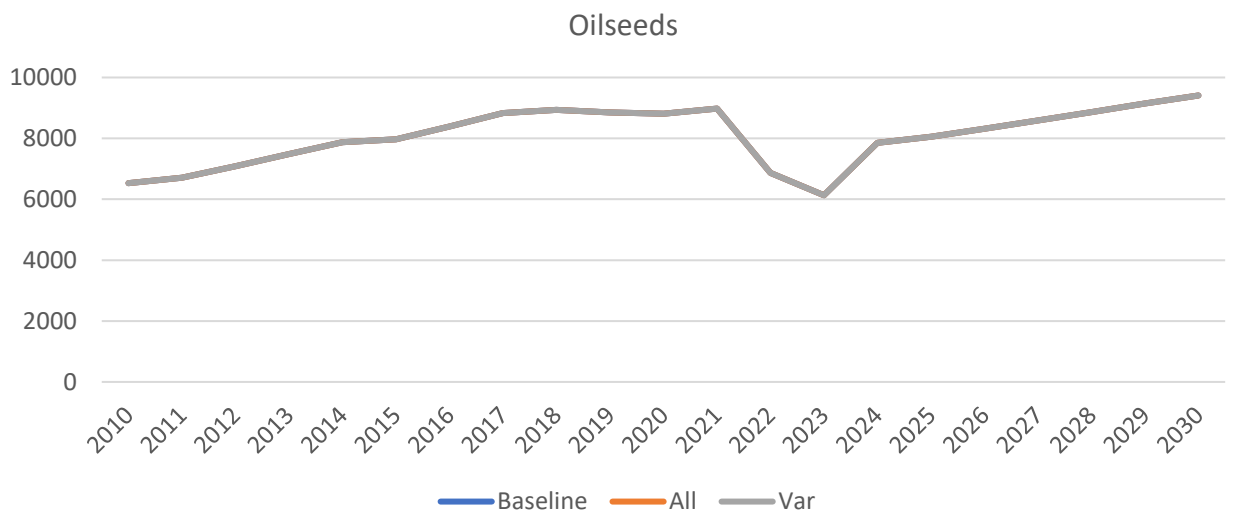


Figure Acreage of oilseeds in 2010-2030, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2030



Figure Acreage of wheat, maize, barley, rye and oats in 2010-2030, thsd ha
Source SSSU for 2021-2022, own estimation for 2023-2030

During the war, in 2022-2023, the production of oilseeds and cereals drops. Under the Baseline, starting from the first post-war year, assumed 2024, the production slowly recovers. With Var and All scenarios, the recovery rate for oilseeds and grains production is much quicker. Total grains production reaches the pre-war level by 2025, and oilseeds by 2027. Whereas the recovery of areas for oilseeds is not affected by

compensation of production costs, the recovery of yields are. The recovery of oilseeds production, under the Var and All scenarios comes from increase in sunflower and rapeseed yields. Soya beans yields remain nearly unchanged. Once again, the areas for these crop commodities, as mentioned in the section above, are not affected. Sunflower is expected to remain the major oilseed crop under all three scenarios.

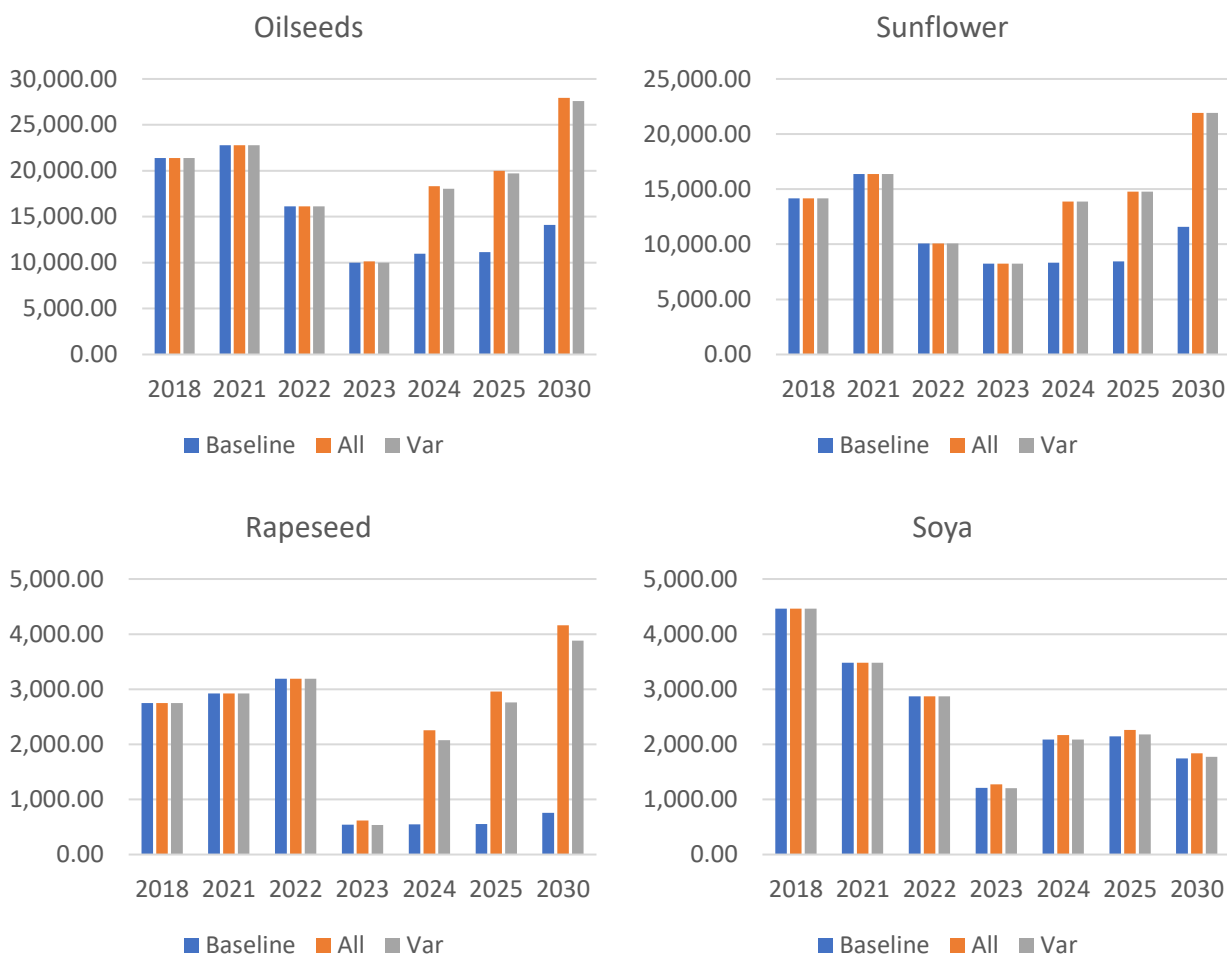


Figure Production of oilseeds in 2018-2030, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2030

