Ukraine Country Climate and Development Report: Agriculture

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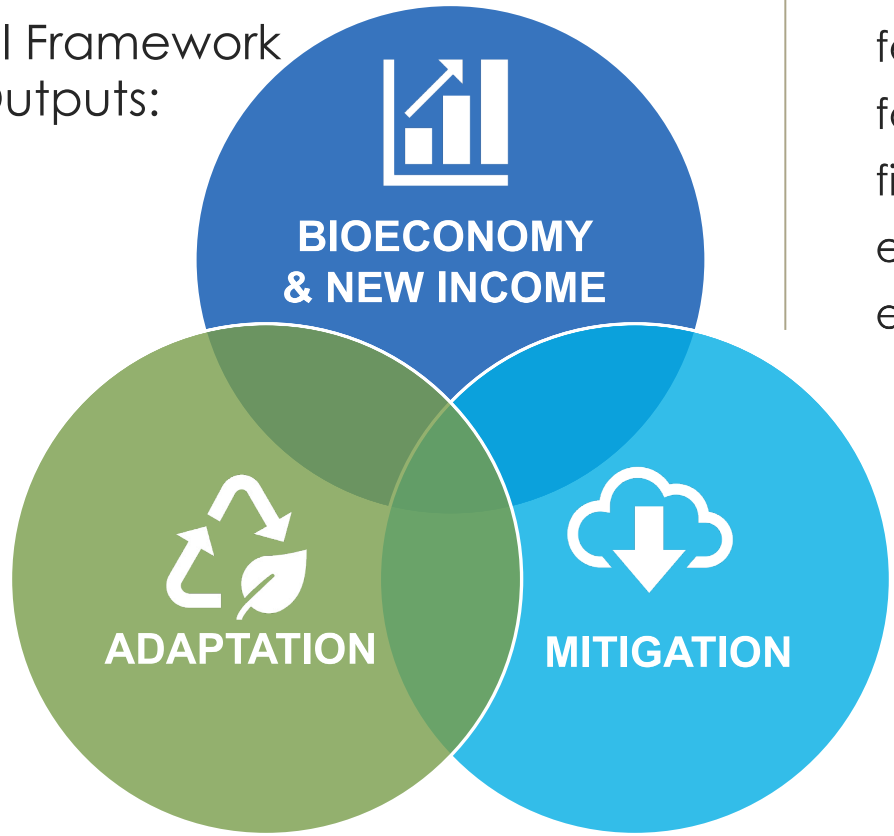
Outline

1. Importance of Ukraine's agriculture for development and climate
2. Impact of climate change on Ukraine's agriculture
3. Cost of inaction and benefits of action
4. Climate-smart agriculture technologies for increasing resiliency and decarbonization of agriculture
5. Role of public policy in promoting climate-smart agriculture: global lessons
6. Current public policy and expenditures in Ukraine for climate-smart agriculture
7. Recommendations for mainstreaming climate-smart agriculture in agricultural policy and expenditures

Climate-Smart Agriculture (CSA) - is an approach that helps to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate.

CSA Conceptual Framework and Expected Outputs:



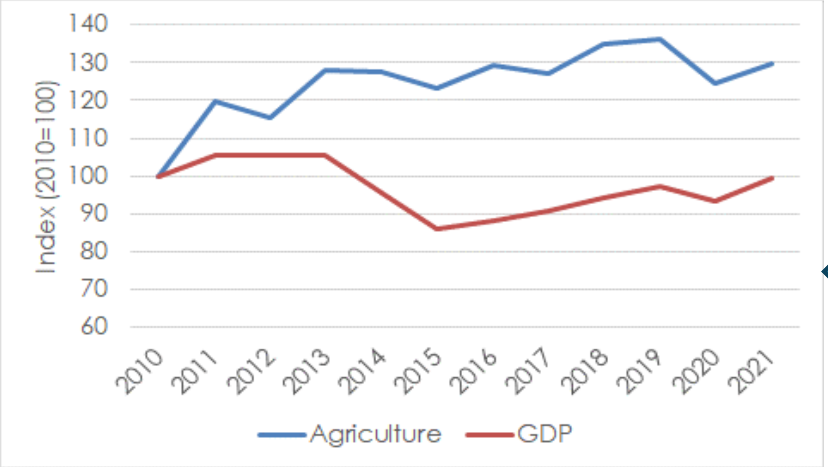
Bioeconomy & new income:
- feed
- food
- fiber
- energy
- ecosystem services

Adaptation:
- resilience to climate change
- land use efficiency
- food security
- green infrastructure

Mitigation:
- reduced GHG emissions
- carbon sequestration
- clean fuels
- methane capture

1. Importance of Ukraine’s Agriculture for Development and Climate

Agriculture is a large contributor to GDP and jobs



GDP

Agriculture generates 10% of GDP (~ US$20b)

Input supply, food processing, and food trade generate 10% of GDP

In 2020.

Jobs

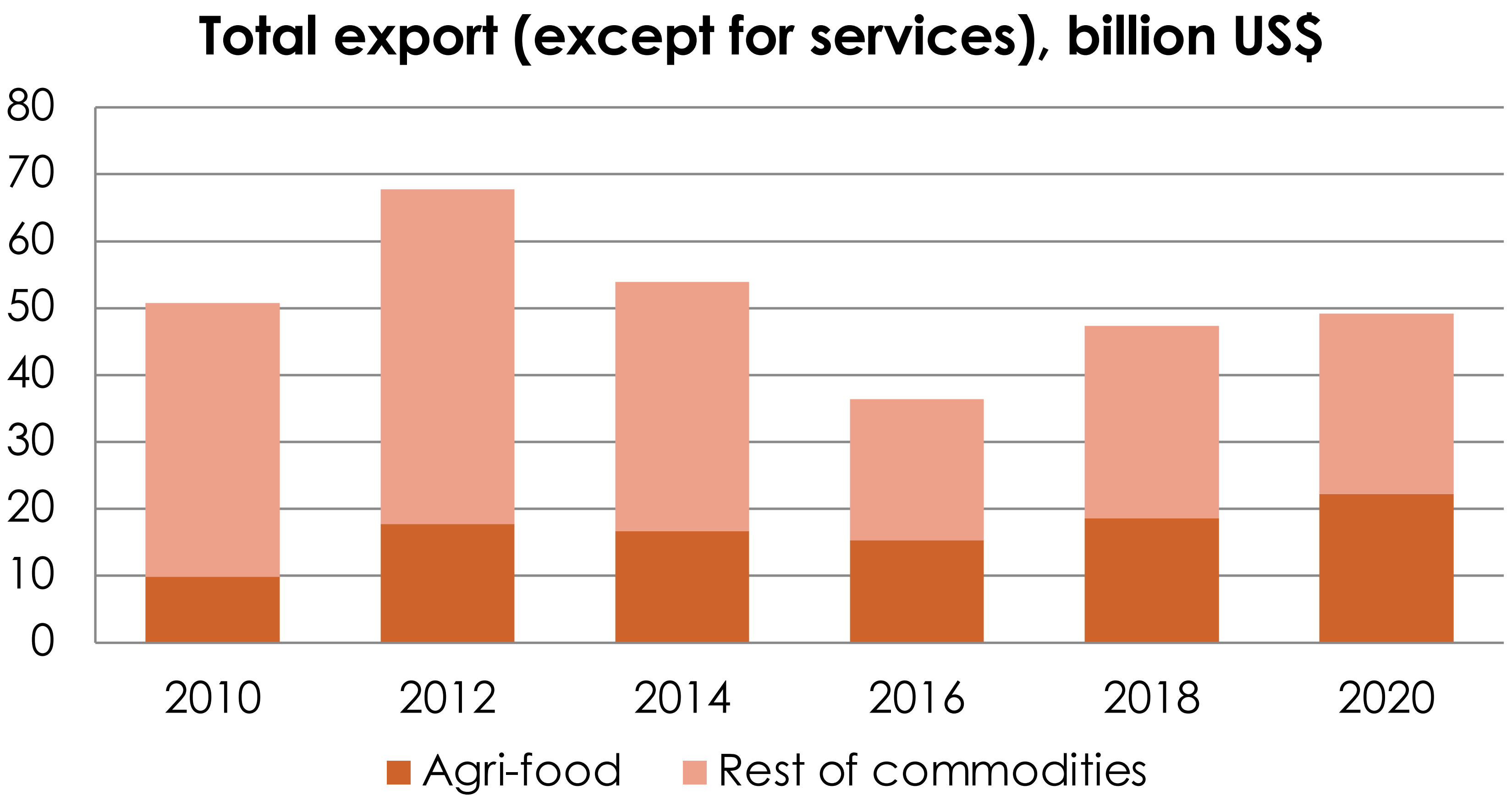
14% of labor employed in primary agriculture

3-4 million small farmers

20% of jobs in primary agriculture, food processing and input supply (registered at the State Employment Center)[1]

[1] *Source: State Employment Center, Analytical and statistical information, 2021", https://www.dcz.gov.ua/analitics/69*

Agriculture is also a large contributor to export

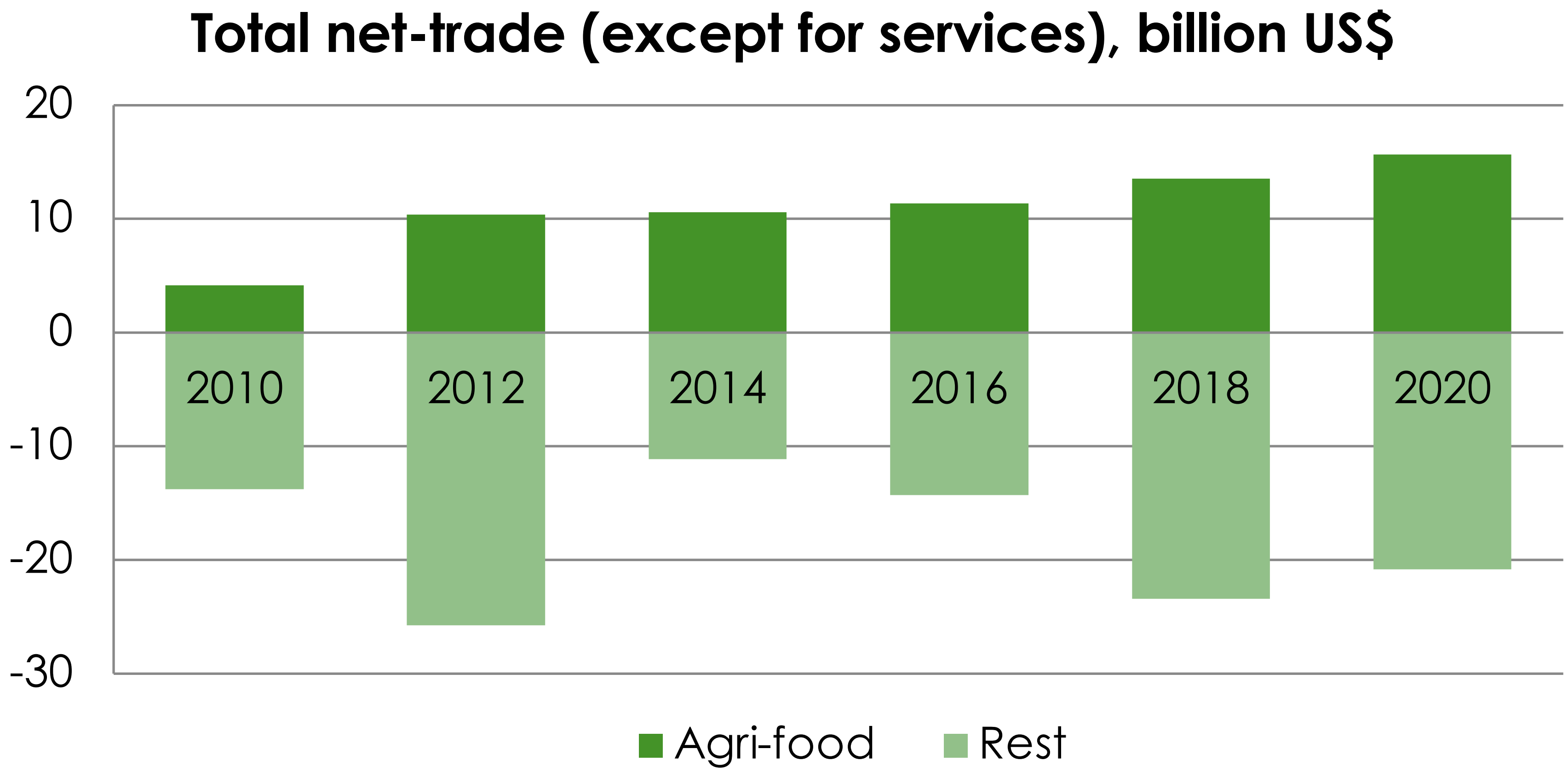


% of the EU market for Ukraine’s agrifood export:

2010: 19%, US$1.9b
2016: 27%, US$4.1b
2020: 24%, US$6.5b

Source: State Statistics Service of Ukraine (2021): Commodities structure of international trade of Ukraine 2010-2020, http://www.ukrstat.gov.ua

… and the current account

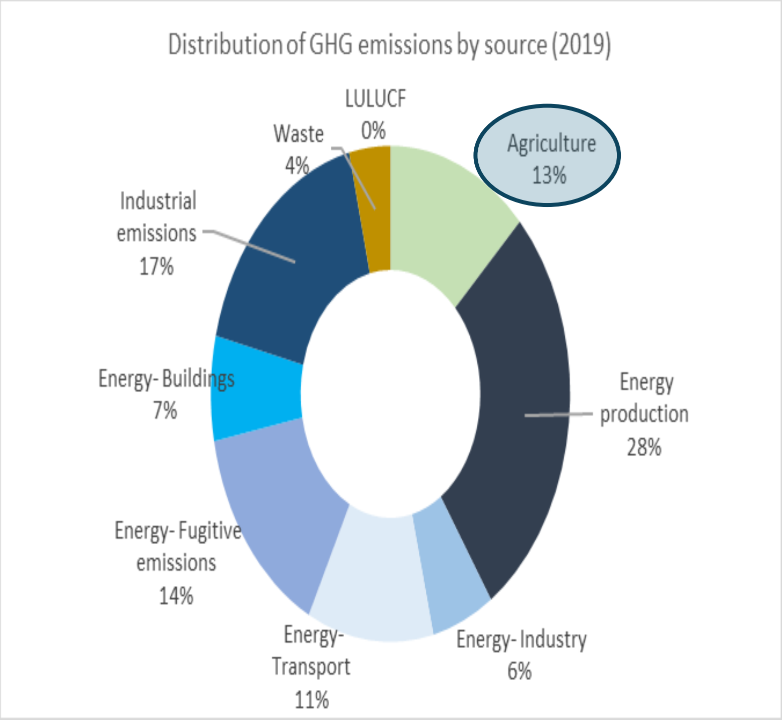


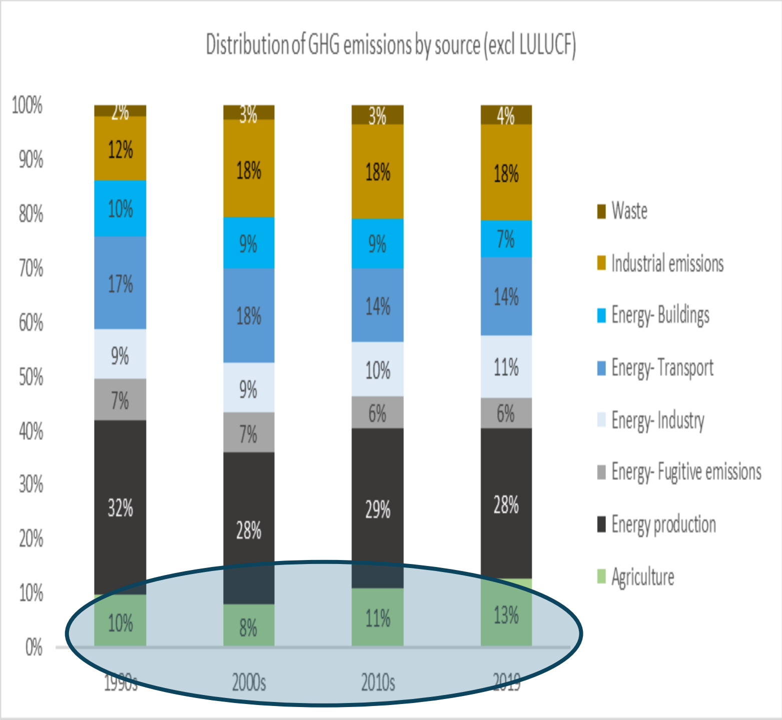
Source: State Statistics Service of Ukraine (2021): Commodities structure of international trade of Ukraine 2010-2020, http://www.ukrstat.gov.ua

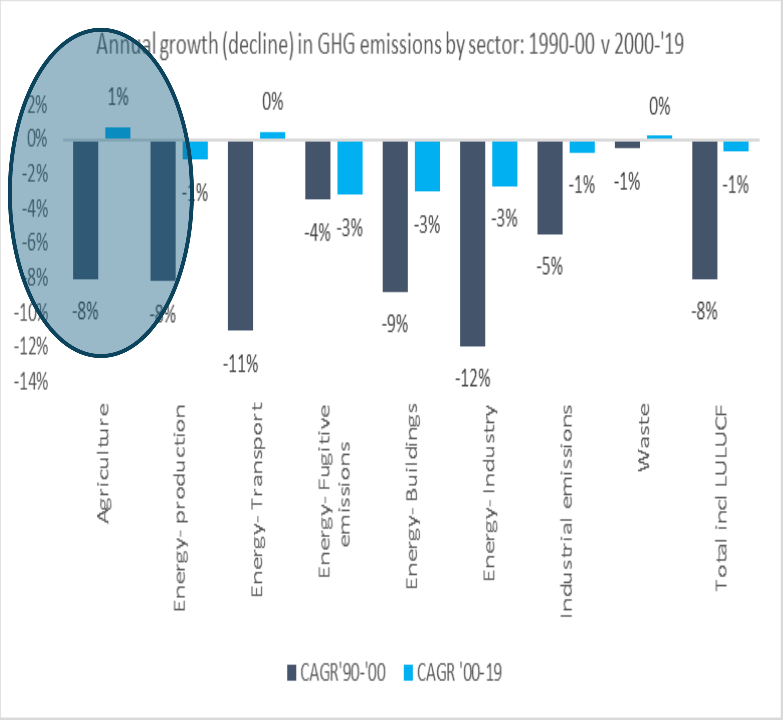
Agriculture is contributing to the climate change

In 2019, the agriculture generated 42.5 million tons of CO2-eq.