Decoupled support significantly impacts cereals areas, as well as cereals yields, that ends up in significant production changes. Under the Var and All scenarios, corn becomes by far the major crop in Ukraine already in 2025. Barley, rye and oats production grows under all three scenarios, but the growth rate is the highest in the All scenario. The growth comes from the increase in both, the areas and yields, the latter having greater magnitude. This is because the production costs compensation is higher in All than in Var which allows the producers accumulating more resources for reinvestments into yield intensification. In the Baseline and Var scenario wheat production is at around 2022 level until 2030, but under the All scenario it drops significantly. This drop is attributed to reallocation of arable land to corn. Wheat yield

in Var and All scenarios grows slightly. The wheat and corn substitution comes from the fact that both crops are export-oriented and the costs compensation allows profiting from the world market prices more. The relative profitability created by the world market prices is significantly higher for corn than for wheat



Figure Production of cereals in 2018-2030, thsd t
Source SSSU for 2000-2022, own elaboration for 2023-2030

Summary

- area of barley, rye and oats will not be responsive to the direct financial support,
- wheat seems to be substituted by corn already in the Baseline. Decoupled direct financial aid will only re-enforce this substitution,
- corn production will be most responsive to the financial aid, as compared to the other four crops,
- the oilseeds area will react to the financial aid very marginally,
- decoupled financial aid covering only fertilizer, seeds and fuel will allow corn to reach the pre-war areas already in 2025, but total cereals area will remain below the prewar acreages until 2030. The aid covering the total production costs will return the pre-war acreage of cereals by 2028 with the help of corn,
- production of barley, rye and oats is projected to grow steadily with and without the costs compensation,
- wheat production will be substituted by corn. The costs compensation will facilitate this process,
- corn production will be most responsive to the financial aid, as compared to the other crops,
- yields of rapeseed and sunflower will react strongly to the support. This will drive the oilseeds production to a quicker recovery,
- soya beans production will have a very weak reaction to the support.

DISCUSSION OF THE SIMULATED IMPACTS

In 2019-2021, primary agriculture, forestry and aquaculture constituted 9-11% of the country's GDP in current prices. In 2022, after 10 months of the full-scale invasion of RF, GDP of Ukraine dropped by 3.9% and the value of agriculture, forestry and aquaculture by 24.3% when estimated in current prices (SSSU, 2022). When using constat, i.e., 2010, prices, the GDP and the value of agriculture, fishery and forestry change differently from year to year, falling by the dramatic 28.4% for GDP and 43.6% for the value of agriculture, forestry and fisher (figure below).

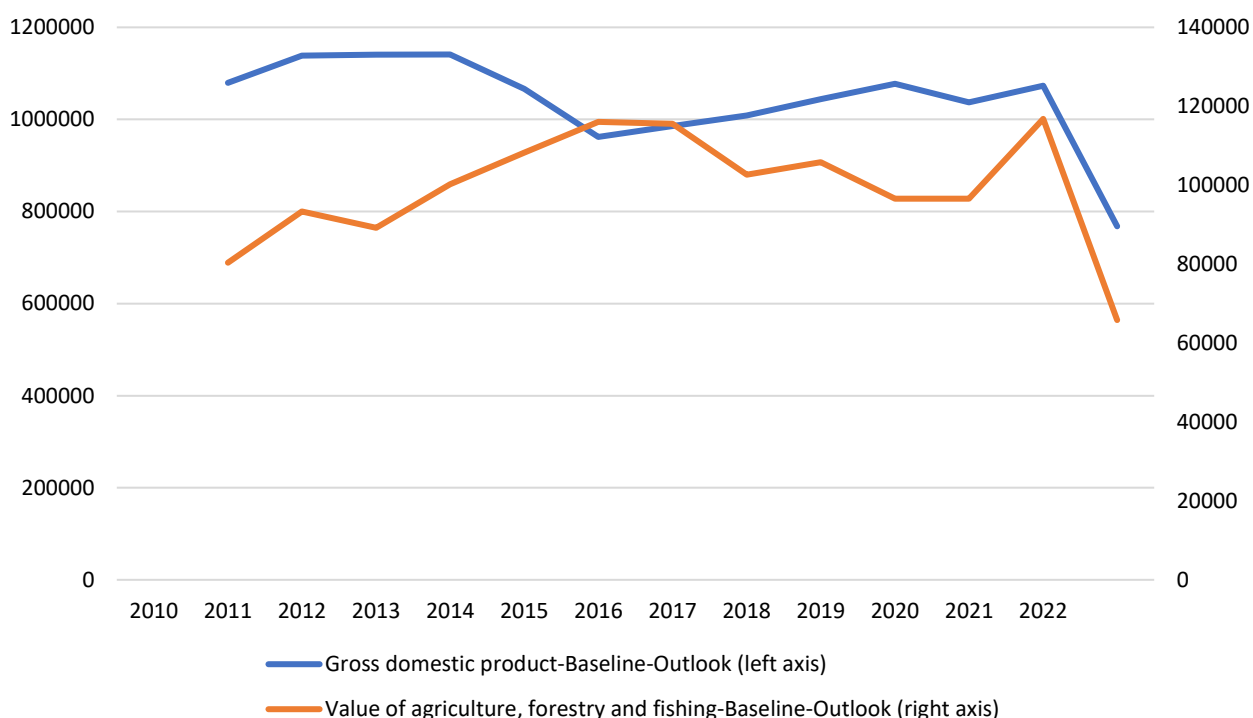


Figure: GDP and “Agriculture, forestry and fishery” values in constant 2010 prices, mIn UAH. The GDP deflator values considered are: 2010-1, 2011-1.14, 2012-1.23, 2013-1.28, 2014-1.49, 2015-2.07, 2016-2.42, 2017-3.00, 2018-3.41, 2019-3.69, 2020-4.07, 2021-5.08, 2022-6.82.

Source: own elaboration based on SSSU data

Given the simulated quantities of crops under the baseline (Outlook) and the Financial Aid Scenarios, it is possible to extrapolate the values added of agriculture at constant 2010 prices and provide the numbers on the GDP changes in ceteris paribus conditions. The table below includes the simulated production quantities of cereals and oilseeds in 2023-2050, along with the expected changes in valued added of agriculture and GDP in constant prices under the three scenarios. In particular, the annual changes in production quantities with respect to 2022 are applied to the GDP and value added in agriculture to generate the values.

Table Simulated quantities of cereals and oilseeds production under the baseline (Outlook), and two scenarios of financial aid (Var and All) and the respectively expected changes in value added of agriculture and GDP until 2050 for baseline and 2030 for the financial aid scenarios, mln UAH

Production of primary agricultural commodities simulated	Unit of measure	Scenario	2018	2021	2022	2023	2024	2025	2030	2040	2050
Wheat	thsd tonnes	baseline	25,071	32,076	19,423	22,478	22,677	20,503	24,581	34,918	47,080
		scenario-All	25,071	32,076	19,364	16,004	21,525	11,267	12,962	NA	NA
		scenario-Var	25,071	32,076	19,364	19,406	23,641	17,858	21,229	NA	NA
Barley	thsd tonnes	baseline	7,531	9,427	5,600	5,909	4,270	4,694	7,482	13,935	20,099
		scenario-All	7,531	9,427	5,616	5,270	6,065	7,564	9,854	NA	NA
		scenario-Var	7,531	9,427	5,616	4,921	5,422	7,080	9,276	NA	NA
Maize	thsd tonnes	baseline	35,801	41,874	17,188	26,079	22,036	23,652	22,841	36,527	52,711
		scenario-All	35,801	41,874	25,037	20,948	20,847	63,946	84,480	NA	NA
		scenario-Var	35,801	41,874	25,037	9,093	8,171	36,740	49,267	NA	NA
Rye	thsd tonnes	baseline	430	595	359	222	240	285	387	443	663
		scenario-All	430	595	359	233	267	316	428	NA	NA
		scenario-Var	430	595	359	229	248	295	400	NA	NA
Oats	thsd tonnes	baseline	439	470	362	220	249	333	441	487	715
		scenario-All	439	470	362	248	295	412	547	NA	NA
		scenario-Var	439	470	362	220	250	356	474	NA	NA
Sunflower	thsd tonnes	baseline	14,165	16,380	10,013	11,936	8,325	8,450	11,587	18,959	23,178
		scenario-All	14,165	16,380	10,062	8,242	13,884	14,790	21,928	NA	NA
		scenario-Var	14,165	16,380	10,062	8,242	13,884	14,790	21,928	NA	NA
Rapeseed	thsd tonnes	baseline	2,751	2,924	3,163	4,005	545	553	759	1,917	3,966
		scenario-All	2,751	2,924	3,190	616	2,258	2,961	4,160	NA	NA
		scenario-Var	2,751	2,924	3,190	536	2,074	2,761	3,884	NA	NA
Soya	thsd tonnes	baseline	4,461	3,479	3,679	4,778	2,089	2,146	1,746	41	0
		scenario-All	4,461	3,479	2,870	1,276	2,170	2,260	1,836	NA	NA
		scenario-Var	4,461	3,479	2,870	1,204	2,085	2,178	1,772	NA	NA

Production of primary agricultural commodities simulated	Unit of measure	Scenario	2018	2021	2022	2023	2024	2025	2030	2040	2050
Total	thsd tonnes	baseline	90,649	107,224	59,786	75,626	60,433	60,616	69,824	107,227	148,411
		scenario-All	90,649	107,224	66,859	52,837	67,310	103,514	136,196	NA	NA
		scenario-Var	90,649	107,224	66,859	43,852	55,774	82,060	108,229	NA	NA
Total	change to 2022, %	baseline				126%	101%	101%	117%	179%	248%
		scenario-All				79%	101%	155%	204%	NA	NA
		scenario-Var				66%	83%	123%	162%	NA	NA
GDP	mIn UAH in 2010 prices	baseline	1,043,887	1,073,034	767,829	785,269	768,541	768,743	778,881	820,063	865,407
		scenario-All	1,043,887	1,073,034	767,829	754,023	768,272	803,917	836,093	NA	NA
		scenario-Var	1,043,887	1,073,034	767,829	745,177	756,915	782,794	808,559	NA	NA
Value of agriculture, forestry and fishing	mIn UAH in 2010 prices	baseline	105,845	116,808	65,826	83,266	66,538	66,740	76,878	118,060	163,405
		scenario-All	105,845	116,808	65,826	52,021	66,269	101,914	134,090	NA	NA
		scenario-Var	105,845	116,808	65,826	43,174	54,912	80,791	106,556	NA	NA
GDP	growth to 2022, %	baseline				2%	0%	0%	1%	7%	13%
		scenario-All				-2%	0%	5%	9%	NA	NA
		scenario-Var				-3%	-1%	2%	5%	NA	NA

Source: own estimation

Note: the value in blue are the values calculated by applying production growth rates to the 2022 values of GDP and agriculture.

The figure below demonstrates the development of the GDP and value added of agriculture in constant 2010 prices with respect to the changes in simulated growth of cereals and oilseeds production under the baseline until 2050.