- *Agriculture's contributions to GHG emissions increased from 10% in 1990s to 13% in 2019*
- *Yet, this increase was moderate compared to agricultural growth, pointing to a relative decoupling of emissions from ag. growth*



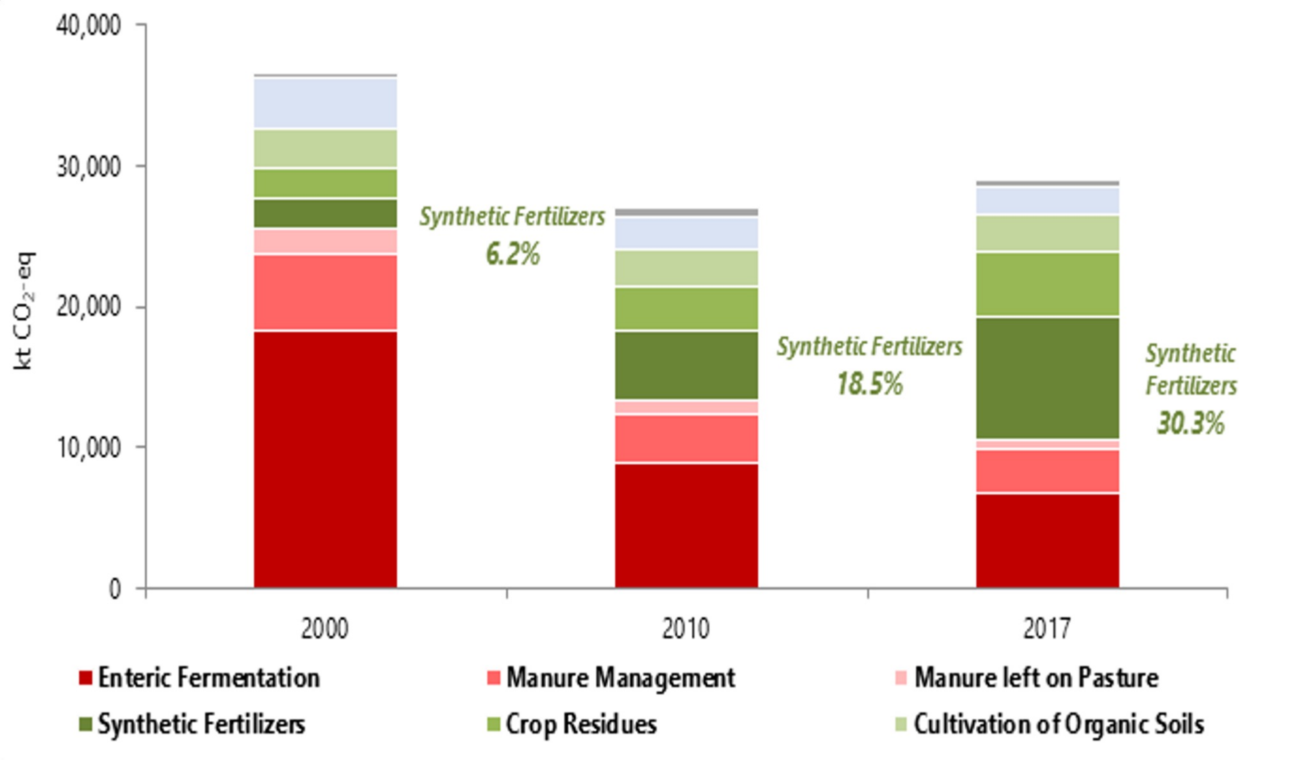




Source: UNFCC

Sources of GHG emission from Ukraine's agriculture changed from livestock to crops

DYNAMICS OF GREENHOUSE GAS EMISSIONS IN AGRICULTURE OF UKRAINE, KT CO2-EQ



Source: UNFCC

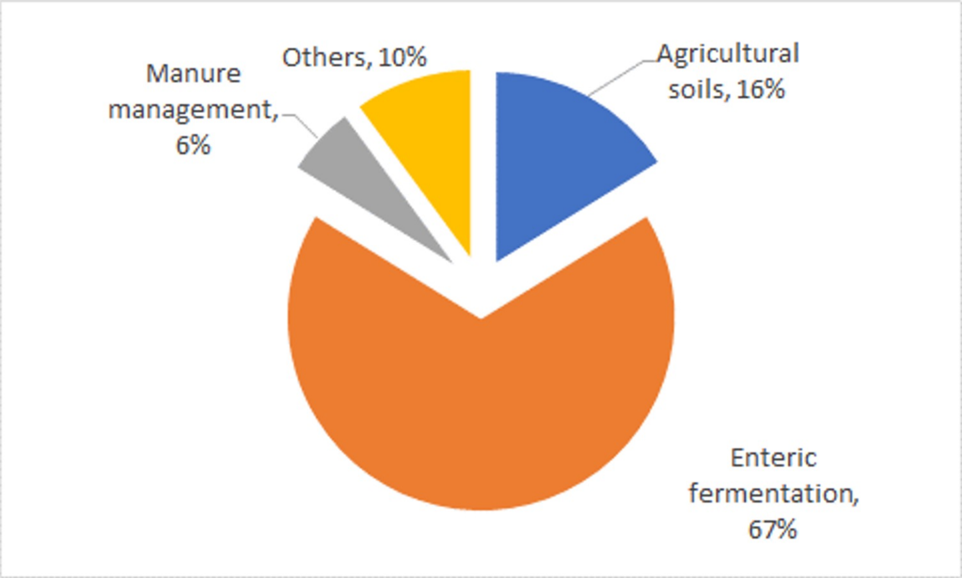
With the expansion of crop production and decline of livestock sector in 2000-2017, GHG emissions from

- agricultural soils management increased from 45% to 70%
- application of

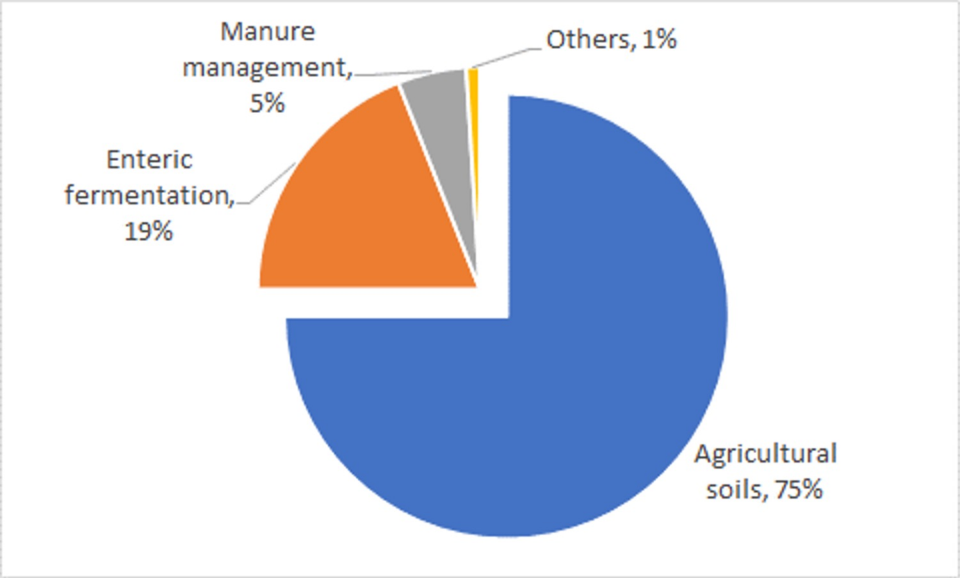
Ukraine is different from global averages

driven by soil mismanagement, relatively low contribution from livestock (compared to region and globally)

% breakdown of emission sources in global agriculture (2019)

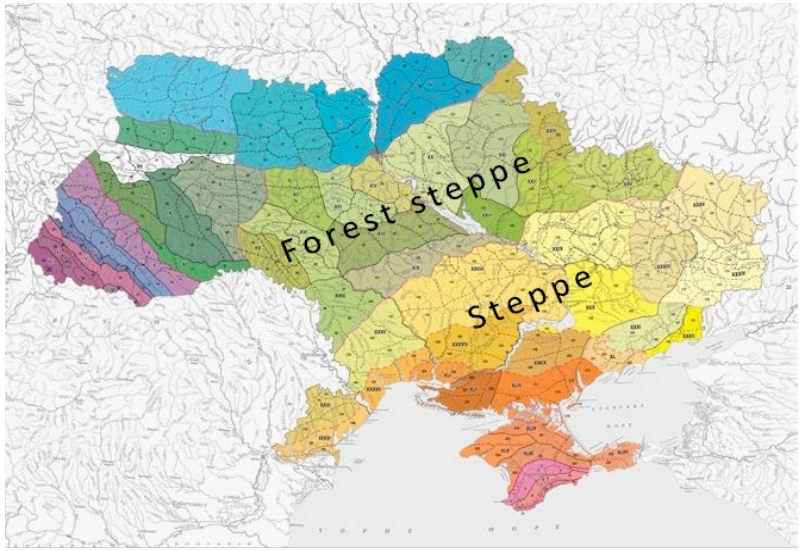


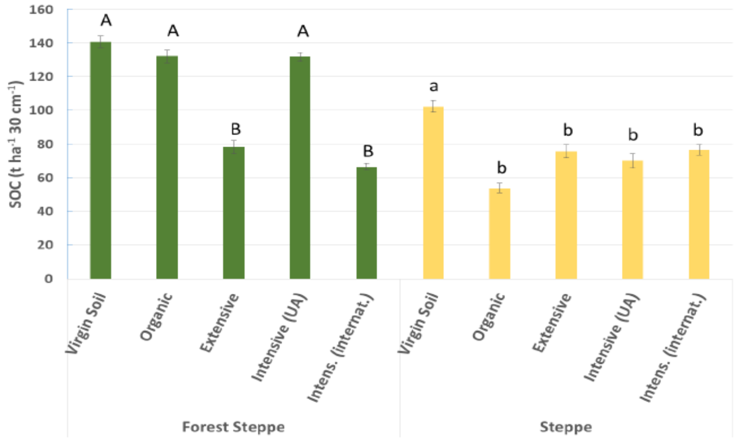
% breakdown of emission sources in Ukraine's agriculture (2019)



Source: FAO.

Soil (mis)management fleshes humus out, increasing demand for more fertilizers to maintain productivity



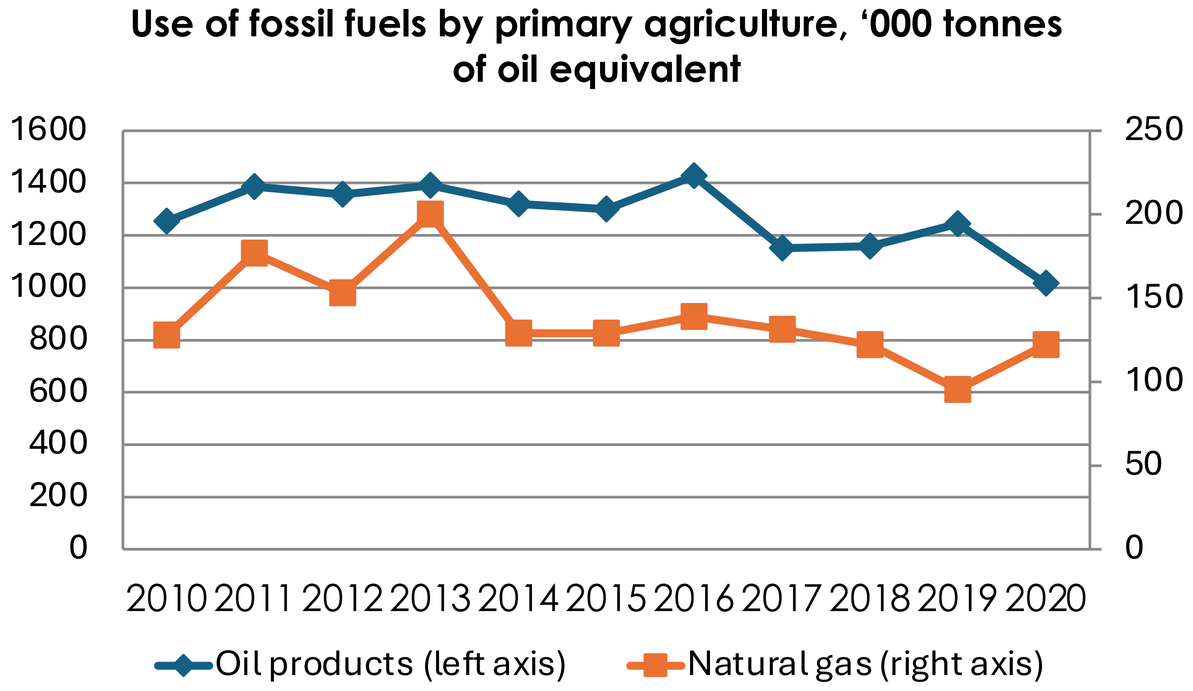


- **Farm/soil management measures have a significant effect on the level of humus storage in Ukraine**: on average, humus content was 30% lower than in natural soils in protected areas
- In black soils of steppe, humus content was 32% lower than in forest steppe, demanding more attention to soil management
- Highest humus contents are found in soils where humus-amplifying agronomic measures are applied, such as multi-unit crop rotation with more than 7 different crops, including cultivation of legumes, organic fertilization with compost and reduced tillage intensity (no ploughing)
- The modelling shows **that in the case of no change** in Ukraine's climate policy applied to agriculture (business-as-usual scenario), **humus contents would decrease by 4% by 2030**
- **In the case of promoting CSA, humus stocks would remain constant** (target of C-neutrality by 2060)

Source: Succow Stiftung (2021): Presentation on the Climate Adaptation through Humus Management in Black Soils of Ukraine. German-Ukraine project.

Agriculture is also affecting energy security

"The increasing use of fossil energy in agriculture leads to increasing GHG emissions from the agricultural sector, which in turn impacts agricultural production itself"[1].

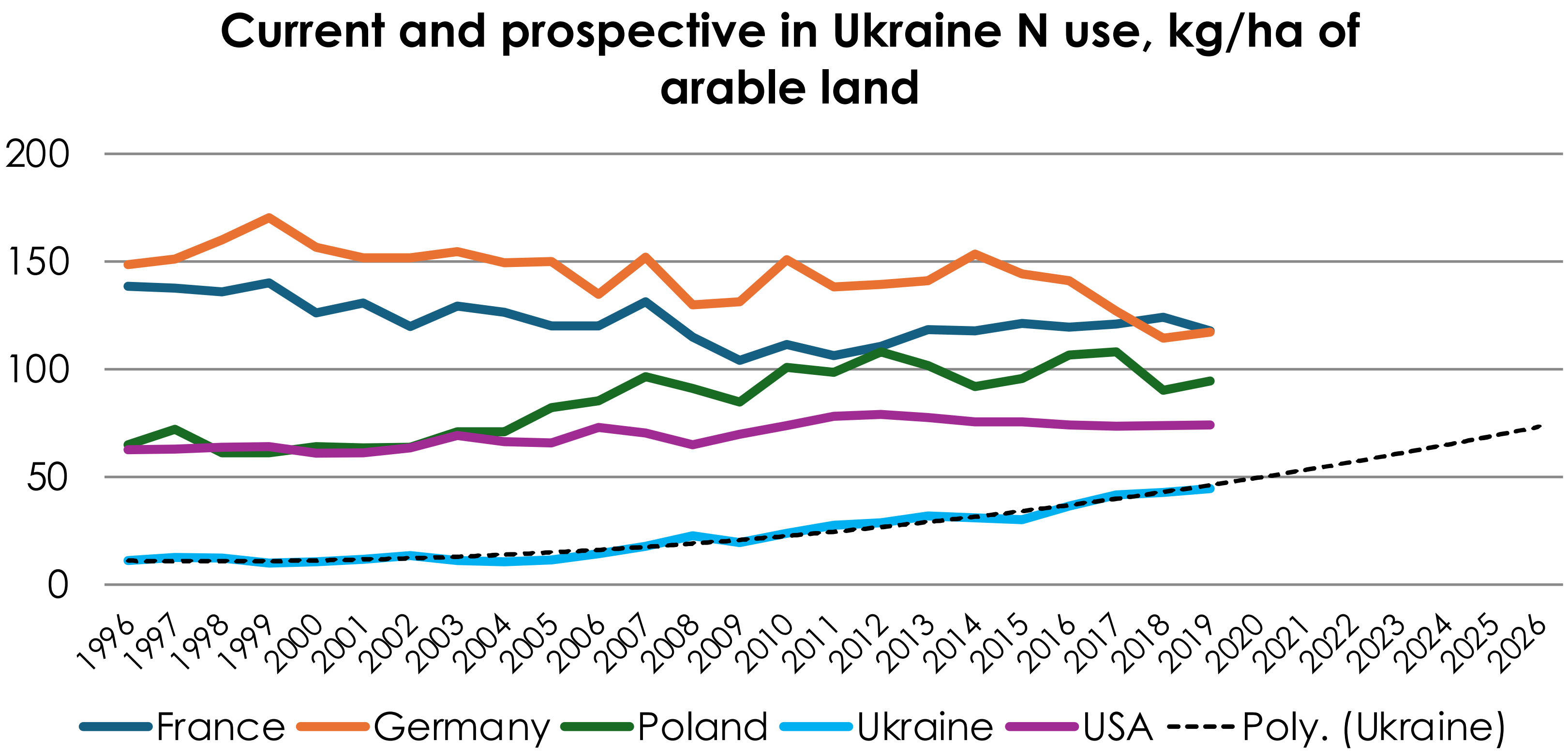


[1] FAO (2016): Energy, Agriculture and Climate Change: towards energy-smart agriculture, https://www.fao.org/3/I6382EN/i6382en.pdf

Source: State Statistics Service of Ukraine (2021): Energy balance of Ukraine 2010-2020, http://www.ukrstat.gov.ua/operativ/operativ2012/energ/en_bal/arh_2012.htm

Without using climate-smart technologies, the demand for energy from agriculture will grow

The use of fertilizers in Ukraine is currently lower as compared to some other developed countries. However, there is a trend of catching up!



Source: FAOSTAT

Although fertilizer application will likely increase as Ukrainian farmers close the productivity gap with their EU peers, combining the use of slow or controlled released fertilizers with digital technologies can curb the upward trend of emissions related to increased fertilizer use, while ensuring productivity levels

Following current trends, the N, P2O5 and K2O use in Ukraine will reach the levels of the EU and USA by around 2026

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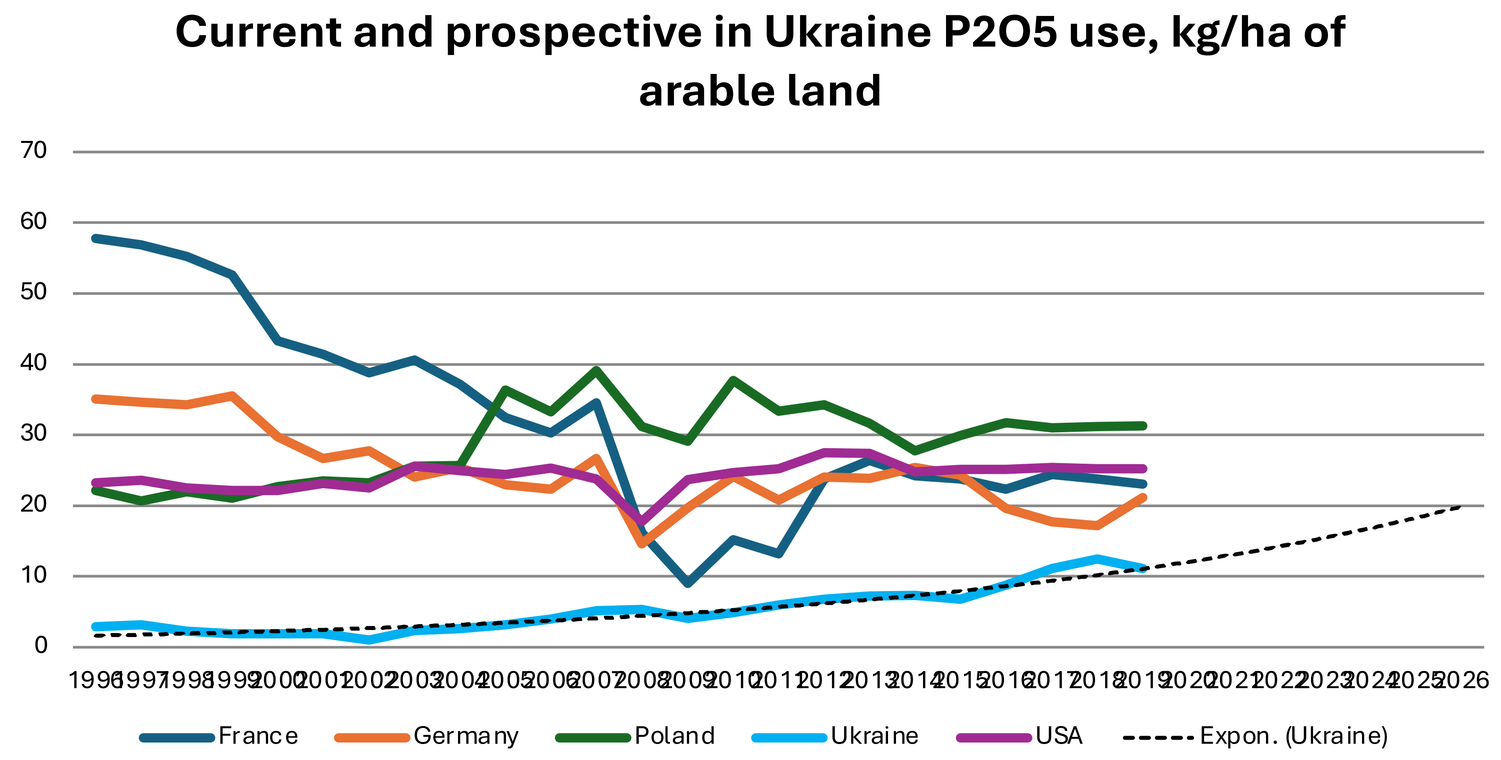

Source: FAOSTAT

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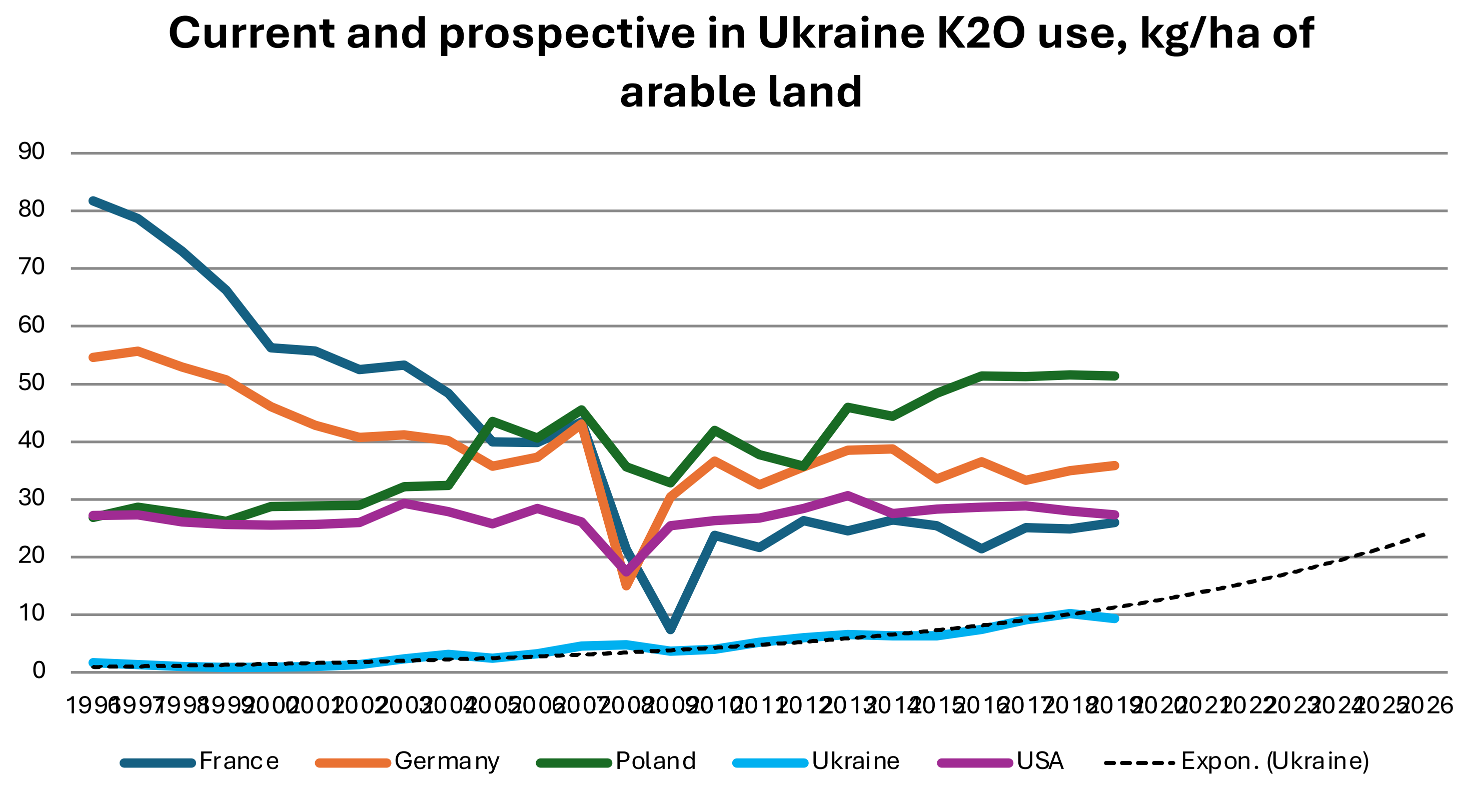
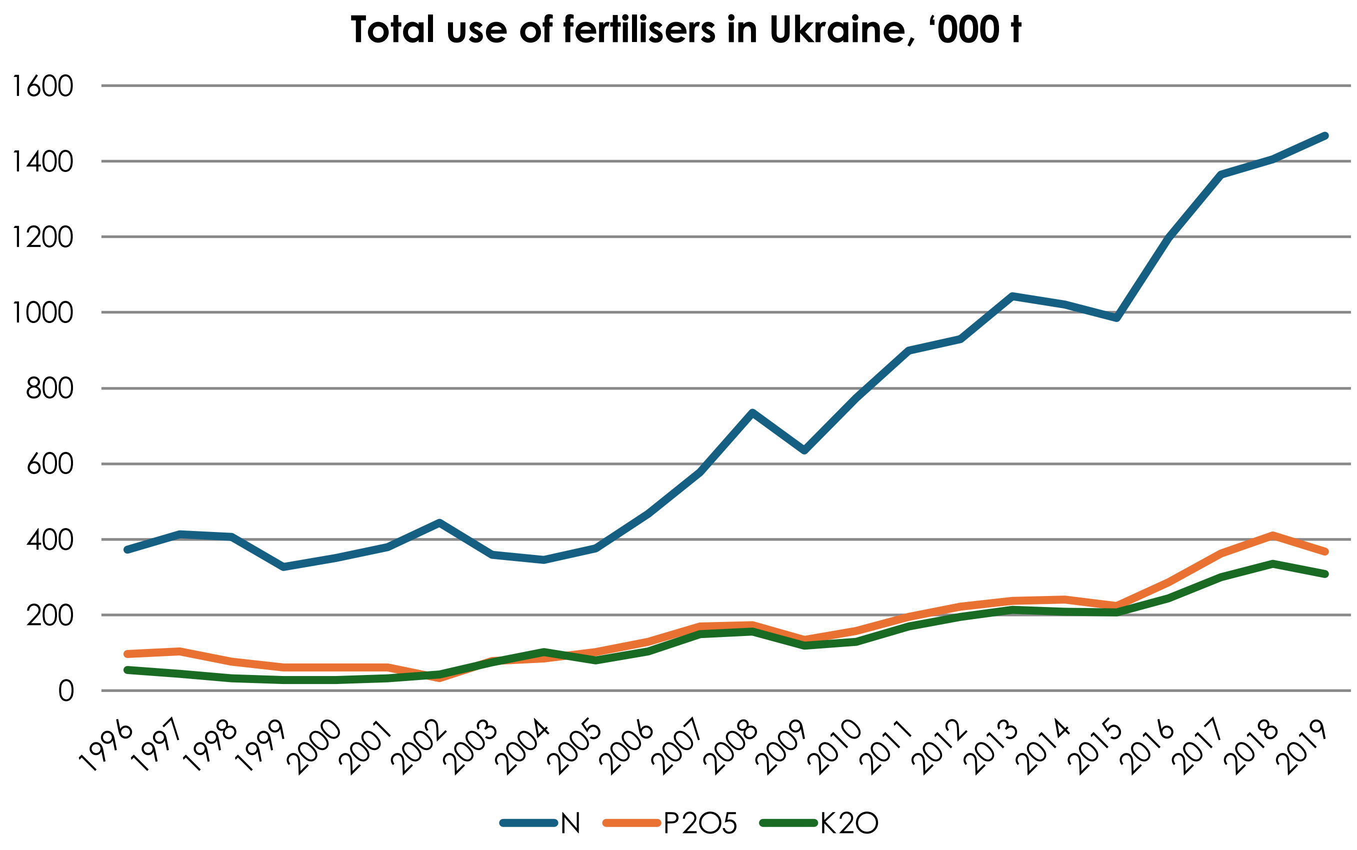


Source: FAOSTAT

Use of fertilizers increased significantly in the recent decade



Source: FAOSTAT

Precision agriculture has a potential to lower the rate of increase of the use of fertilizers for achieving higher yields!

Reduction in the use of fossil fuels would reduce import dependency and, thus, improve Ukraine's energy security

Decrease of sulfur emissions from traditional petroleum products

Use of fertilizers increased significantly in the recent decade

Precision agriculture has a potential to lower the rate of increase of the use of fertilizers for achieving higher yields!

EC (2019) indicates that the EU farmers assess the reduction in

- N-fertilizer use by 8% when applying Variable-rate-nitrification-technology (VRNT), and by 2.9% when applying machine guidance (MG)
- Fuel use by 2.8% when applying VRNT, and by 5.4% when applying MG

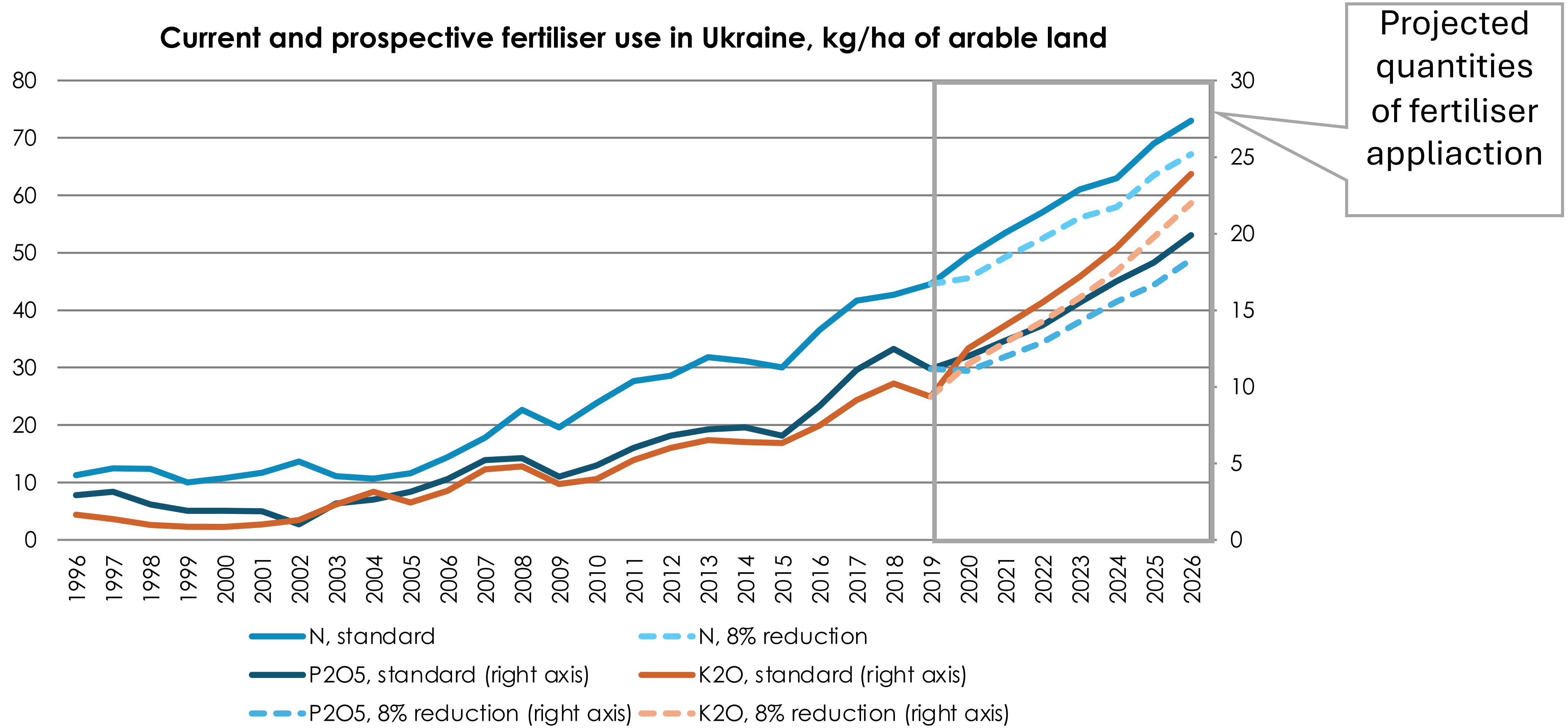
Considering the fact that productivity of agricultural land in Ukraine has not reached its optimum, which is demonstrated by considerable differences in average crop yields between Ukraine and the EU countries (e.g., average corn yield in France in 2014-2019 was 9.1 t/ha and in Ukraine 6.8 t/ha, and average wheat yield in Germany was 7.7 t/ha and in Ukraine 4 t/ha), application of PAT may reduce the use of fertilizers by 8%, but will not likely slow down its growth rate.

Reduction in the use of fossil fuels would reduce import dependency and, thus, improve Ukraine's energy security

Decrease of sulfur emissions from traditional petroleum products

Source: State Statistics Service of Ukraine (2021): Application of mineral and organic fertilizers 2010-2020, http://www.ukrstat.gov.ua; Soto, I., at al (2019): The contribution of precision agriculture technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU. Luxembourg: Publications Office of the European Union, 2019.

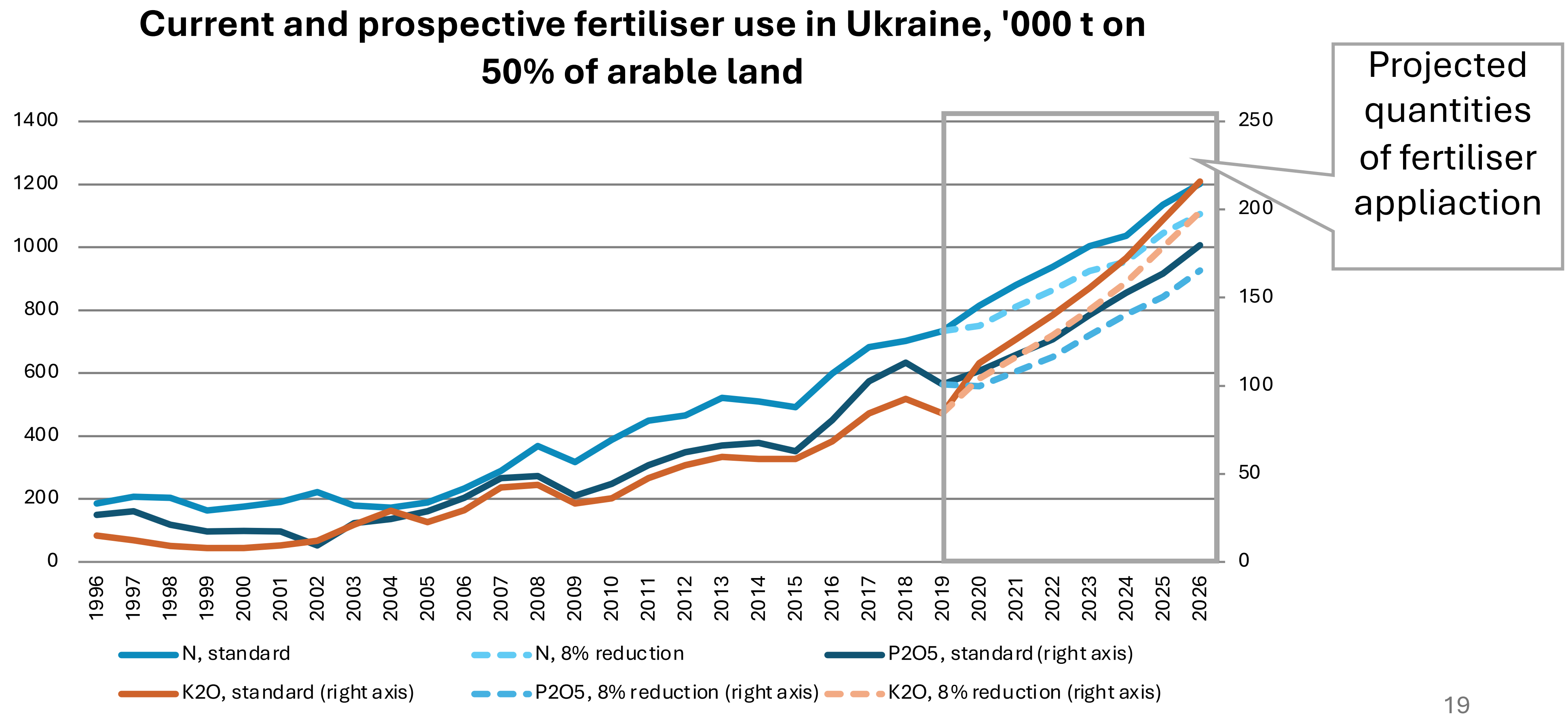
Without using climate-smart technologies, the demand for energy from agriculture will grow



Source: FAOSTAT

Without using climate-smart technologies, the demand for energy from agriculture will grow

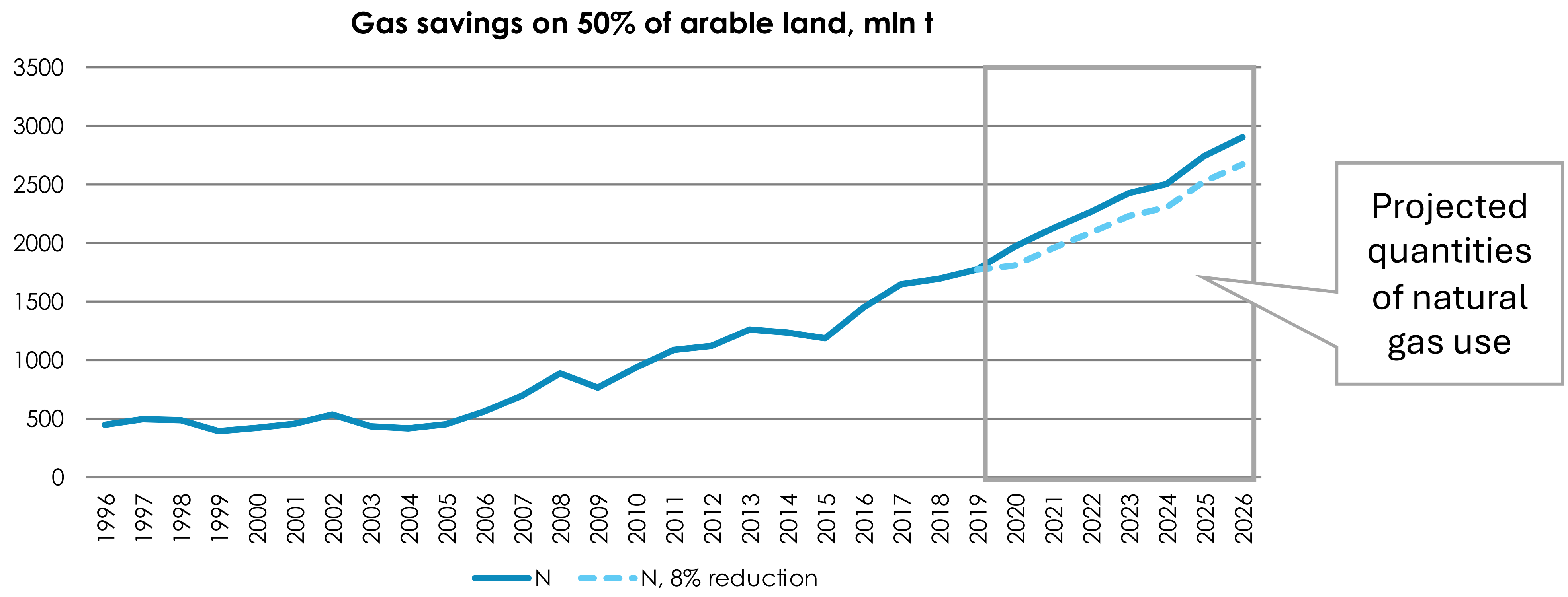
If Variable rate of fertilizer application technology was applied on at least a half of arable land, then...