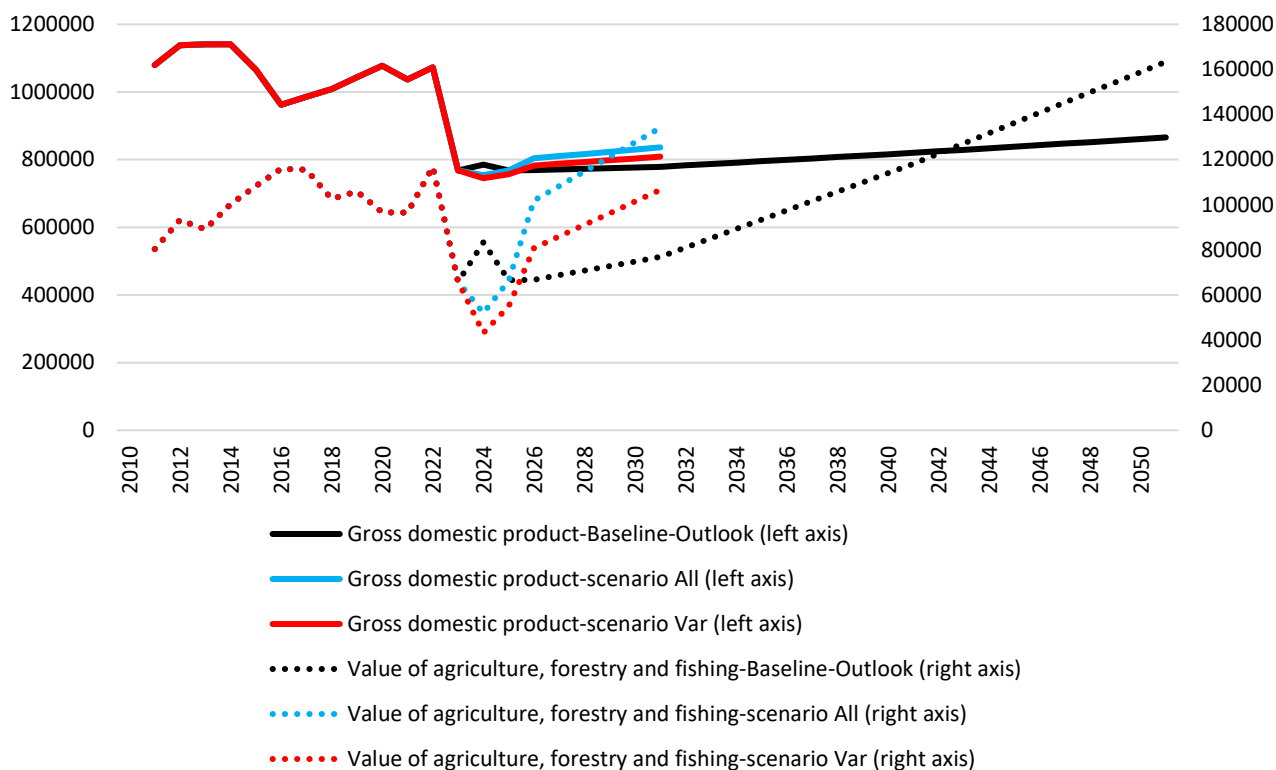


Figure: Simulated trends of cereals and oilseeds production under the baseline (Outlook), and two scenarios of financial aid (Var and All) and the respectively expected changes in value added of agriculture and GDP until 2050 for baseline and 2030 for the financial aid scenarios, mIn UAH

Source: own elaboration

The calculations indicate that the growth in cereals and oilseeds production will bolster GDP through enhanced value added in agriculture, with estimates ranging from 1-9% by 2030, depending on the scenario considered. In the baseline projection (Outlook), GDP is forecasted to experience gradual improvement driven by increased grain production following the cessation of hostilities, with a projected 1% rise by 2030, 7% by 2040, and 13% by 2050, compared to 2022 figures, adjusted for constant 2010 prices.

In scenarios where financial assistance is extended to grain producers to offset either their variable or total costs, GDP growth projections vary. With aid to cover variable costs, GDP is anticipated to increase by 5% in 2030 compared to 2022, while assistance covering total costs could result in a 9% GDP growth by 2030. Notably, under these financial aid scenarios, there is a temporary dip in GDP, occurring in 2023 for the All scenario and spanning 2023-2024 for the Var scenario. This phenomenon is attributed to the immediate impact of substantial subsidies on domestic market prices, leading to a transient increase. However, in subsequent years, the market stabilizes, and grain production resumes its growth trajectory.

As financial aid leads to 5-9% growth in GDP, it is worth reviewing the costs and benefits of such subsidy. The approach we undertake to do this is to estimate the total value of the aid under the Var and All scenarios and compare it to the benefits it generates. The complete table is presented in Annex 2: Calculation of costs/benefits of the financial aid simulated. In the following table the calculation results are presented.

Table Calculated benefits/losses in GDP per UAH (in constant 2010 prices) of aid in the financial aid scenarios in 2023-2030

Indicator	Units of measure	Scenario	2023	2024	2025	2030
Difference between GDP growth from 2022 and the aid	mln UAH in 2010 prices	Var	-34,544	-26,361	-5,534	16,918
		All	-56,233	-53,859	43,261	26,350
Benefit/Loss per UAH of aid	UAH in 2010 prices	Var	negative GDP change	negative GDP change	0.73	1.71
		All	negative GDP change	negative GDP change	0.26	0.61

Source: own estimation

Note: Scenario Var: variable production costs are compensated in 2023-2030, scenario All: total production costs are compensated in 2023-2030

The analysis indicates that in the Var scenario, the growth in GDP compared to 2022 will be offset by the value of financial aid (calculated for all modeled crops annually) by 2030. Specifically, in 2025, 1 UAH of financial aid is projected to generate 0.73 UAH of GDP growth, and by 2030, the same amount of financial aid is anticipated to yield 1.71 UAH of GDP growth, all measured in constant 2010 prices. Conversely, the All scenario appears to be less effective, with financial aid surpassing GDP growth values in both 2025 and 2030. In these instances, 1 UAH of financial aid is expected to generate only 0.26 and 0.61 UAH in GDP growth, respectively, highlighting its inefficiency as a strategy.

CONCLUSIONS

Throughout its storied history, Ukraine has been hailed as a cornerstone of global agriculture, earning its moniker as the "breadbasket" of neighboring and distant lands. Enduring through trials such as the devastating famine of 1932-33 and navigating intricate geopolitical landscapes, Ukraine emerged as a major grain producer, playing a pivotal role in the Soviet Union's grain supplies during the mid-20th century. From the moment of its proclamation of independence in 1991 until 2021, Ukraine witnessed significant policy and economic milestones, including landmark land reform, privatization initiatives, and pivotal trade agreements that shaped the course of its agricultural trajectory. Despite enduring economic crises and geopolitical tensions, reforms aimed at market liberalization and integration with the European Union propelled Ukraine's agricultural sector forward. This transformation witnessed the emergence of diverse agricultural producers, spanning from rural households and family farms to large-scale agricultural enterprises and agroholdings. While crop production showcased positive trends, challenges arose in the realm of livestock production, with declines in cattle and sheep numbers mitigated by increases in swine production. Nonetheless, Ukraine's agricultural sector has remained a linchpin of the nation's economy, contributing approximately 9-11% to GDP, employing around 18% of the population, and boasting an export value that encompasses nearly 40% of the nation's total.