Source: FAOSTAT

Without using climate-smart technologies, the demand for energy from agriculture will grow

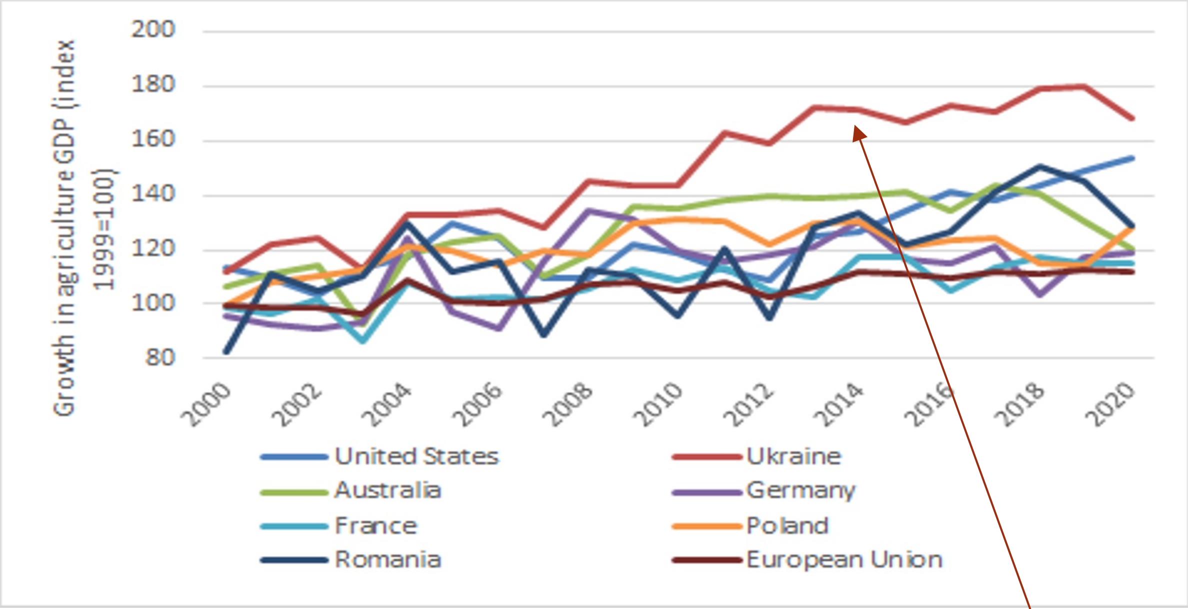
Assuming that 29 million Btu (2417 t) of gas is required for production of a metric ton of ammonia based on the lower heating value (LHV), the respective savings of natural gas for N production would be:



Source: FAOSTAT

2. Impact of Climate Change on Ukraine’s Agriculture

Ukraine's agriculture has been growing rapidly, but with more volatility



Agricultural growth volatilitty, % per year	
	2000-2020
United States	28%
Ukraine	35%
Australia	9%
Germany	7%
France	9%
Poland	21%
Romania	8%
European Union	14%

Ag GDP per worker (constant 2015 US$)				
	2000	2010	2019	Change, times (2019/2010)
United States	71,173	82,862	100,062	1.41
Ukraine	1,198	2,140	4,888	4.08
Australia	57,121	84,134	86,838	1.52
Germany	22,258	37,406	43,715	1.96
France	33,768	46,262	53,556	1.59
Poland	3,489	5,958	6,560	1.88
Romania	1,327	2,391	5,017	3.78
European Union	12,458	18,930	25,476	2.04

Source: WDI.

Agricultural performance is very susceptible to climate and weather

- In Ukraine, climatic and weather variables alone explain 49–58% of wheat yield variability

- Climatic means have more explanatory power than weather extremes, but both are important:

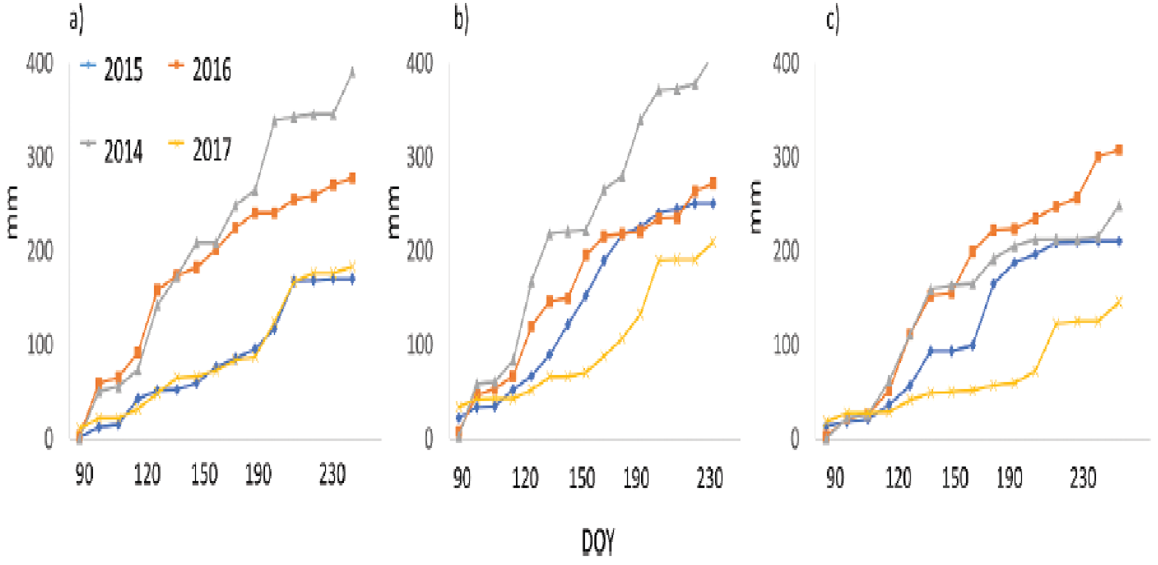
  - Climatic means alone captured 58% (country-wide), 62% (Northwest), and 53% (Southeast) of the yield variability

  - Weather extremes accounted for a mean yield variability of 36% (country-wide), 40% (Northwest), and 36% (Southeast)

Source: Schiehorn, F. et al. (2021): Machine learning reveals complex effects of climatic means and weather extremes on wheat yields during different plant development stages. Climate Change 169, 39. www.doi.org/10.1007/s10584-021-03272-0

Droughts can lead to large yield losses

Accumulated values of precipitation during the main crop growth period between April and September in (a) Bila Tserkva, (b) Mironivka, and (c) Yahotyn districts of Kyiv oblast

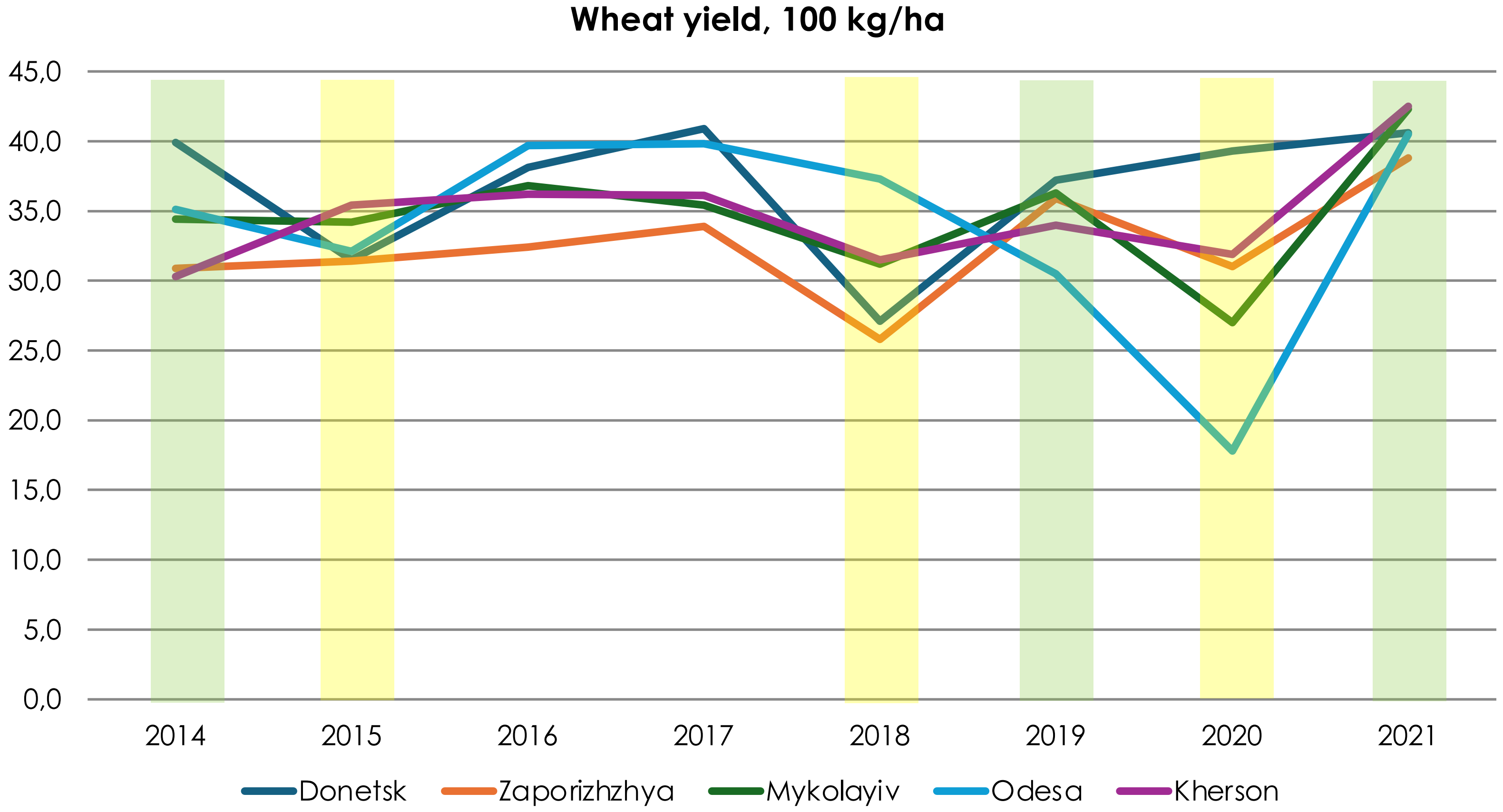


- Examination of several crops showed that in different districts of Kyiv region yields decreased significantly in 2017 relative to the years with no drought condition
- For soybean, a 26–30% decrease was recorded, and sunflower yields were 17–26% less, whereas maize and wheat yields decreased by 16–40% and 20–33%, respectively
- The yield losses, in general, were less in 2015, especially for wheat and sunflower comprising 7–10% compared to non-drought years. Nevertheless, in 2015 maize and soy had a 20% yield decrease.

Source: Ghazaryan, G. (2020): Local-scale agricultural drought monitoring with satellite-based multi-sensor time series. GIS Science and Remote Sensing, 57:5: 704-718

Droughts can lead to large yield losses

Examination of wheat, corn, barley and sunflower yields in southern regions of Ukraine regarding their response to droughts



The graphical analysis shows that the droughts of 2020, 2018 and 2015 have severely affected wheat yields in the southern regions of Ukraine.

In 2020, for example, as compared to the average of 2014, 2016 and 2017 (relatively neutral years) the yields were:

- in Odesa region 53% lower
- in Mykolaiv 24% lower
- in Kherson 7% lower
- and in Zaporizhzhya 4% lower

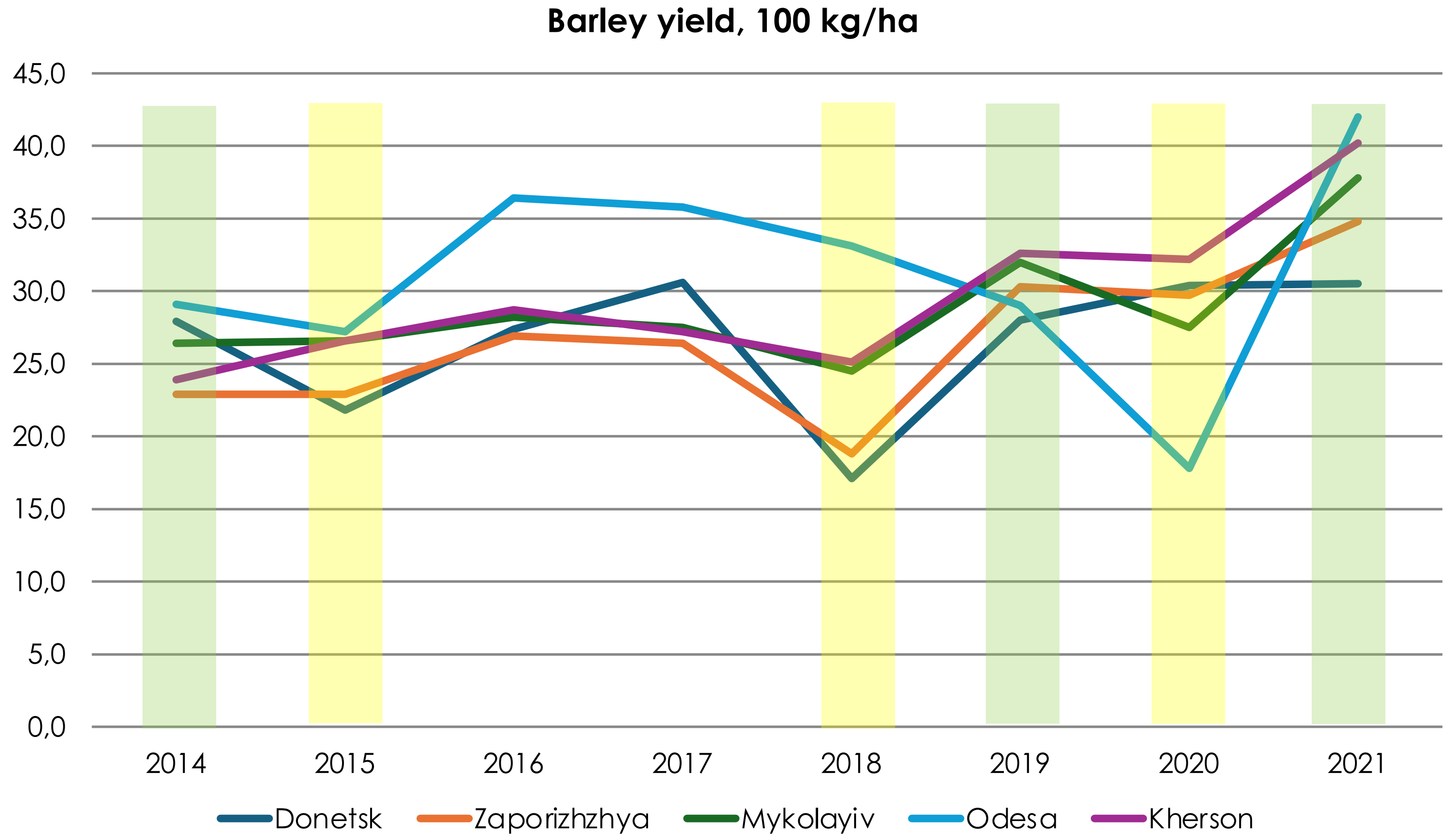
In 2018, which affected winter crops mostly, compared to the average of 2014, 2016 and 2017 (relatively neutral years) the yields were:

- in Donetsk region 32% lower
- in Zaporizhzhya 20% lower
- in Mykolaiv 12% lower
- in Kherson 8% lower

Source: State Statistics Service of Ukraine (2021-2014): Crop production, http://www.ukrstat.gov.ua/

Droughts can lead to large yield losses

Examination of wheat, corn, barley and sunflower yields in southern regions of Ukraine regarding their response to droughts



The graphical analysis shows that the drought of 2018 has severely affected barley yields in the southern regions of Ukraine.

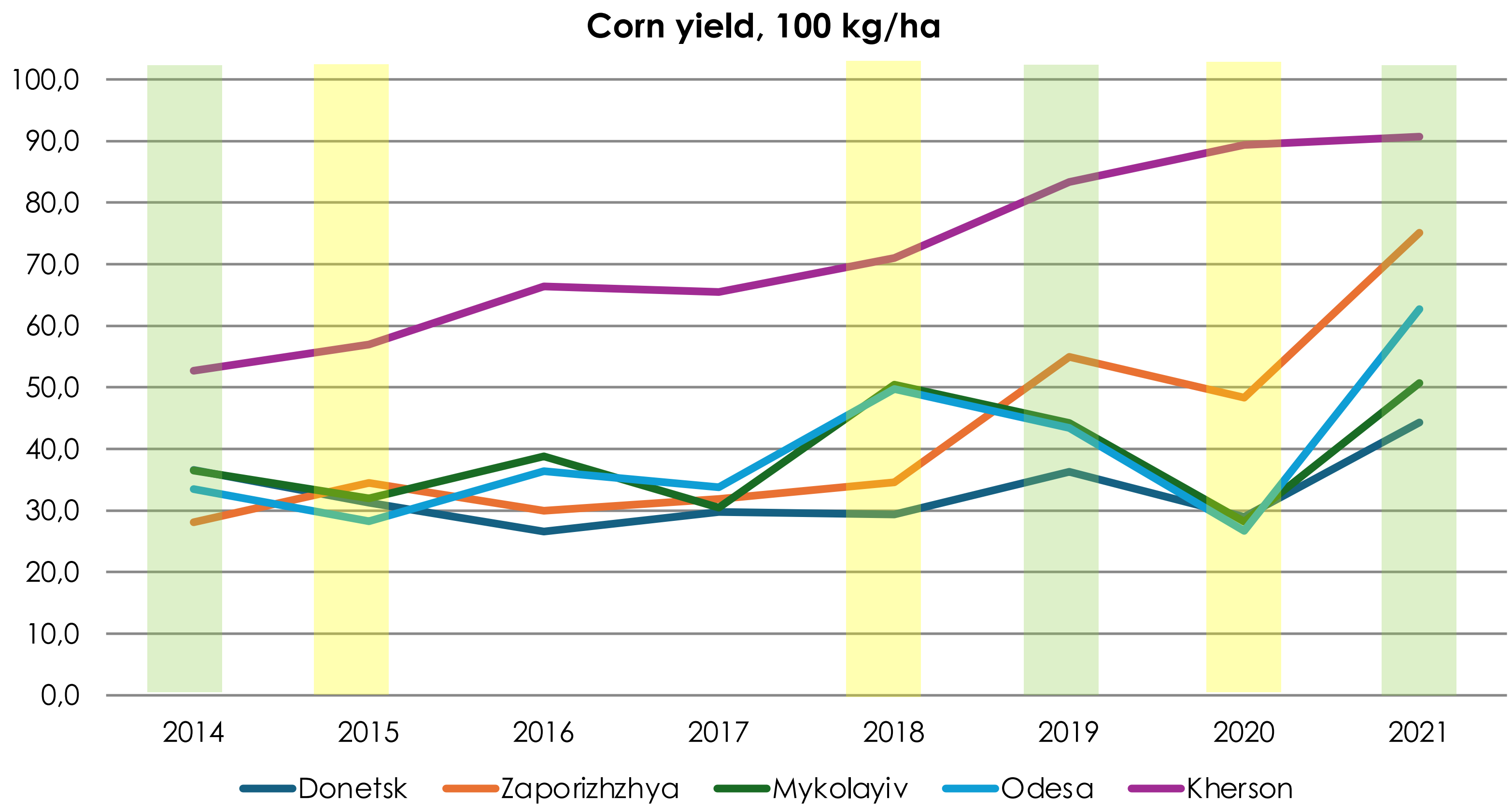
In 2018, which affected winter crops mostly, compared to the average of 2014, 2016 and 2017 (relatively neutral years) the yields were:

- in Donetsk region 40% lower
- in Zaporizhzhya 26% lower
- in Mykolaiv 10% lower
- in Kherson 6% lower

Source: State Statistics Service of Ukraine (2021-2014): Crop production, http://www.ukrstat.gov.ua/

Droughts can lead to large yield losses

Examination of wheat, corn, barley and sunflower yields in southern regions of Ukraine regarding their response to droughts



The graphical analysis shows that the drought of 2020 has severely affected corn yields in the southern regions of Ukraine.

As compared to the average of 2014, 2016 and 2017 (relatively neutral years) the yields were:

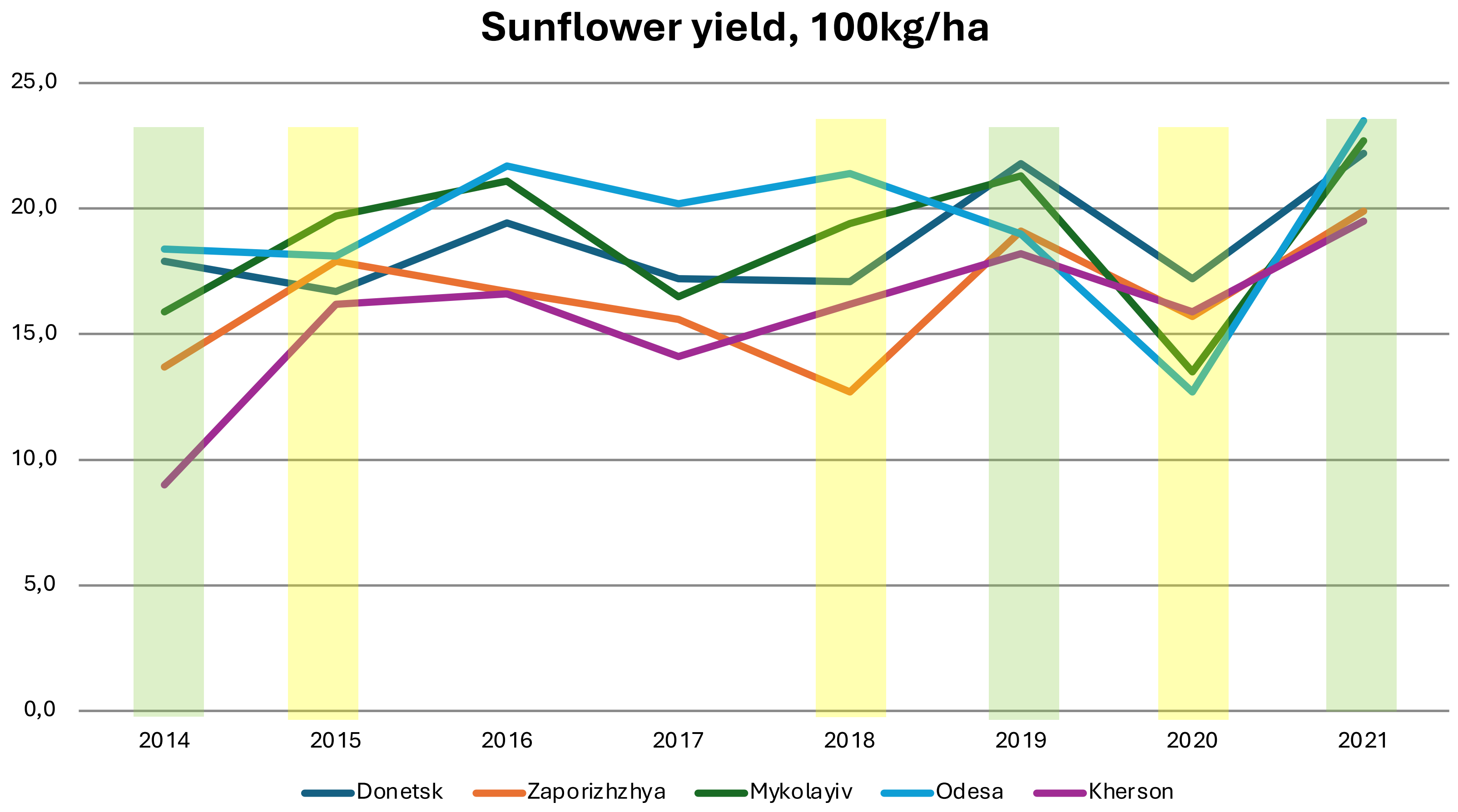
- in Odesa region 23% lower
- in Mykolaiv 20% lower
- in Donetsk 6% lower

Since corn is not a winter crop, its yields in the southern regions were not negatively affected by the drought of 2018.