By the onset of the 21st century, Ukraine had firmly entrenched itself as a formidable force in global agricultural markets, boasting significant shares in exports of wheat, corn, barley, and sunflower oil. The nation's bountiful black soils and conducive agricultural conditions served as catalysts for this growth, with policies aimed at market liberalization and integration with the European Union driving further strides.

However, the full-scale invasion launched by Russia on February 24, 2022, inflicted profound devastation, particularly upon Ukraine's agricultural sector, as detailed in a February 2023 report by the Center for Food and Land Use Research at Kyiv School of Economics and the World Bank, supported by the Food and Agriculture Organization of the United Nations. The conflict wrought extensive damages and losses, both direct and indirect. Damages to agricultural machinery and storage facilities amounted to \$6.0 billion, while losses to livestock, bees, fisheries & aquaculture totaled \$277.6 million. The destruction of perennial crops caused losses totaling \$489.8 million, and stolen and lost outputs and inputs accounted for approximately \$2.0 billion. Indirect losses in agriculture amounted to a staggering \$31.5 billion, primarily due to decreased production of crops (see figure below on detailed losses) and livestock, logistical disruptions, and escalated production costs.

The impact on domestic food affordability was palpable, with consumer prices skyrocketing and average incomes plummeting, resulting in widespread challenges in accessing essential food supplies.

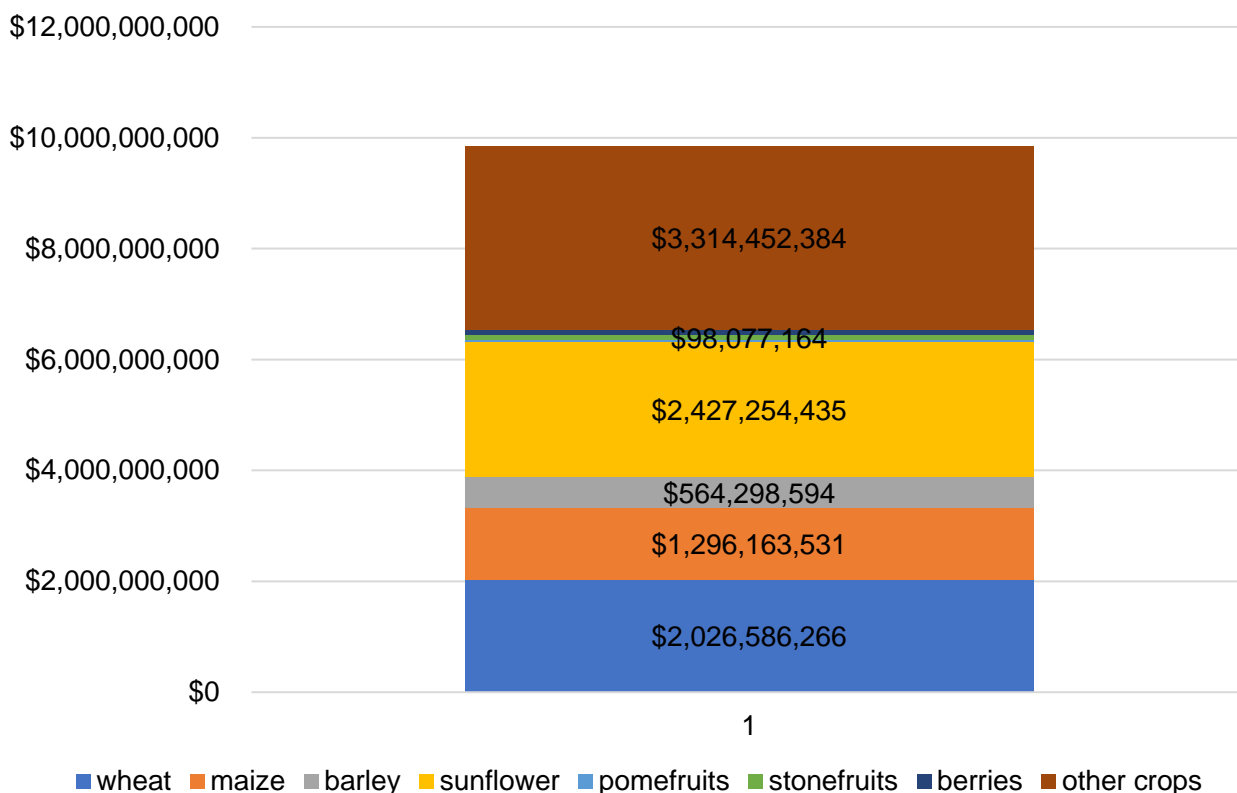


Figure: Estimates of the total value of crop losses by major crop categories, USD in current prices

Source: KSE Agrocenter, https://docs.google.com/spreadsheets/d/1evVqWxm-U9ZRC0_T7HI01NuxPxPLjUj/edit#gid=2058202045

The full-scale war in Ukraine inflicted a devastating blow upon small agricultural enterprises, despite their modest size, they served as indispensable contributors to the nation's agricultural landscape. Responsible for over 8 percent of harvested grain and leguminous crops, these enterprises grappled with substantial challenges, with many being compelled to shutter operations due to the conflict. The Food and Agriculture Organization (FAO) meticulously documented these harrowing impacts, underscoring the urgent imperative for support to alleviate their profound distress.

Prior to the full-scale invasion, wheat and maize prices closely tracked with world market prices. However, the significant increase in logistics costs widened the gap substantially. In January 2022, the EXW price for milling wheat was \$262 per tonne domestically, compared to \$314 per tonne at Euronext, resulting in a -52 basis. By April 2022, this basis had dropped to -264, with the domestic price plummeting to \$166 per tonne while Euronext traded the commodity at \$430 per tonne. Although the introduction of the Black Sea Grain Corridor improved the basis, it did not return to

pre-war levels, settling at -183 USD per tonne. The same trend was observed for maize, with domestic prices at \$263 per tonne in January 2022 compared to \$308 per tonne at Euronext, dropping to \$166 per tonne domestically and surging to \$430 per tonne at Euronext by April 2022. Despite improvements following the introduction of the BSGI initiative, a significant gap remained, with prices at \$130 per tonne domestically versus \$314 per tonne at Euronext in December 2022. The EXW prices set the reference to the domestic regional prices in Ukraine in the national currency. Therefore, the price changes are reported in US dollars through this report.

As a consequence of the conflict, notable operational shifts ensued, marked by a nearly 8 percent decrease in crop-producing enterprises and the closure of approximately 1.7 thousand small farms. Yet, amidst the adversity, some enterprises showcased remarkable resilience, with around 40 percent adapting their operations, particularly in front-line areas where the impact was most acute. These adaptive measures included strategies such as curbing the use of agricultural inputs and exploring new output markets to sustain operations. The financial strain on these enterprises intensified exponentially due to inflated costs for agricultural inputs, supply chain disruptions, and land contamination stemming from active combat battles. Over 80 percent of crop-producing micro enterprises grappled with substantial input price hikes, culminating in estimated financial losses approaching \$3.5 billion.

Moreover, the destruction of critical infrastructure, such as the Kakhovka dam, exacerbated the crisis, resulting in damages primarily to crops, livestock, and fisheries, with losses estimated at a staggering \$1,154.5 million. The collapse of irrigation infrastructure wrought a significant blow to crop yields, further exacerbating economic losses. Additionally, import bans imposed by neighboring countries, coupled with the decimation of transport routes, further hampered Ukraine's agricultural exports, resulting in diminished revenues for farmers. While initiatives like the Grain Deal and Solidarity Lanes were introduced to mitigate these challenges, domestic prices for export-oriented commodities continued to plummet.

Furthermore, the ongoing full-scale Russian military invasion of Ukraine, now enduring for 1.5 years, has wrought far-reaching ramifications on global food security and economies. The FAO Food Price Index underscores the persistence of elevated food prices, with inflation casting a long shadow over many low- and middle-income countries. Despite concerted efforts such as the Black Sea Grain Initiative and intensified global humanitarian aid, the crisis remains profoundly challenging.

Overall, after 10 months of the full-scale invasion of RF, GDP of Ukraine dropped by 3.9% and the value of agriculture, forestry and aquaculture by 24.3% when estimated in current prices (SSSU, 2022). When using constat, i.e., 2010, prices, the GDP and the value of agriculture, fishery and forestry change differently from year to year, falling by the dramatic 28.4% for GDP and 43.6% for the value of agriculture, forestry and

fisher.

As the conflict continues to ravage Ukraine, the nation's agricultural sector finds itself grappling with a dearth of resources for recovery. By 2023, financial and labor inputs were already stretched to their limits. Modeling projections foretell that certain sectors may fail to regain pre-war levels even after seven years of peace. In this protracted struggle for sovereignty and freedom of choice, Ukraine's people, including its resilient farmers, appear resolute in their defiance against the oppressive regime of the Russian Federation. Nonetheless, with **market forces alone, sectors such as sunflower, barley, and wheat are expected to regain their footing by 2040. By 2050, maize, rye, oats, and rapeseed sectors are projected to recuperate, while wheat, barley, and sunflower sectors are anticipated to experience growth.** However, **soybean production seems poised to witness a precipitous decline.** The **financial aid will speed up the recovery process**, however it would be more effective if focused on compensating the variable production costs instead of the total costs. This protracted timeline suggests that Ukraine may require up to two decades to reclaim its erstwhile strength in agriculture following the devastation wrought by the Russian military assault. Hence, the sooner Ukraine emerges triumphant over the aggressive totalitarian regime, the greater the likelihood that its agricultural sector will have the opportunity to rebound and flourish once more.

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ANNEX 1: METHODOLOGY AND ASSUMPTIONS FOR THE OUTLOOK

AGMEMOD is an econometric, dynamic, partial-equilibrium, multi-country, multi-market model. It covers all EU Members States, some non-EU countries (e.g., Balkan countries, Ukraine, Kazakhstan, Russian Federation, some African countries) and a stylised version of the rest of the world (RoW). The model provides annual projections (currently) until the year 2030 for markets of the main agricultural commodities at national and aggregated EU levels. AGMEMOD is based on a set of commodity-specific model templates and country-specific models. The template approach facilitates aggregation of the simulation results, analytical consistency across countries and comparison of policy impacts. The model does not only provide baseline projections, but as well allows analysing impacts of countries' agricultural policies (e.g., CAP) and macroeconomic changes on the agricultural markets (Salamon et al., 2019).

The commodity markets in AGMEMOD are represented by equations for supply and demand, stocks, international trade and market prices. They represent behavioural responses of economic agents to changes in prices and exogenous variables such as agricultural policy instruments, GDP, currency exchange rate, tariff rate quotas etc. The equations' parameters are usually estimated as time series regressions from the AGMEMOD database. The latter contains annual observations on the endogenous and exogenous variables. Depending on the country, these data range from 1973 until the latest available year. Most of the data is obtained from national statistics, Eurostat, Short-term Outlook and Commodity price dashboard of the European Commission (Salamon et al., 2017; Chantreuil et al., 2012).

Following the partial equilibrium approach, commodity prices adjust to clear each commodity market considered in AGMEMOD. Lagged endogenous variables introduce (recursive) dynamic behaviour when entered as determinants in the next period's equilibrium supply and/or demand. Closing of global commodity balances in AGMEMOD is achieved by forming world market prices in the RoW model. Commodity markets in a country are linked to each other by substitution or complementary parameters on the supply or demand side. Interactions between the crops and livestock sub-models are captured via the derived demand for feed. The various meat types, dairy products and crops are partly substitutes in demand, while cattle, pig, sheep and goat, and poultry compete for feed (Salamon et al., 2017; Chantreuil et al., 2012).

Each country model comprises markets for its main agricultural commodities. These commodities usually include six types of cereals, three types of oilseeds and their

processed products (oil and meal), sugar beet and sugar, protein crops, potatoes, live animals such as cattle, sheep and goats, pigs and poultry and their products such as meat, milk, dairy and eggs. The projections for the crops sector cover area harvested, yield per hectare, total production as a product of area harvested and yield, domestic use, quantities imported and exported, stocks and domestic market price. Crops area is defined following the top-down approach. In particular, the total country land area is divided into woods, usable agricultural area (UAA) and other areas. UAA is split into permanent grassland, kitchen gardens, arable land, land under permanent crops, fodder from arable land and vegetable area.

The livestock sector in AGMEMOD comprises a complex system of total animal numbers, numbers of dairy and suckler cows, sows and ewes, livestock reproduction rates, total number of slaughtered animals, slaughter weight, death loss, numbers imported and exported. Meat production is determined by the number of slaughtered animals and their slaughter weight. Markets of milk and dairy products include milk delivered to dairies, consumed at the farm level and for human consumption, and milk fat and protein coefficients which are used in the equations of production of butter, cream, cheese, whole and skimmed milk powder (Salamon et al., 2017; Chantreuil et al., 2012).