Source: State Statistics Service of Ukraine (2021-2014): Crop production, http://www.ukrstat.gov.ua/

Droughts can lead to large yield losses

Examination of wheat, corn, barley and sunflower yields in southern regions of Ukraine regarding their response to droughts



The graphical analysis shows that the drought of 2020 has severely affected sunflower yields in the southern regions of Ukraine.

As compared to the average of 2014, 2016 and 2017 (relatively neutral years) the yields were:

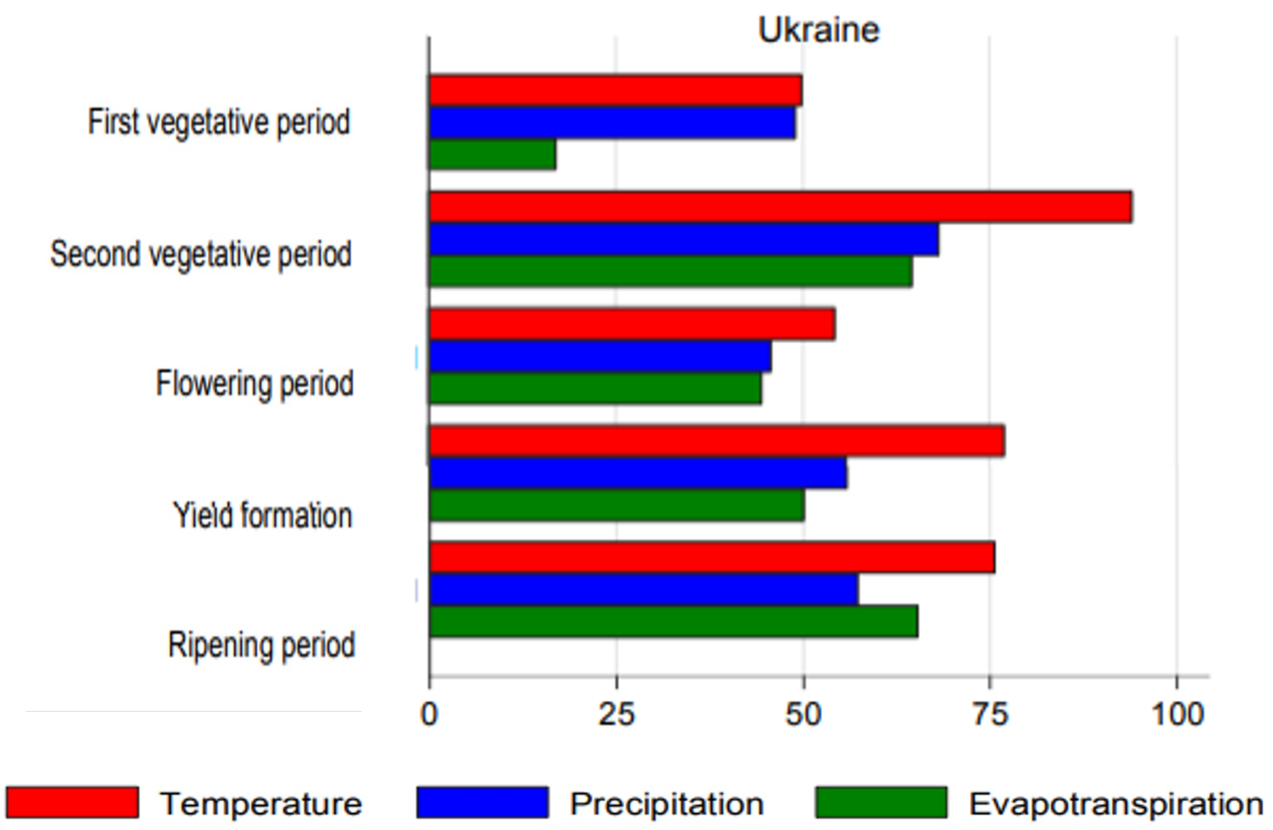
- in Odesa region 37% lower
- in Mykolaiv 24% lower
- in Donetsk 5% lower

Since sunflower is not a winter crop, its yields in the southern regions were not negatively affected by the drought of 2018.

Source: State Statistics Service of Ukraine (2021-2014): Crop production, http://www.ukrstat.gov.ua/

Observed effects of climate change on winter wheat yield

Winter yield is compromised due to warmer winters, which cause winterkills and significant yield loss

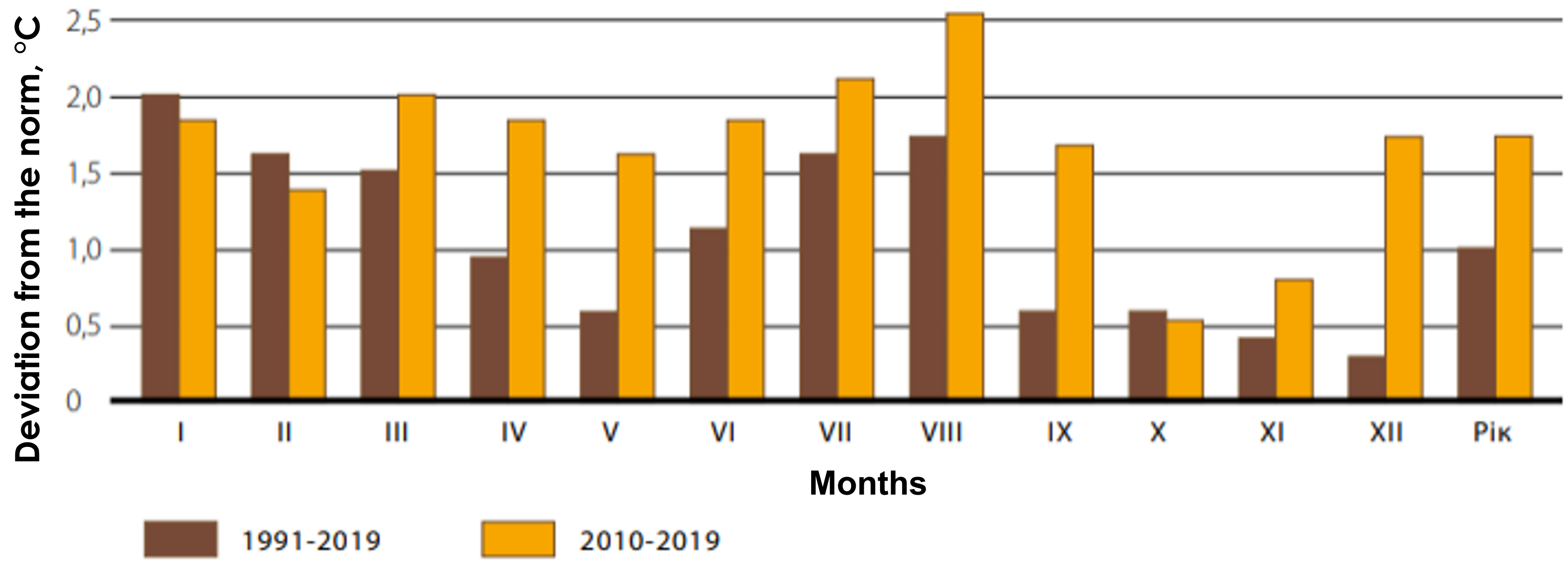


Source: Müller, D. et al. (2016): Impact of Climate Change on Wheat Production in Ukraine. https://apd-ukraine.de/images/APD_APR_05-2016_impact_on_wheat_eng_fin.pdf

Temperature changes

Average annual temperature in Ukraine increased by 1,2°C in the last 30 years, and by 1,7°C in the last 10 years

Deviation from the norm (1961-1990) of the average monthly temperatures in 1991-2019 and 2010-2019 in Ukraine

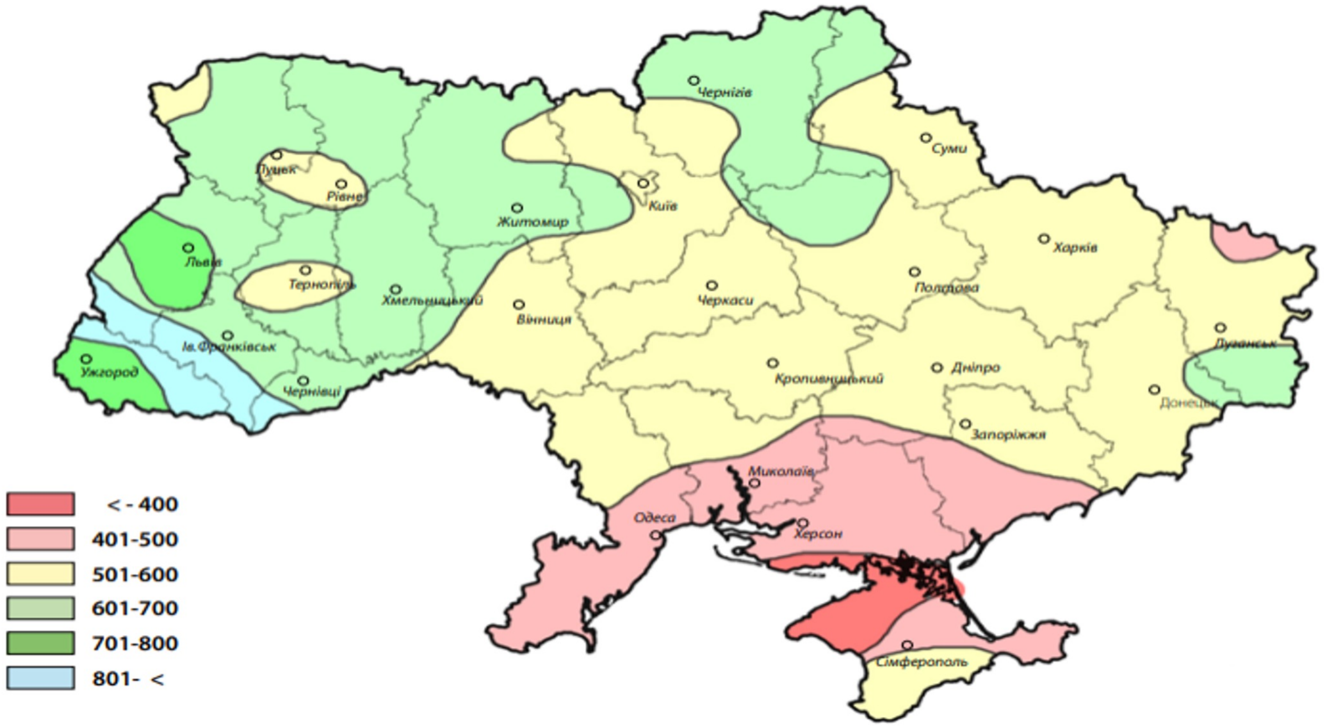


Source: APD (2019): Climate change and agriculture in Ukraine: what farmers should know? German Ukrainian agricultural policy dialogue, shorturl.at/nwzA0

Precipitation changes

Average precipitation level decreased by 1.5-2% in the last years. In Donetsk, Zaporizhia, Vinnytsia, Kyiv, Ternopil, Khmelnytsky, Rivne, Cherkasy, Chernihiv and Zakarpattia oblasts, precipitation fell by 7-12%

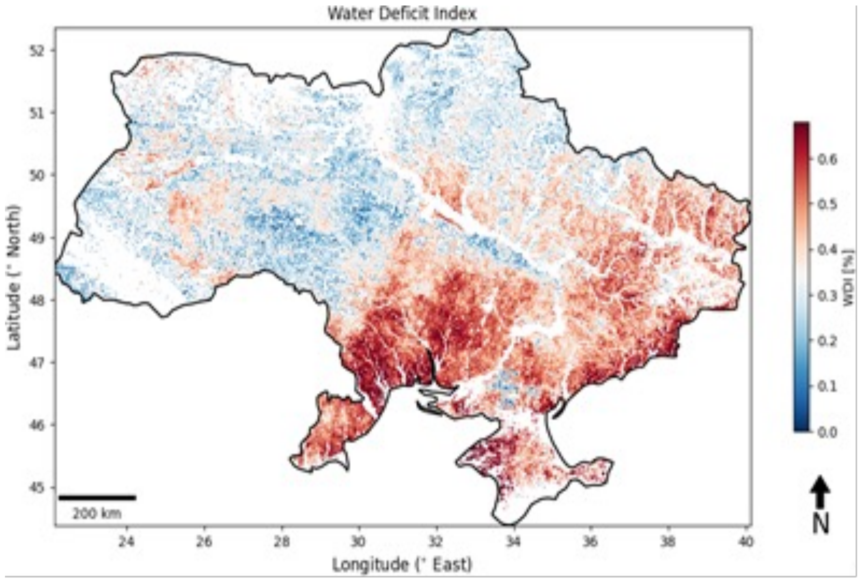
Annual precipitation in Ukraine, mm

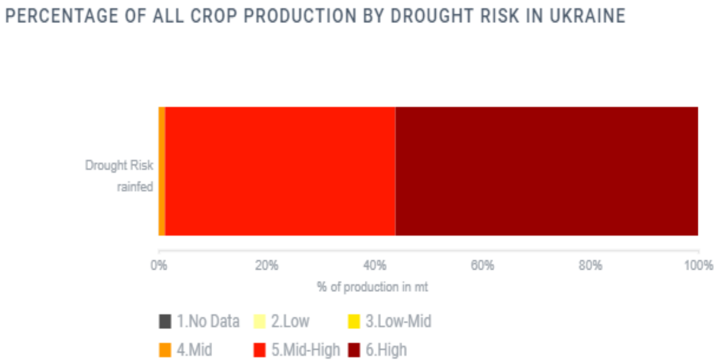


Precipitation required for non-irrigated agricultural production in temperate climate is around **700 mm** on average

Sources: APD (2019): Climate change and agriculture in Ukraine: what farmers should know? German Ukrainian agricultural policy dialogue, shorturl.at/nwzA0; FAO (1986): Irrigation Water Management: Irrigation Water Needs, CHAPTER 2: CROP WATER NEEDS, https://www.fao.org/3/s2022e/s2022e02.htm

Water stress poses growing risks to rain-fed crop production





- Evidence of high-water deficit over southern and eastern crop land areas of Ukraine

- Close to 60% of overall rain-fed crop production is exposed to high levels of drought risk in Ukraine

Source: Water Accounting Report 2010-2020 & WRI, Aqueduct, 2019

Irrigation needs have been growing

Figure 4. Irrigation requirements in the territory of Ukraine according to the Aridity Index and soil moisture regime

- A trend to aridity increase resulted in significant enlargement in the territory requiring irrigation for sustainable crop production but today **irrigation covers only 1% of all agricultural land**
- Nearly **90% of the territory of Ukraine are currently needing irrigation** to grow the full specter of crops, while in the period of 1961–1990 this area share was about 55%
- The most vulnerable regions **are in south Ukraine** (coastal Black Sea area including Khersons'ka, Mykolaivs'ka, Odes'ka and Zaporiz'ka oblasts) and in the center of the country (Dnipropetrovs'ka, Kirovohrads'ka oblasts)
- During 2010–2020, **46% of Ukrainian croplands required mandatory irrigation, 51% required irrigation for some crops**, and **only 3% of the croplands might remain rainfed**
- Urgent not only to ensure the satisfaction of crops' demands for irrigation water in the regions where irrigation systems are readily available, but also it is needed to find ways to add irrigation water supply where irrigation was not previously present.

Source: Lykhovyd, R. (2021): Irrigation needs in Ukraine according to current aridity level. Journal of Ecological Engineering, 22(8).

Future volatility of Ukraine's agricultural growth may further increase with climate change

World Bank (2021): Building Climate Resilience in Agriculture and Forestry.