As equations in AGMEMOD are estimated econometrically, the model does not require calibration. However, when it is used for producing the Agricultural Outlook for the EU countries, its EU country models are calibrated to projections of the EU Agricultural Outlook. In particular, the projected by AGMEMOD values of production, use and trade at the EU-14 and EU-N13 aggregate levels must, to the extent possible, reproduce the values of the EU Outlook. Therefore, parameters of equations for the EU country models are accordingly modified (Salamon et al., 2017). This is not the case for the non-EU country models which generate projections based on the original, estimated and adjusted by the market experts, modelling parameters (Nykolyuk et al. 2021).

The AGMEMOD model produces market projections based on the functions representing behavior of the market agents and equalities. The latter are computations which represent production or market balances in equilibrium. For example, quantity of wheat produced equals yield per hectare and the acreage of wheat harvested. The behavioral equations, on the contrary, are estimated econometrically and refer to such variables as, for example, market prices, consumption per capita, quantities exported and imported, crop yields and areas, processing coefficients, etc. Real costs for producing crop commodities are included in the behavioural equations, which represent the supply side of the agricultural markets. These costs comprise payments for rented land and property, labour, fodder, seeds, fertilizers, fuel, depreciation, as well as expenses on additional materials such

as disinfectants, services and veterinary treatment.

The database of the AGMEMOD Ukraine country-model starts from 1992. For the current study it has been updated until 2021 and, where possible, 2022. The series include observations on production (e.g., crops yields and area harvested, livestock number and crop, slaughter weight, production of oilseed oils and meals), domestic use (e.g., use for feed, human consumption and processing, losses), prices, change in stocks, import and export. Observations on most of the domestic market prices and supply components were obtained from the State Statistics Service of Ukraine. For quantities exported and imported, components of domestic use and domestic prices for oilseed oils and meals, FAOSTAT and statistics of the International Trade Centre were used. Data for 2022 were obtained from publicly available database of commodities prices and reports of the Ministry for Agrarian and Food Policy of Ukraine.

The projections of the agricultural commodity balances in AGMEMOD are based on the number of factors, including agricultural and trade policies, production costs, world market prices of the agricultural commodities, and macroeconomic indicators such as, for example, national GDP, GDP deflator, currency exchange rate and population. These are exogenous variables, i.e. variables that are not computed or projected by the model. Their observed and projected values are collected from various external sources and implemented into the model as a separate component representing modelling assumptions.

Although the model allows for running simulations for the values of the world market prices, the current study is conducted within the general frameworks of the OECD-FAO and the EU Agricultural Outlooks. Accordingly, the historical and projected values of the world market prices for the commodities analysed correspond to those of the EU Agricultural Outlook.

Table Projection basis and assumptions

Assumptions	Values
Level of export	2023 as of today, 2024-2026 – only Odesa and Danube ports, 2027-2050 – all ports are available except of the Azov sea ports
Duration of war	2022-2023
Reduction of grains area due to occupation and active fighting	-13% from the 2021 grains area harvested in 2021
Reduction of oilseeds area due to occupation and active fighting	-20% from the 2021 oilseeds area harvested in 2021
Production costs	
Availability of financial resources for	the producers get the profit just to cover

variable costs	their expenses in 2023-2024, return to normal in 2025
Increase in fuel expenses compared to 2021	following annual average crude oil price change in 2022-2023 and projection for 2024 based on World Energy Outlook. For further years adjusted to inflation.
Increase in fertilizer expenses compared to 2021	80% increase in 2022 and 30% increase in 2023, further changes is annual inflation adjustment
Decrease in labor availability, and the resulting change in labor costs, due to mobilization, migration and war-related death*	in 2023-2024 30% less, starting from 2025 - gradual return to 2021 level*
Additional area of uncultivated arable land as an effect of increased production costs	-5%
World market prices in 2022–2030 2031-2050	OECD-FAO Outlook 2022 Follow the trend
Crops storage assumption	Storage available
GDP projections 2022-2030 <i>IMF, April 2022</i> <i>SSSU projections</i> <i>Growth rate projected by USDA in 2021 and trends</i>	<i>2022-2023: - 35% compared to 2021</i> <i>2024: rebound by 12.5%</i> <i>2025-2050: +3.1% annually</i>
GDP deflator <i>As of July 2022, according to the National Bank of Ukraine</i> <i>According to the USDA 2021 projections and trends</i>	- 2022: 30 2023–2050: +5% annual growth
UAH/USD currency exchange rate <i>As of July 2022, according to the National Bank of Ukraine</i> <i>According to the USDA 2021 projections and trends</i>	- 2022–2023: 36.6 2024–2050: +0.2% annual growth
Population <i>Assuming 4 mil people left Ukraine considering 2021 USDA projections until 2030</i> <i>Return of all the war refugees, according to 2021 USDA projections until 2030 and trends</i>	- <i>2022-2023: -4 mil from the projected number</i> <i>2024-2050: according to the former projections</i>

Source Own elaboration

Note *We assume Leontieff production function, and that one worker may extend their working hours by max $\frac{1}{3}$ that translates into the daily workload of 10.7 hours

In order to introduce access to ports into the model, we assume the maximum export capacity in 2023-2024 to equal the quantity exported during March 2022-March 2023, which is [54.6 million tonnes](#)³⁷. The Odesa port is assumed to be able to transport [6.4 million tonnes](#)³⁸ of agricultural commodities, and Azov ports are assumed to be able to transport up to 2.4 million tonnes of agricultural commodities.

³⁷ https://export.gov.ua/news/4574-eksport_agroproduksii_ukraini_za_pershu_polovinu_bereznia#:~:text=%D0%97%20%D0%B1%D0%B5%D1%80%D0%B5%D0%B7%D0%BD%D1%8F%202022%20%D1%80%D0%BE%D0%BA%D1%83,%E2%80%93%204%2C3%20%D0%BC%D0%B%D0%BD%20%D1%82%D0%BE%D0%BD%D0%BD.