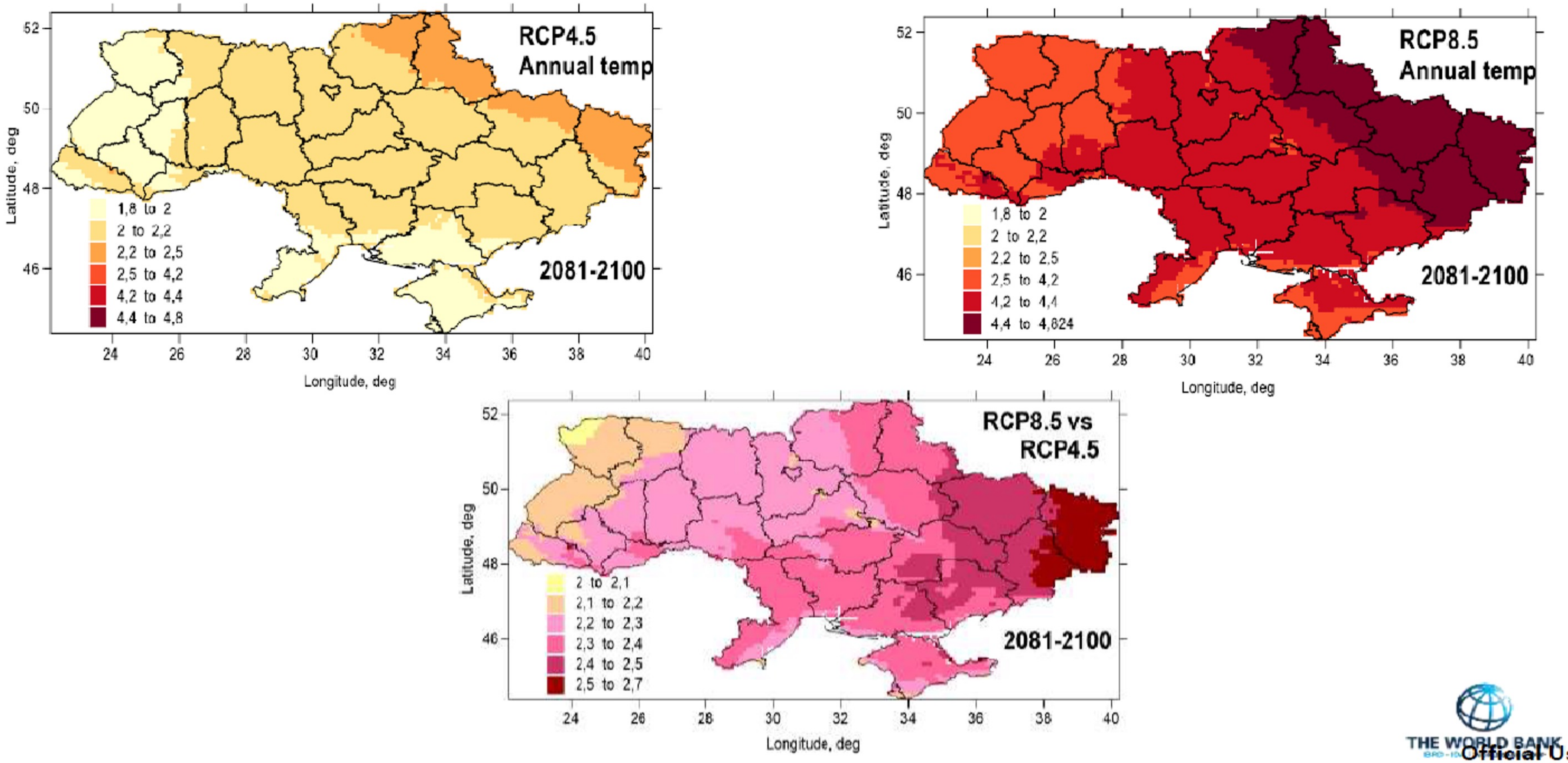
	2021-2040 temperature / precipitation	2041-2060 temperature / precipitation	2081-2100 temperature / precipitation
RCP 2.6	0.8±1.4°C / 3 %	1.0±1.7°C / 2 %	0.9±1.8°C / 6 %
RCP 4.5	0.9±1.4°C / 6 %	1.5±1.7°C / 5 %	2.1±1.8°C / 6 %
RCP 8.5	1.1±1.5°C / 4 %	2.0±1.7°C / 5 %	4.3±2.1°C / 8 %

RCP 2.6 - global 1.5C warming by 2100
RCP 4.5 - global 2.1C warming by 2100
RCP 8.5 – global 4.3C warming by 2100

- Winters are expected to be warmer and summers hotter
- Wetter weather expected in colder months and dryer weather in warmer months
- Southern and central oblasts will become drier; northern oblasts will become wetter

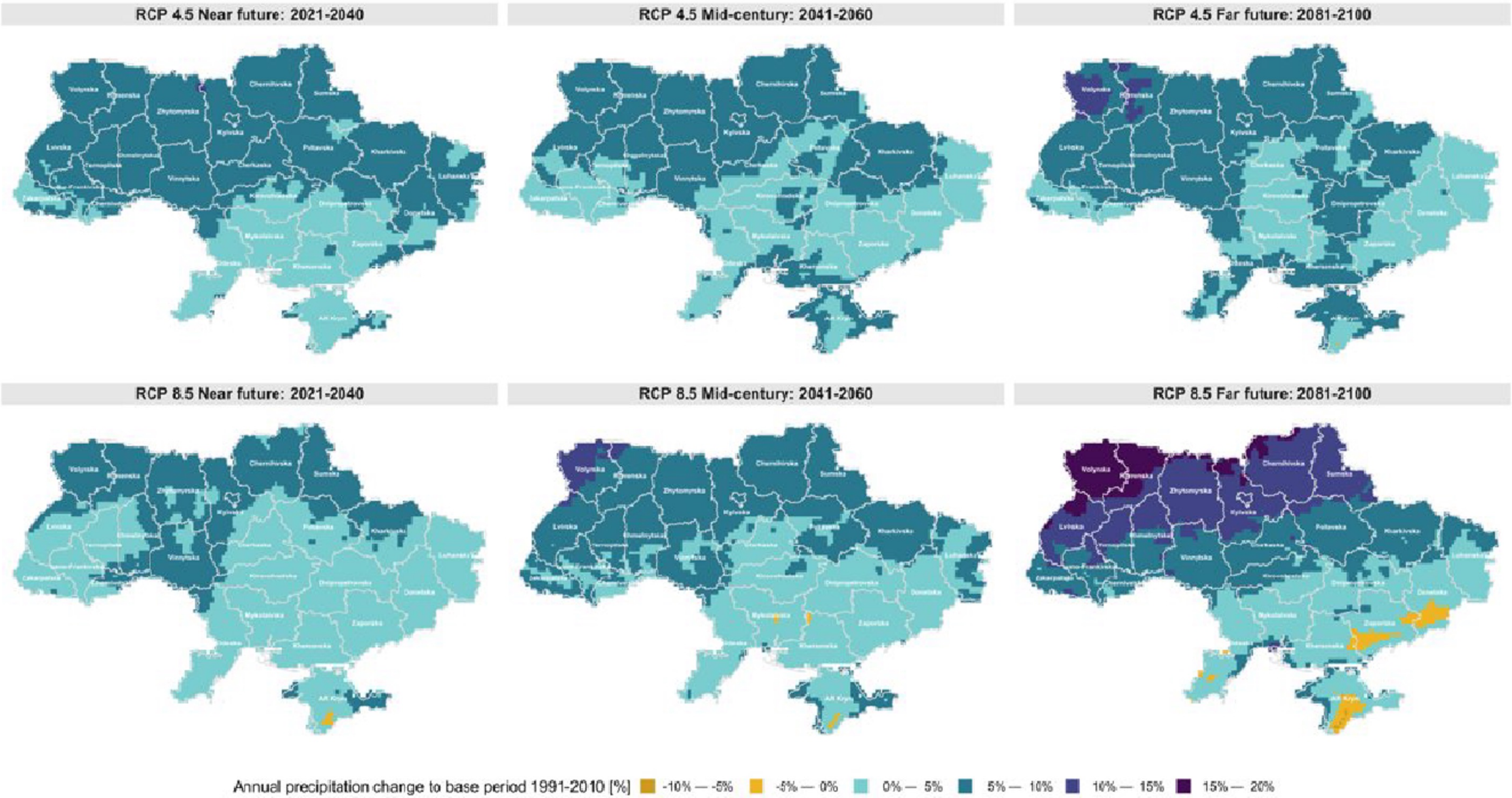
Average temperature is projected to increase (1991/2010 to 2081/2100)

Projected annual mean temperature change for RCP 4.5 (a), RCP 8.5 (b), and the difference between the two scenarios(c)



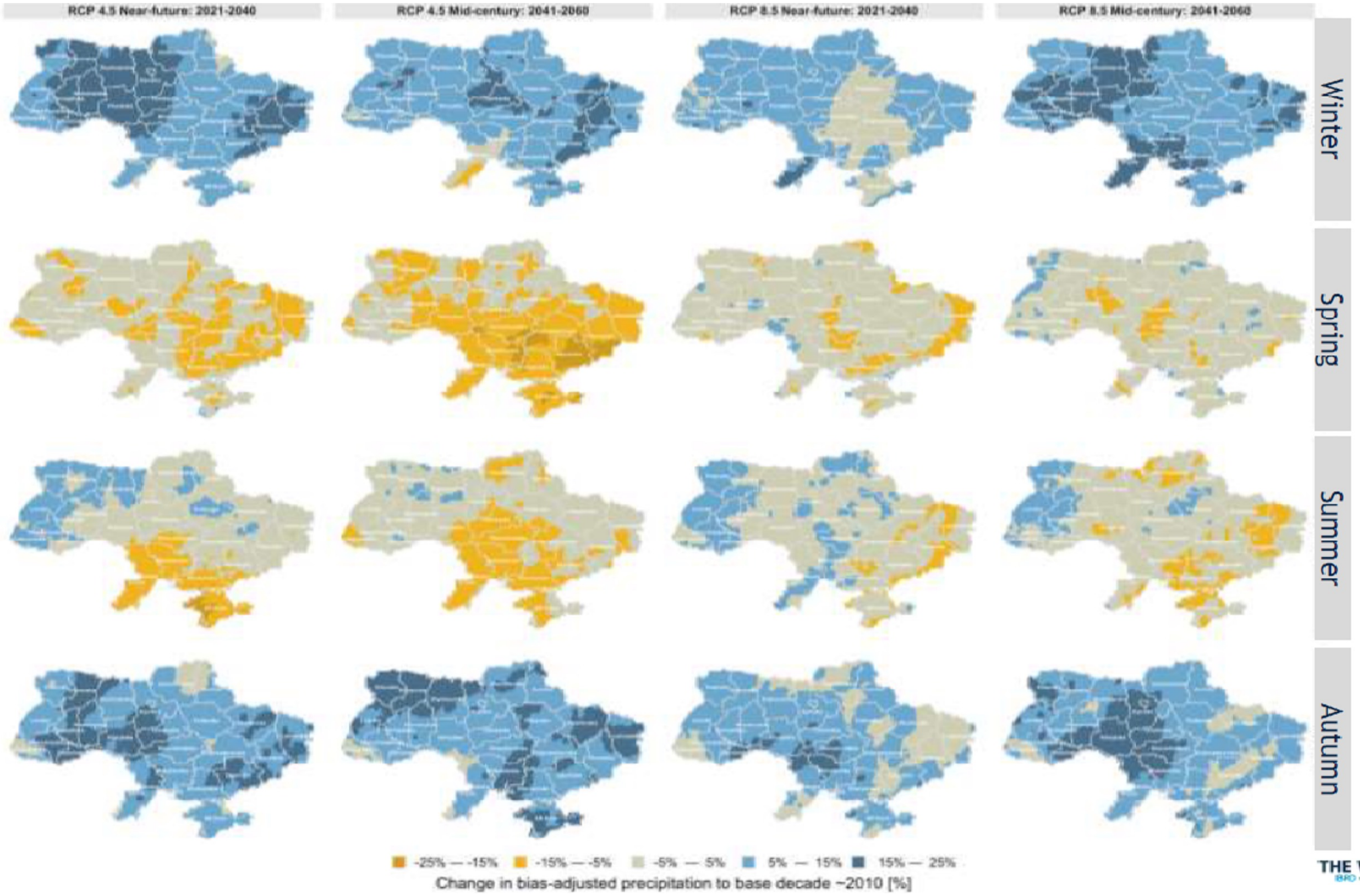
THE WORLD BANK Official Use

Projections for average precipitation



Source: World Bank.

Projections for seasonal precipitation changes



Climate change would bring more volatility to crop production

Changes in yields for main crops due to climate change

	2030		2050	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Barley	-2.3% to +7.5%	-15.1 to -11.5%	-11.0% to -0.3%	-15.8% to -5.2%
Maize	-17.2% to +14.1%	-22.0% to -2.3%	-18.8% to +4.3%	-22.9% to +3.0%
Soybean	+8.6% to +27.9%	+8.8% to +31.7%	+18.3% to +30.4%	+21.1% to +46.7%
Sunflower	-25.1% to +8.1%	-9.4% to +6.1%	-10.6% to +16.0%	-20.9% to +7.6%
Wheat	+8.6% to +44.1%	+13.9% to +40.7%	+11.9% to +49.1%	+20.8% to +63.5%

Figures are for the mean projection and changes are relative to the baseline 2010 year

- Wheat and soybean are expected to gain from climate change
- Maize, barley and sunflower are likely to be negatively affected
- Yield volatility increases significantly between RCP4.5 and RCP8.5 scenarios

3. Cost of Inaction and Benefits of Action

Possible positive impacts

- If considered alone, warming to 2.0-2.5°C can increase the yield of many crops (including wheat)
- Increase of the area for cultivating crops suitable for warmer climate (e.g., soya beans, corn)
- Reduced risk of freezing of winter crops (yet without snow, there is a higher potential of winterkill from freezing/thawing and winter winds)

The benefits of warming are likely to be short-lived, because…

Sources: APD (2019): Climate change and agriculture in Ukraine: what farmers should know? German-Ukrainian agricultural policy dialogue, shorturl.at/nwzA0; World Bank (2021): Building Climate Resilience in Agriculture and Forestry. Washington, D.C.

Possible negative impacts

Crops

- **In recent years, droughts have been observed in areas where they did not appear before. The calculated indices of climate aridity over the last decade indicate a significant increase in the area of insufficient moisture.**
  - **Increased irrigation requirements, hence, <u>increased production costs</u>**
  - **Decreased crop yields in case of absent irrigation**
- **Significant warming in winter, slight freezing of the soil and early onset of spring processes contribute to the increase in the number and area of <u>pests and diseases</u> of crops and forests**
- **CO_2 on vegetables is mostly beneficial for production, but may <u>alter internal product quality:</u>**
  - **for example, cauliflower and asparagus, need a period of cold accumulation to produce a harvest and warmer winters may not provide those requirements.**
- **Tripathi et al. (2016) found <u>fruits and vegetable production to be highly vulnerable</u> to climate change at their reproductive stages and due to potential for <u>greater disease pressure</u>**

Sources: APD (2019): Climate change and agriculture in Ukraine: what farmers should know? German Ukrainian agricultural policy dialogue, shorturl.at/nwzA0; Moore, F. and D. Lobell (2015): The fingerprint of climate trends on European crop yields. PNAS 12 (9): 2670-2675; first published February 17, 2015; https://doi.org/10.1073/pnas.1409606112; Bisbis, M. et. Al (2018): Potential impacts of climate change on vegetable production and product quality - A review. Journal of Cleaner Production, 170: 1602-1620; Tripathi, A. et al. (2016): Paradigms of climate change impacts on some major food sources of the world: A review on current knowledge and prospects. Agriculture, Ecosystems & Environment, 216: 356-373

Livestock

- At temperatures above their comfortable levels (10-30°C) animals considerably reduce their feed intake (Rojas-Downing et al. 2017). Thus, their <u>yields drop</u>
- Reduced milk yields and <u>increased cow mortality</u> as the result of heat stress (Becker et al. 2020). Need to improve cooling facilities at the stables. Hence, increase of fixed and variable production costs
- <u>Spread of pests and diseases</u> (Kipling et al. 2016)
- Decreased forage quality (Craine et al. 2010), leading to <u>livestock yields drop</u>
- <u>Increase in the costs</u> of water, feeding, housing, transport and the possible destruction of infrastructure due to extreme events
- <u>Increasing volatility of the price of feedstuff</u> (Rivera-Ferre et al. 2016)

Sources: Rojas-Downing, M. et al (2017): Climate change and livestock: Impacts, adaptation, and mitigation. Climate Risk Management (16): 145-163; Becker, C. et al. (2020): Invited review: Physiological and behavioral effects of heat stress in dairy cows. Journal of Dairy Science (103), Issue 8: 6751-6770; Kipling, R.P. et al. (2016): Key challenges and priorities for modelling European grasslands under climate change. Science of the Total Environment 566-567: 851-864; Craine, J. et al. (2010): Climate change and cattle nutritional stress. Global Change Biology; Rivera-Ferre, M. et al. (2016): Re-framing the climate change debate in the livestock sector: mitigation and adaptation options. Climate Change. https://wires.onlinelibrary.wiley.com/doi/pdf/10.1002/wcc.421

Adaptation lag

- A lack of advisory services and research means that alternative cropping systems are not being practiced to create adaptation opportunities
- End result is that private sector will have to figure this out on their own, which will mean delayed adaptation and transition until moments when profits are ensured, resulting in an adaptation lag

MONETARY LOSSES OF UKRAINE AGRICULTURE FROM CLIMATE CHANGE

WINTERKILL

(low temperatures + ice crust)

LOSSES:
2 billion UAH

FLOODS
in the West

LOSSES:
1 billion UAH

SEEDING DROUGHT
(seeds don't germinate due to lack of moisture)

LOSSES:
0.1 billion UAH

2002-2003 **2007** **2008** **2010-2011** **2012, 2015** **2020** ???

DROUGHT
in the South and East

LOSSES:
0.5 billion UAH

2 CYCLONES AND FROST

LOSSES:
0.1 billion UAH

DROUGHT

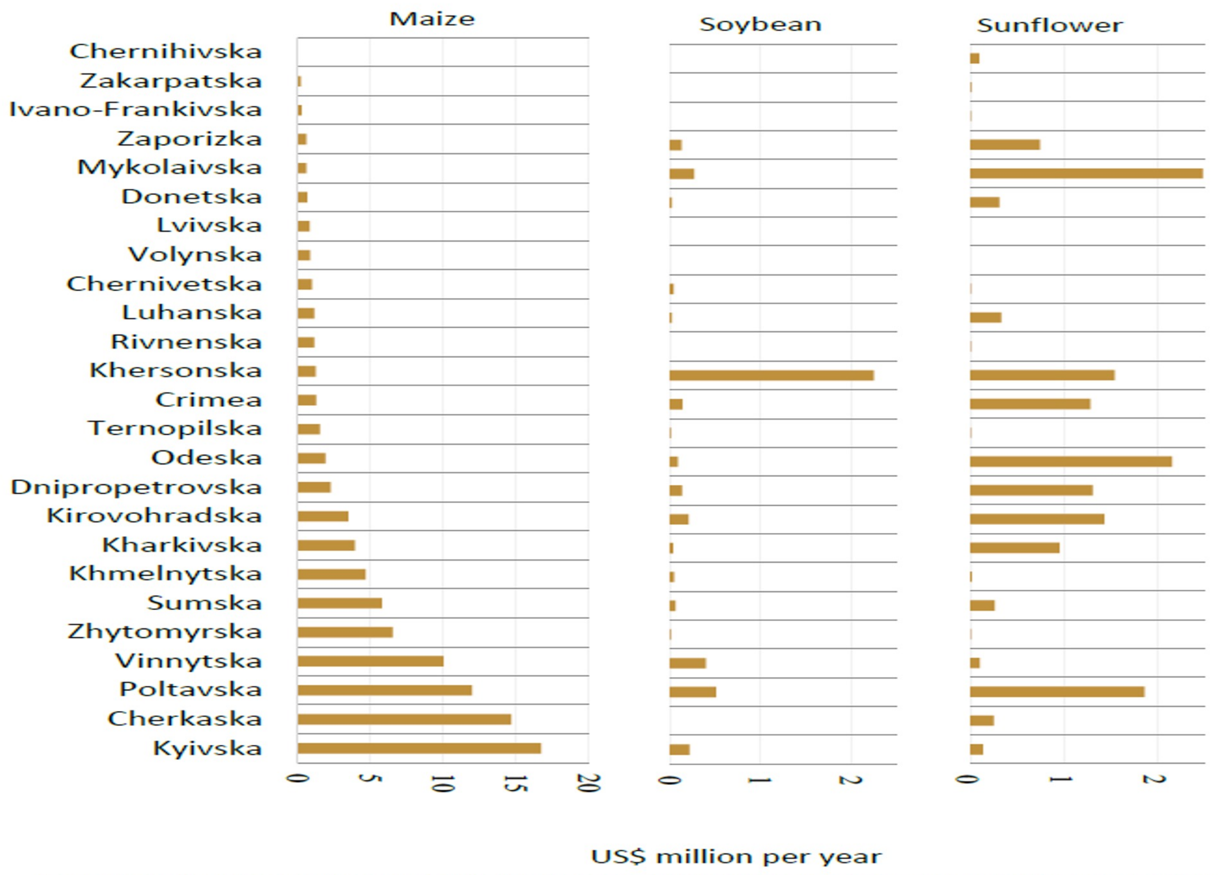
in Southern Ukraine

LOSSES:
3.8 billion UAH

In the last 20 years Ukrainian farmers lost US$2 billion or 12% from the yearly Ag GDP (or 0.6% Ag GDP a year). And more bad weather conditions will likely occur.

Cost of inaction: Long run losses

Figure 37: Difference in the Value of Agricultural Production Between Optimal Water Availability and Water Scarcity Projections in US$ million/year[29]



Source: Authors' estimates using IFPRI data and Ukrainian statistics on agricultural croplands in 2019

Source: World Bank (2021): Building Climate Resilience in Agriculture and Forestry. Washington, D.C.

Cost of inaction: stakeholders' interview

- Summer begins after winter, which introduces new requirements for operational efficiency, especially for sowing (**Farmer**)
- Demand for early post emergent herbicides for sunflower, corn, and soybeans has increased due to global climate change (**Arysta, chemical company**)
- The need for fungicides is on the rise because of unstable weather conditions during the growing season and significant impact of temperature and moisture or humidity on the immune system of plants. Therefore, supporting plant health with protection products is a high priority (**Corteva,**

Cost of inaction: Summary

- Inaction does not mean collapse of Ukraine's agriculture, but the losses still could be significant
- Volatility and unpredictability of agricultural growth would greatly increase
- Negative impact on soil fertility and eventually productivity
- Increased production costs, and thus, possible negative impact on farm incomes and development of rural areas
- Decreased market access/revenue due to a required carbon footprint calculation (this trend is emerging in the Renewable Energy Directive II in the EU)
- Decreased food availability and increased food prices (farm income may still drop due to disproportional increase in production costs)

Benefits of action

- Increases in humus content are associated with increased crop yields
- Minimization of nutrient run-off from agriculture and pasture lands, improving water quality and soil health, and reduction of air pollution
- Improvement in productivity and input use efficiency → reduction of production costs
- Buffer crop yields against weather extremes
- Prevention of livestock yield losses
- Higher plant and livestock resistance to pests and diseases
- Ukraine's potential benefits of sustainable irrigation expansion into rain-fed croplands that are economically water scarce can increase food production for an additional 84-119 million people (Rosa et al. 2020)

Source: Lorenzo, R. et al. (2020): Global agricultural economic water scarcity. Science Advances, 6(18): 1-11.

4. CSA Technologies for Increasing Climate Resiliency and Decarbonization of Agriculture

Examples of climate-smart farm technologies

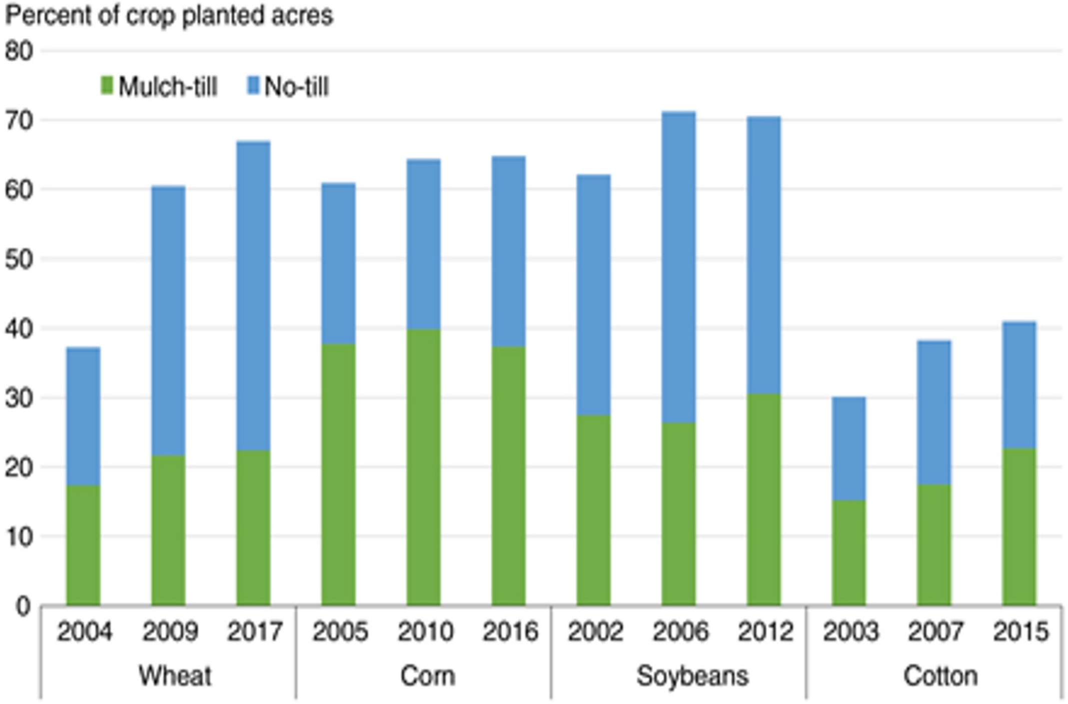
CSA TYPE	CSA MEASURE	DESCRIPTION	BENEFIT
Nutrient smart	Fertiliser	Soil sampling and mapping	Improved yields / lower input costs
		Type of fertiliser	
		GPS application following scouting / drone / satellite / tractor data	
	Crop protection chemicals	Types of protection	Improved yields / less crop losses
		GPS application following scouting / drone / satellite / tractor data	
	Crop rotation	Rotation of crop types to increase soil nutrition	Preserve soil nutrients / less fertiliser
Water smart	Irrigation	Irrigation of crops when required	Produce crops on unproductive land where there is low precipitation
Knowledge smart	AgriTech / Data & planning	Weather Station / Precipitation records	Efficiencies across farm inputs (e.g. fertiliser, fuel)
		Production and yield records	
	Seeds	Drought, disease resistant or yield increasing	Improved yield / less crop loss
Energy smart	No-till	No-till / low till, seeders, cover crops	Less inputs (fuel, fertiliser)

Role of Climate-Smart Irrigation in Ukraine

- **What is climate-smart irrigation?:** Climate-smart irrigation (CSI) technology consists of several main "elements" – conventional irrigation technology combined with meteorological stations and their sensors.
- CSI system is based on use on modern technologies, such as IoT (Internet of Things), different meters, drones, GSM, GLONASS and automated systems used to increase agricultural output productivity.
- **Benefits**:
  - prevention of crop loss due to overwatering or underwatering;
  - more reasonable and diminished use of water, that leads to the decreased amount of nutrients reaching water bodies;
  - the maximal use of soil moisture;
  - the indirect conservation of biodiversity through cleaner water;
  - large-scale CSI as water technology is subject to integrated water resource management at the national level (and even at basin) level, contributing to enhanced management of water balancing the availability of water supply and irrigation demand;
  - Major mitigation's co-benefit is the reduction of CO2 emissions into the atmosphere as a result of lower electricity consumption, as less water is required to be transported for irrigation.

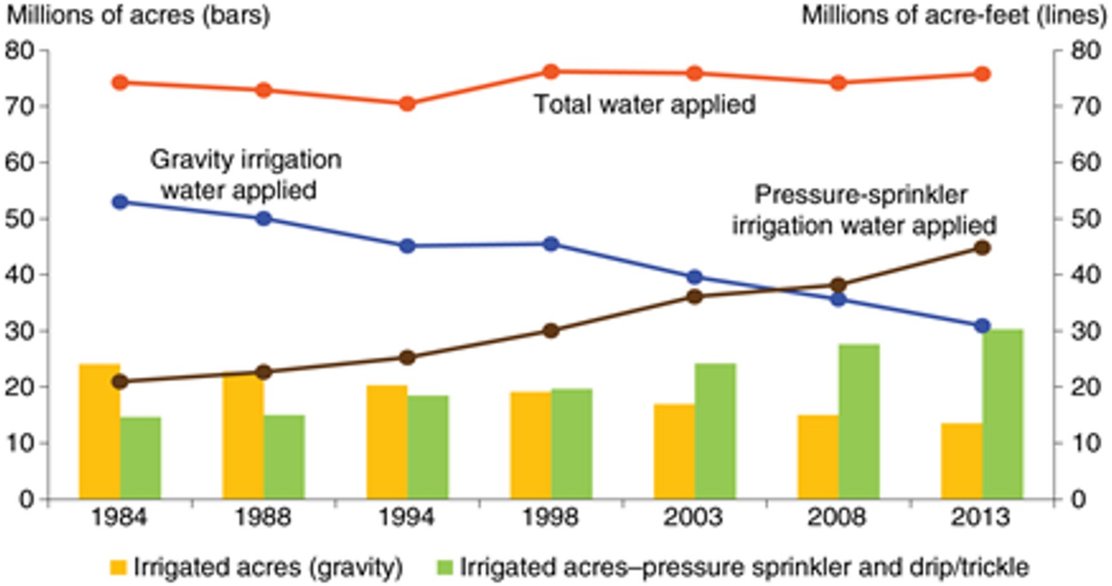
Adoption of CSA technologies in the USA

No-till production has increased across major commodity crops, 2004-17



Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, 2002-17.

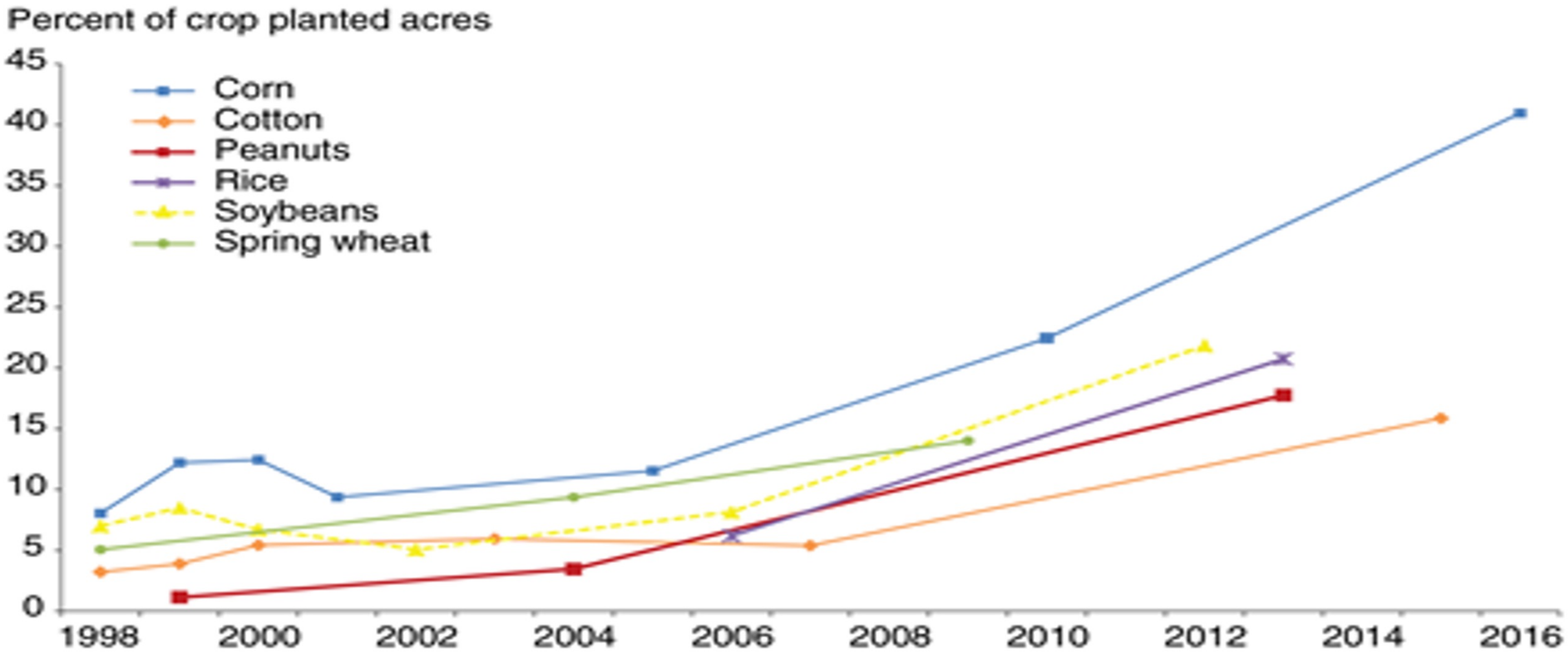
Irrigation systems in the arid Western States have shifted toward more efficient pressurized sprinkler systems



Note: Water-use information from USDA's Farm and Ranch Irrigation Survey (FRIS) reports onfarm water applied, not withdrawals. Also, the area tracked includes only acres irrigated in the open. It excludes area (square-feet) under protection on horticulture operations.
Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service 1984, 1988, 1994, 1998, 2003, 2008, and 2013, FRIS data.

Adoption of CSA technologies in the USA

Adoption of variable rate technology is increasing across crops



Note: Line markers indicate survey years for each crop.
Source: USDA, Economic Research Service (ERS) estimates using data from ERS and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase II.

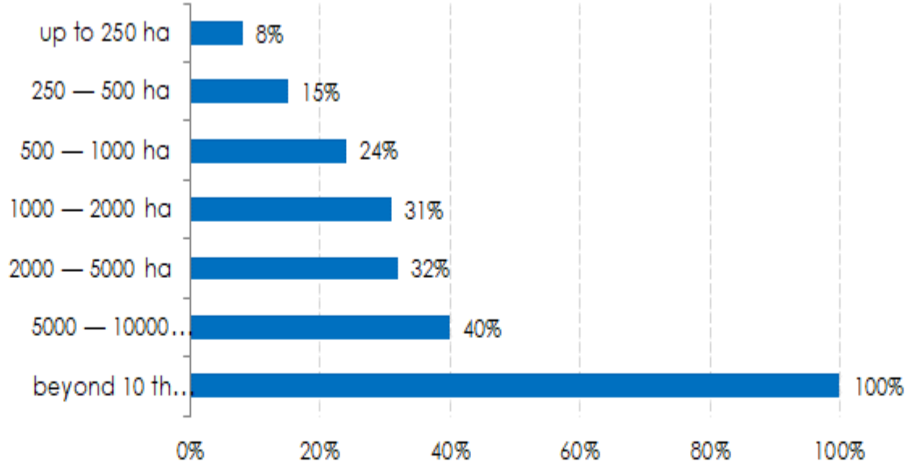
Adoption of CSA technologies in Ukraine

- Interview of 479 individual farms and 10 agro-holdings in 2021
- These farms account for 15% of sown area for grain production
- Various types of precision agriculture technologies (PAT) is adopted on 8.4 million ha, which is 45% of interviewed farm area and 25% of the county's arable land area (32.5 million ha)

Are you familiar with PATS, and do you use them in your business activities?

Group	% of the total number of respondents in the group		
	Familiar, but do not use	**Use**	**Not familiar**
up to US$0.1 million	52%	13%	35%
US$0.1—0.6 million	53%	30%	17%
US$0.6—1.15 million	59%	35%	6%
US$1.15—4.0 million	33%	67%	0%
beyond US$4 million	50%	50%	0%
not ready to say	49%	35%	16%
Total	**52%**	**28%**	**20%**

Do you plan to invest in PAT in your farm in the future? % of positive answers (~ 3.8 million ha)



Source: FAO Investment Center (2022 – forthcoming): Digital technologies in the grain sector of Ukraine.

Adoption of CSA technologies in Ukraine (contd.)

	< 1,000 ha farms	1-3,000 ha farms	3-10,000 ha farms	>10,000 ha farms
Digital field maps(basic element for the introduction of tools for precision farming)	17%	48%	68%	86%
Heading indicators / autopilot (designed to control agricultural machinery with maximum processing accuracy and as a result of reducing fuel consumption, fertilizers and seed)	35%	67%	86%	92%
GPS monitoring (tracker) and fuel control sensors	39%	66%	84%	98%
Satellite images / NDVI (to quantify vegetation cover)	16%	38%	71%	93%
Drone/UAV	11%	22%	68%	86%
Meteorological stations, soil moisture stations	17%	31%	52%	79%
Forecasting programs (pests, diseases)	6%	19%	21%	43%
Management systems (Field View, Cropio)	3%	9%	27%	64%
Conclusion:				
Precision farming technologies	rather problematic	low	more than average	high

Source: UCAB (2021): Precision farming technologies in the Ukrainian agricultural sector.

Estimated costs of GHG abatement technologies in Ukraine

Technology	Cost (US$/ha)	Hectares (mill)	Total cost (US$ mill)	Description
Irrigation systems	2,400	2.0	4,800	Establish modern irrigation systems, including drip and pivot, covering at least 2 million ha
No-till	27	20.5	553	Purchase of no-till equipment (4-meter till for tractor). $150,000-$300,000 per no-till drill with 3-5-year payback and an increase to agriculture production in dry years of 3-5 times the production rate without using the technology); plus decrease annual diesel fuel usage 2-3 times.
Agritech data and planning	17	20.4	346	Purchase of software to access data and planning tools
Crop Protection Systems	14	21.1	295	Purchase of software and equipment to spray protection chemicals using a drone
Organic Fertilizers	2	20.5	41	Purchase of sprayers for liquid, organic and low emission fertilizer
Crop Rotation	Not required			No additional/minimal capital expenditure required. Annual cost changes due to change in fertilizer need.
Climate- smart Seeds	Not required			No capital expenditure required. Annual cost changes due to purchase of higher cost seeds

Source: IFC (2021): CREATING MARKETS IN UKRAINE. Doubling Down on Reform: Building Ukraine's New Economy. CPSD.

Estimated benefits of GHG abatement technologies in Ukraine

CSA SOLUTION	AVERAGE GHG REDUCTION PER HECTARE (KGCO2E)	AVERAGE CHANGE IN COST PER YEAR (USD)	AVERAGE YIELD IMPROVEMENT IN YEAR 1	AVERAGE CHANGE IN REVENUE PER YEAR (USD)
Fertiliser	138.4	\$6	10%	\$99
Crop Protection Chemicals	1.8	-\$2	10%	\$99
No-Till	308.9	-\$4	8%	\$79
AgriTech / Data and planning	68.7	-\$16	12%	\$117
Irrigation	-	\$0	3%	\$0
Seeds (drought, disease, yield)	1.8	\$18	10%	\$99
Crop Rotation	32.6	-\$6	-8%	\$49

Source: IFC (2021): CREATING MARKETS IN UKRAINE. Doubling Down on Reform: Building Ukraine's New Economy. CPSD.

Estimated benefits of GHG abatement technologies in Ukraine

BIOGAS PRODUCTION FROM MANURE:

- utilization of technically available manure for agricultural biogas production could cover up to 11% of natural gas or up to 19% of electricity demand
- the theoretical potential for reducing GHG emissions could reach 5% to 6.14% of total emissions
- the achievable technical potential varies between 2.3% and 2.8% of total emissions

Size of Biogas Plant	Small ~25 kWe	Medium ~100 kWe	Large ~750 kWe
Investment cost (EUR/plant)	210,000	600,000	3,750,000
Biogas production (m^3/year/plant)	97,038	360,085	2,728,485
Electricity generated (kWh/year)	164,536	647,365	4,914,943
Operating costs (EUR/year/plant)	8628	25,300	210,750
Revenues (EUR/year/plant)	21,225	83,510	634,027
Simple payback period (years)	16.6	10.3	8.9
IRR	−1.35%	5.1%	7.4%

Source: Adam W, Piotr Sulewski , Vitaliy Krupin, Nazariy Popadynets, Agata Malak-Rawlikowska, Magdalena Szyma ´nska, Iryna Skorokhod and Marcin Wysoki ´nski: The Potential of Agricultural Biogas Production in Ukraine—Impact on GHG Emissions and Energy Production. *Energies. https://www.mdpi.com/1996-1073/13/21/5755/htm.*

Estimated CAPEX costs and GHG benefits from adoption of selected CSA technologies in Ukraine

	CAPEX estimates (US$ million)	GHG emission potential (million tons CO2 eq)
Irrigation systems	4,800	N/A
No-till	553	6.32
Agritech data and planning	346	1.40
Crop Protection Systems	295	0.37
Organic Fertilizers	41	2.87
Crop Rotation	0	0.67
Climate-smart Seeds	0	0.37
Sub-total	***6,035***	***11.31***
Biogas (manure management)		8.20
Total		***19.51***

Source: World Bank estimates based on the IFC (2021): CREATING MARKETS IN UKRAINE. Doubling Down on Reform: Building Ukraine's New Economy. CPSD, and other sources

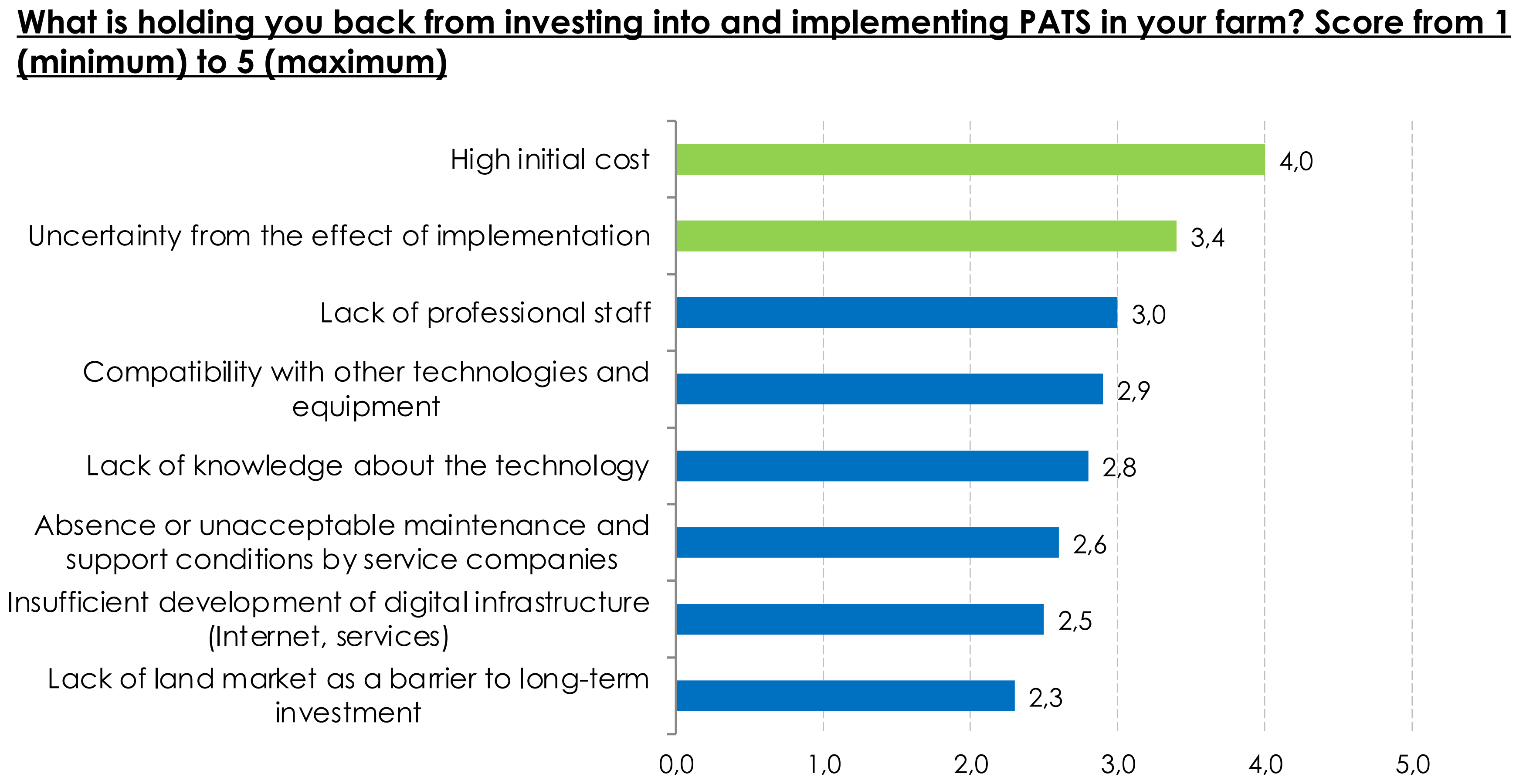
5. Role of Public Policy in Promoting Climate-Smart Agriculture: Global Lessons

Slow adoption of CSA technologies calls for government action

- Barriers related to the actual or perceived effects on performance, as well as information awareness, including on knowledge and capacity to properly use technologies
- Barriers related to the cost of adoption, access to credit, hidden and transaction costs, social and cultural factors
- Barriers related to perception of carbon leakage
- Barriers related to land tenure and availability of infrastructure (such as irrigation water)
- Barriers created by existing policies such as input subsidies designed to support production in marginal areas and low/zero cost of water

Source: OECD (2017): Overcoming Barriers to the Adoption of Climate Friendly Practices in Agriculture.