³⁸ <https://uga.ua/ru/news/top-5-ukrainskih-morskih-portov-po-obemam-perevalki-zerna-v-2020-godu/>

ANNEX 2: CALCULATION OF COSTS/BENEFITS OF THE FINANCIAL AID SIMULATED

Table Calculation of benefits/losses in GDP per UAH (in constant 2010 prices) of aid in the financial aid scenarios in 2023-2030

GDP deflator, 2010=1		8.09	9.15	10.06	14.86
		2023	2024	2025	2030
Scenario Var: variable production costs are compensated in 2023-2030					
Financial aid					
Soft wheat intervention price	UAH/100kg	165	169	177	226
Maize intervention price	UAH/100kg	183	188	197	252
Barley intervention price	UAH/100kg	162	165	174	222
Rye intervention price	UAH/100kg	226	232	243	311
Oats intervention price	UAH/100kg	165	168	176	226
Sunflower seeds	UAH/100kg	382	401	422	539
Rapeseed seeds	UAH/100kg	576	605	636	813
Soya beans	UAH/100kg	357	375	394	503
Production					
Soft wheat intervention price	thsd tonnes	19,406	23,641	17,858	21,229
Maize intervention price	thsd tonnes	9,093	8,171	36,740	49,267
Barley intervention price	thsd tonnes	4,921	5,422	7,080	9,276
Rye intervention price	thsd tonnes	229	248	295	400
Oats intervention price	thsd tonnes	220	250	356	474
Sunflower seeds	thsd tonnes	8,242	13,884	14,790	21,928
Rapeseed seeds	thsd tonnes	536	2,074	2,761	3,884
Soya beans	thsd tonnes	1,204	2,085	2,178	1,772
Total aid in current prices					
Soft wheat intervention price	mIn UAH	31,932	39,883	31,643	48,077
Maize intervention price	mIn UAH	16,609	15,359	72,539	124,322
Barley intervention price	mIn UAH	7,950	8,958	12,287	20,575
Rye intervention price	mIn UAH	517	574	718	1,243
Oats intervention price	mIn UAH	363	420	629	1,068
Sunflower seeds	mIn UAH	31,500	55,728	62,351	118,153
Rapeseed seeds	mIn UAH	3,091	12,560	17,560	31,565
Soya beans	mIn UAH	4,296	7,814	8,574	8,916
TOTAL AID	mIn UAH	96,258	141,297	206,301	353,920
Total aid in 2010 prices					
Soft wheat intervention price	mIn UAH	3,945	4,360	3,144	3,235

GDP deflator, 2010=1		8.09	9.15	10.06	14.86
		2023	2024	2025	2030
Maize intervention price	mIn UAH	2,052	1,679	7,208	8,365
Barley intervention price	mIn UAH	982	979	1,221	1,384
Rye intervention price	mIn UAH	64	63	71	84
Oats intervention price	mIn UAH	45	46	62	72
Sunflower seeds	mIn UAH	3,891	6,092	6,196	7,950
Rapeseed seeds	mIn UAH	382	1,373	1,745	2,124
Soya beans	mIn UAH	531	854	852	600
TOTAL AID	mIn UAH	11,892	15,447	20,500	23,813
Difference between GDP growth from 2022 and the aid	mIn UAH in 2010 prices	-34,544	-26,361	-5,534	16,918
Difference between value added for agriculture growth from 2022 and the aid	mIn UAH in 2010 prices	-34,544	-26,361	-5,534	16,918
Benefit/Loss per UAH of aid	UAH in 2010 prices	NA	NA	0.73	1.71
Scenario All: total production costs are compensated in 2023-2030					
Soft wheat intervention price	UAH/100kg	493	514	540	690
Maize intervention price	UAH/100kg	555	579	608	778
Barley intervention price	UAH/100kg	479	499	524	669
Rye intervention price	UAH/100kg	567	590	620	792
Oats intervention price	UAH/100kg	451	469	492	629
Sunflower seeds	UAH/100kg	951	999	1049	1341
Rapeseed seeds	UAH/100kg	1394	1464	1538	1965
Soya beans	UAH/100kg	1156	1214	1275	1630
Production					
Soft wheat intervention price	thsd tonnes	19,406	23,641	17,858	21,229
Maize intervention price	thsd tonnes	9,093	8,171	36,740	49,267
Barley intervention price	thsd tonnes	4,921	5,422	7,080	9,276
Rye intervention price	thsd tonnes	229	248	295	400
Oats intervention price	thsd tonnes	220	250	356	474
Sunflower seeds	thsd tonnes	8,242	13,884	14,790	21,928
Rapeseed seeds	thsd tonnes	536	2,074	2,761	3,884
Soya beans	thsd tonnes	1,204	2,085	2,178	1,772
Total aid in current prices					
Soft wheat intervention price	mIn UAH	95,710	121,485	96,386	146,445
Maize intervention price	mIn UAH	50,488	47,334	223,546	383,129
Barley intervention price	mIn UAH	23,565	27,029	37,073	62,077
Rye intervention price	mIn UAH	1,299	1,462	1,829	3,167
Oats intervention price	mIn UAH	993	1,173	1,753	2,979

GDP deflator, 2010=1		8.09	9.15	10.06	14.86
		2023	2024	2025	2030
Sunflower seeds	mIn UAH	78,374	138,653	155,133	293,972
Rapeseed seeds	mIn UAH	7,475	30,373	42,464	76,332
Soya beans	mIn UAH	13,920	25,317	27,780	28,887
TOTAL AID	mIn UAH	271,824	392,827	585,964	996,988
Total aid in 2010 prices					
Soft wheat intervention price	mIn UAH	11,824	13,281	9,578	9,853
Maize intervention price	mIn UAH	6,237	5,175	22,213	25,778
Barley intervention price	mIn UAH	2,911	2,955	3,684	4,177
Rye intervention price	mIn UAH	160	160	182	213
Oats intervention price	mIn UAH	123	128	174	200
Sunflower seeds	mIn UAH	9,682	15,158	15,415	19,779
Rapeseed seeds	mIn UAH	923	3,321	4,220	5,136
Soya beans	mIn UAH	1,720	2,768	2,761	1,944
TOTAL AID	mIn UAH	33,581	42,945	58,226	67,080
Difference between GDP growth from 2022 and the aid					
Difference between value added for agriculture growth from 2022 and the aid	mIn UAH in 2010 prices	-56,233	-53,859	-43,261	-26,350
Difference between value added for agriculture growth from 2022 and the aid	mIn UAH in 2010 prices	-56,233	-53,859	-43,261	-26,350
Benefit/Loss per UAH of aid	UAH in 2010 prices	NA	NA	0.26	0.61

Source Own calculations