Barriers to CSA adoption in Ukraine are similar



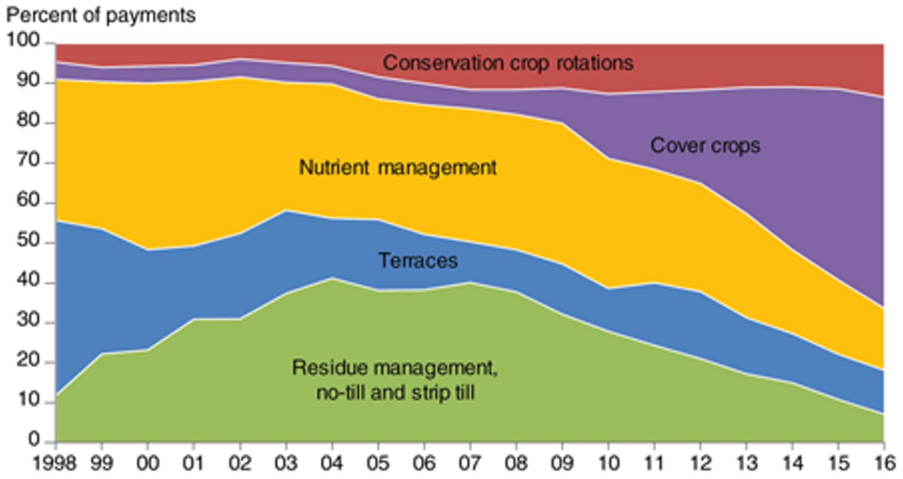
Source: FAO Investment Center (2022 – forthcoming): Digital technologies in the grain sector of Ukraine.

Governments are active in supporting CSA technology adoption

- The governments in OECD and many middle-income countries support adoption of CSA technologies through regulations and public investments
- The United States finances the Environmental Quality Incentives Program
- In the EU, farmers received decoupled and coupled direct payments but must adhere to environmental cross-compliance. They also receive the state support for adoption of agri-environmental measures
- The EU Green Deal will foster green transition through stricter environmental regulations and more public funds for CSA technologies

Public investments to support adoption of green technologies in the USA, 1996-2016

Spending from the Environmental Quality Incentives Program (EQIP) focused on five different crop management practices between 1998 and 2016



Note: Terraces are a structural practice designed to reduce runoff and soil erosion by constructing an earth embankment or ridge that is perpendicular to a field's slope. Between 1998 and 2016, total EQIP payments expanded from $18 million to $840 million.
Source: USDA, Economic Research Service using data from USDA, Natural Resources Conservation Service, EQIP practice suite payments in the United States.

The EU Green Deal

Objectives of the CAP Strategic Plans

1. Climate change mitigation
2. Climate change adaptation
3. Protection or improvement of water quality
4. Greening of farm to fork value chains
5. Prevention of soil degradation
6. Protection of biodiversity
7. Actions for sustainable and reduced use of pesticides
8. Actions to enhance animal welfare or address antimicrobial resistance

→

Targets in Agriculture

- **Reduce by 50% the overall use and risk of chemical pesticides and reduce use by 50% or more hazardous pesticides by 2030**
- **Achieve at least 25% of the EU's agricultural land under organic farming and a significant increase in organic aquaculture by 2030**
- **Reduce sales of antimicrobials for farmed animals and in aquaculture by 50% by 2030**
- **Reduce nutrient losses by at least 50% while ensuring no deterioration in soil fertility; this will reduce the use of fertilizers by at least 20% by 2030**
- **Bring back at least 10% of agricultural area under high-diversity landscape features by 2030.**

Source: EU Commission.

Other global commitments to watch as they will shape regulations, public investments, and market access

Outcomes of the UN COP 26:

- Agriculture was officially recognized, for the first time, as important sector to adopt nature-based solutions to mitigate climate change
- Methane: More than 100 countries agreed to cut emissions of methane, 30% by the end of this decade. The pledge is inclusive of agriculture.
- Negotiators announced a major deal on how to regulate the fast-growing global market in carbon offsets.
- At COP26, governments recognized that soil and nutrient management practices and the optimal use of nutrients lie at the core of climate-resilient, sustainable food production systems and can contribute to global food security. They called for nature-based solutions to mitigate climate change.

Targeted attention of public support

- Research & development to demonstrate and see the local impacts of new innovations such as no till and cover crops and MPV adjustment
- Knowledge transfer (e.g., advisory services)
- Risk sharing (e.g., agricultural insurance and catastrophic events support)
- Infrastructure (e.g., irrigation, agro-meteorology, digital infra)
- Direct farm payments with agri-environmental conditions
- Financing of cross-compliance (good agricultural practices)
- Support to small farms:
  - Small farms face higher costs of accessing finance, knowledge, and technology
  - They require more public support than large farms
  - Many countries have special programs for smaller farms with more public investment support, digitalization, risk management, and knowledge transfer

Farms structure in Ukraine

I. Legally registered commercial enterprises

Private agricultural enterprises

58% of the country's GAO in 2018

State-owned agricultural enterprises

1% of the country's GAO in 2018

Corporate farms

9,892 corporate farms (mainly the successors of the former collective and state farms) each cultivating 1,650 ha of arable land on average and generating almost 50% of GAO in 2018

Individual small-scale commercial farmers

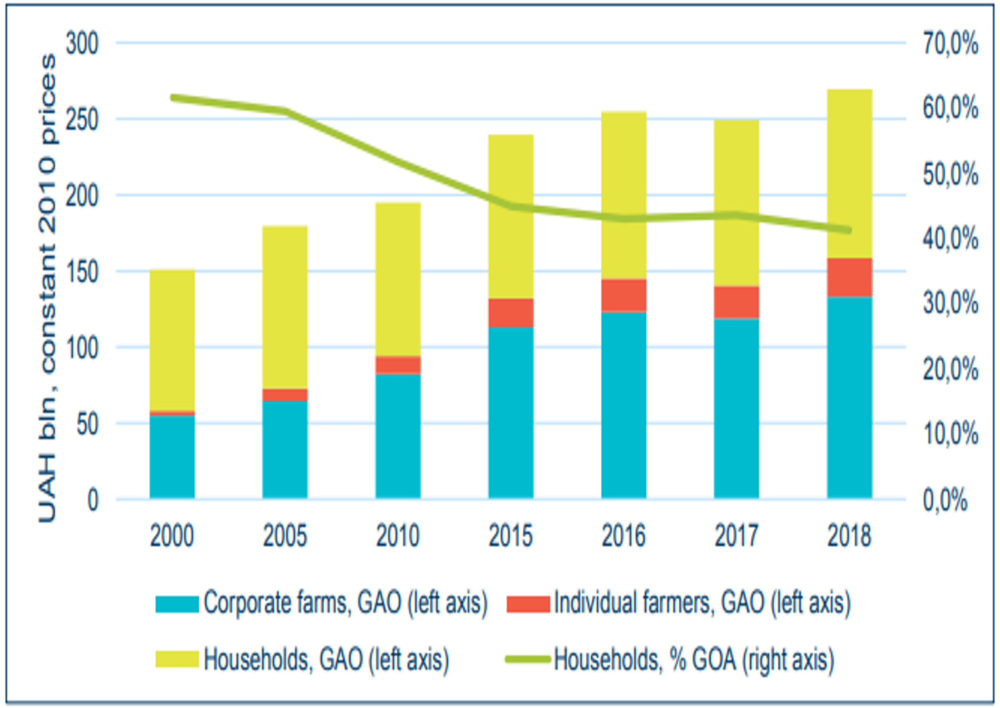
30,441 farmers with an average 105 ha of arable land per farm
altogether cultivating only 13% of Ukraine's arable land and generating 9% of total GAO in 2018

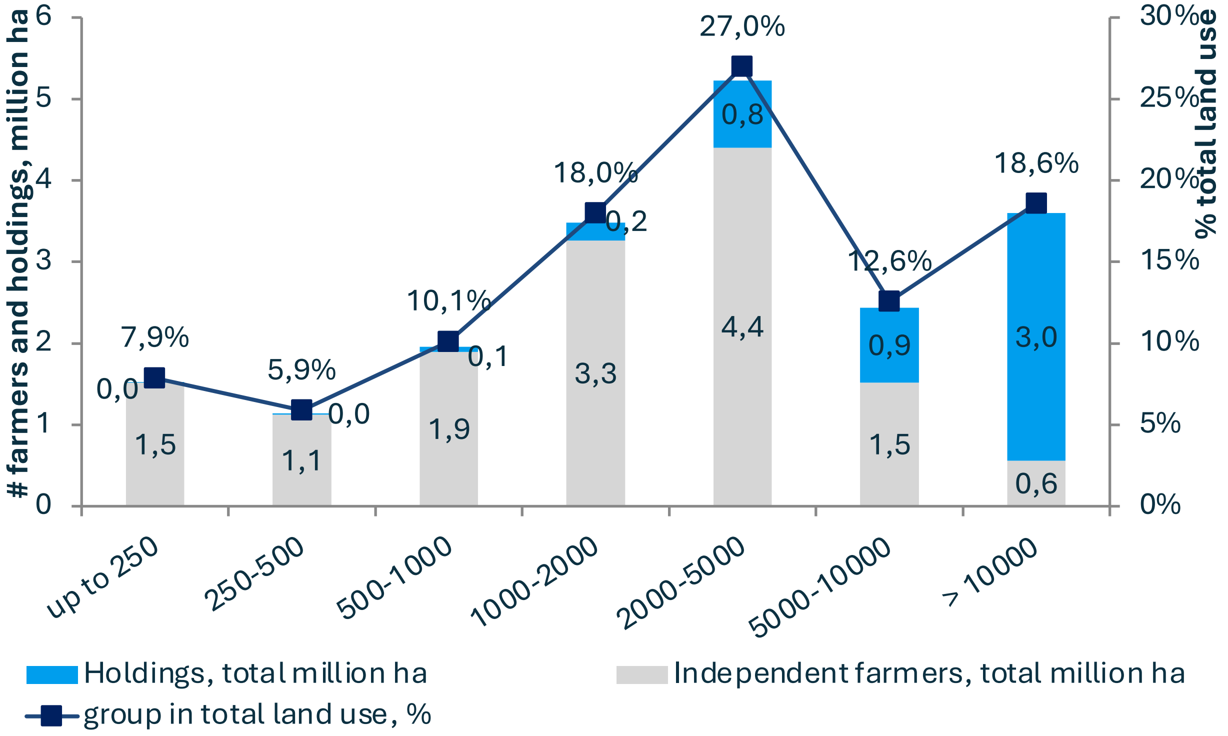
II. Rural households – not legally registered
41% of the country's GAO in 2018

Source: Nivievskyi, O., P. Izvorski, and O. Donchenko (2020): Assessing the role of small farmers and households in agriculture and the rural economy and measures to support their sustainable development. Kyiv School of Economics.

Smaller farms in Ukrainian agriculture

Figure 3 Gross agricultural output (GAO) in Ukraine





Source: Nivievskyi, O., P. Izvorski, and O. Donchenko (2020): Assessing the role of small farmers and households in agriculture and the rural economy and measures to support their sustainable development. Kyiv School of Economics.

6. Current Public Policy and Expenditures in Ukraine for Climate-Smart Agriculture

Initial positive actions for green transition of Ukraine’s agriculture

- **National Economic Strategy 2030** in agriculture section contains harmonization with the EU Green Deal, ecological monitoring, greenhouse gas report, irrigation development, etc.
- More public programs support **agricultural diversification** (horticulture, livestock)
- New **agricultural risk insurance** program supported by the state will be launched in 2022
- New program on **irrigation development** was launched (2021), the draft legislation on water user associations
- More public funds available to **smaller farms** (increase in the number of the direct payment recipients to >55,000 farms in 2021), established maximum limit of 60 million UAH support per farm
- **Partial credit guarantee** (PCG) could increase access to finance for small farms (up to 500 ha), including to finance CSA investments
- Plans to **modernize/digitalize crop receipts system**, which could enable trade in ‘green’ and ‘blue’ carbon credits
- Law and bylaws on **crop rotation** apply in Ukraine
- Government\` s decree on **land conservation** in cultivated, degraded and marginal land plots

Initial positive actions for green transition of Ukraine’s agriculture (contd.)

Currently, under discussion (not submitted to the Parliament): Draft Law “On amendments in some laws of Ukraine on improvement of the state support of agricultural producers”. The amendments include:

- credit subsidies on construction of water purification and waste recycling facilities,
- stimulation of the preservation of the natural environment and the development of renewable energy sources (50% reimbursement on wastewater treatment, emissions into the air, waste management, 50% reimbursement on tech documentation, seeds and planting of bioenergy crops),
- partial reimbursement of purchased drones, GPS systems, autopiloting

The proposed amendments may: (i) increase propensity to wider application of no-till/low-till technologies and (ii) decrease waste

IFC: SECURIZATION FUND WITH Climate smart finance - opportunities in Ukraine

IFC International Finance Corporation WORLD BANK GROUP

Creating Markets, Creating Opportunities

CLIMATE SMART agriculture DEBT platform

Climate smart agriculture builds on IFC innovations in agriculture, ensuring impact across initiatives and bringing more value to investors

ARIA CLIMATE SMART

Offshore fund structure, established in EU jurisdiction

50% Agricultural lending

25% Climate Smart Agricultural lending

25% Irrigation project lending (blue finance)

DIGITAL PLARFORM

Online platform providing the following functions:

- ✓ Farmer application – KYC
- ✓ Big data integrity and credit checks
- ✓ Accounting, monitoring, reporting

DIGITALIZATION: better, faster,

ONSHORE ENTITY

UA financial entity to disburse loans and collect payments

ARIA team is on the ground to support the collection, delivery and other operations of the Fund

CSA AND GREEN: eligibility &

IFC developed the metrics to assess the eligibility of green / blue finance, decarbonization and climate-smart projects.

factors ensuring the Success of the fund

Green and climate smart agriculture finance

In London roadshow investors confirmed high demand for green / blue / climate smart projects. As a result of COP 26, the demand will only grow in the following years.

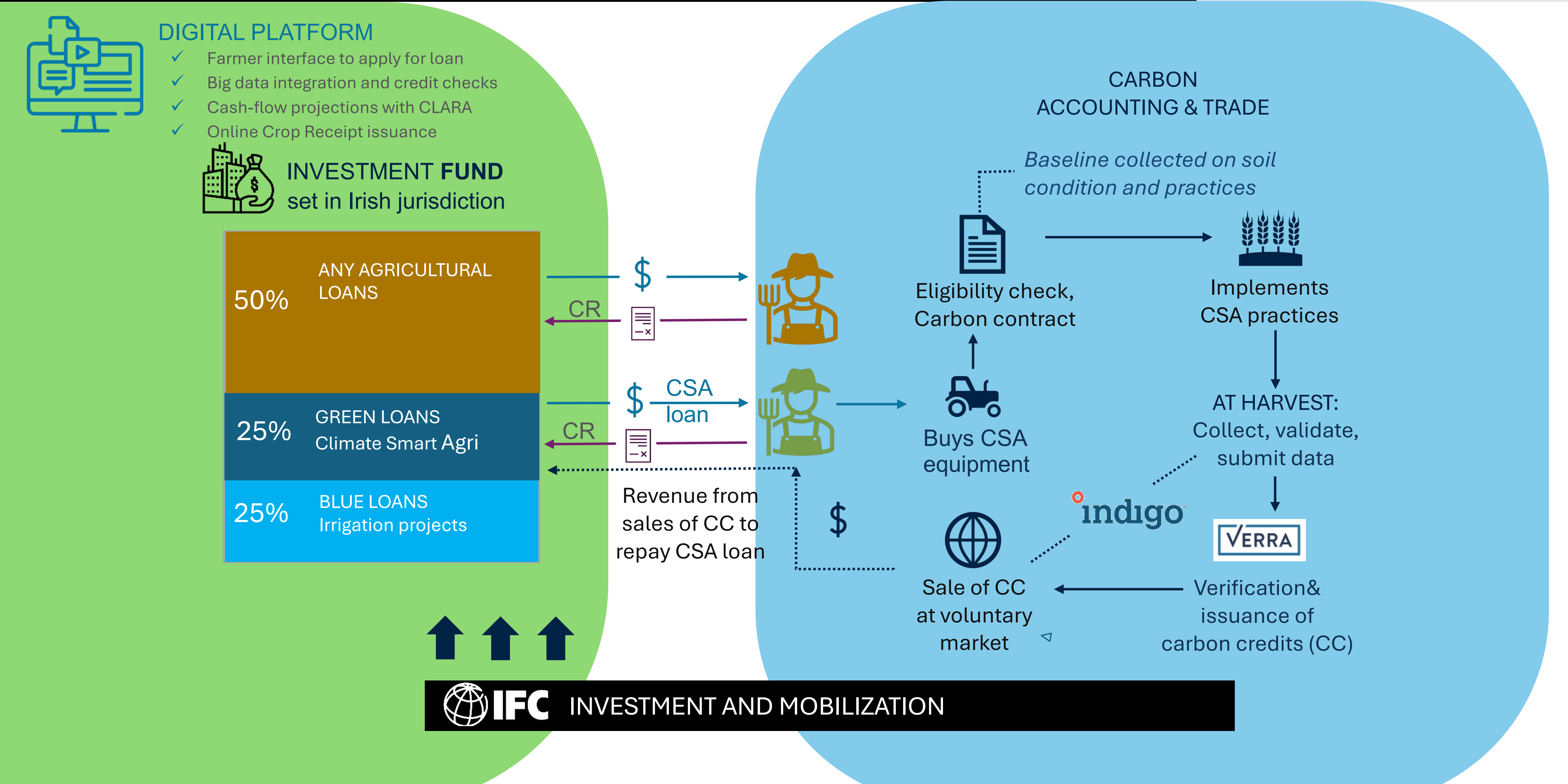
ARIA Commodities – financial arranger & investor

Being experienced in capital markets operations, ARIA will be the financial arranger for the Fund, ARIA will also commit to the Fund as an investor.

USAID – ready to sign in with first loss coverage

In the last meeting USAID confirmed the interest to invest and to provide ≈$5 million of first loss coverage for free.

HOW DOES THE climate agri investment fund WORK?



Need for climate change actions are recognized, but actual plans are missing

The Government of Ukraine recognizes a threat of climate change in many strategic policy documents and the need for action:

  - National Economic Strategy 2030 envisages to achieve climate neutrality by 2060
  - The updated INDC of Ukraine to the Paris Agreement stipulates that by 2030 the GHG emissions should not exceed 35% of their level in 1990

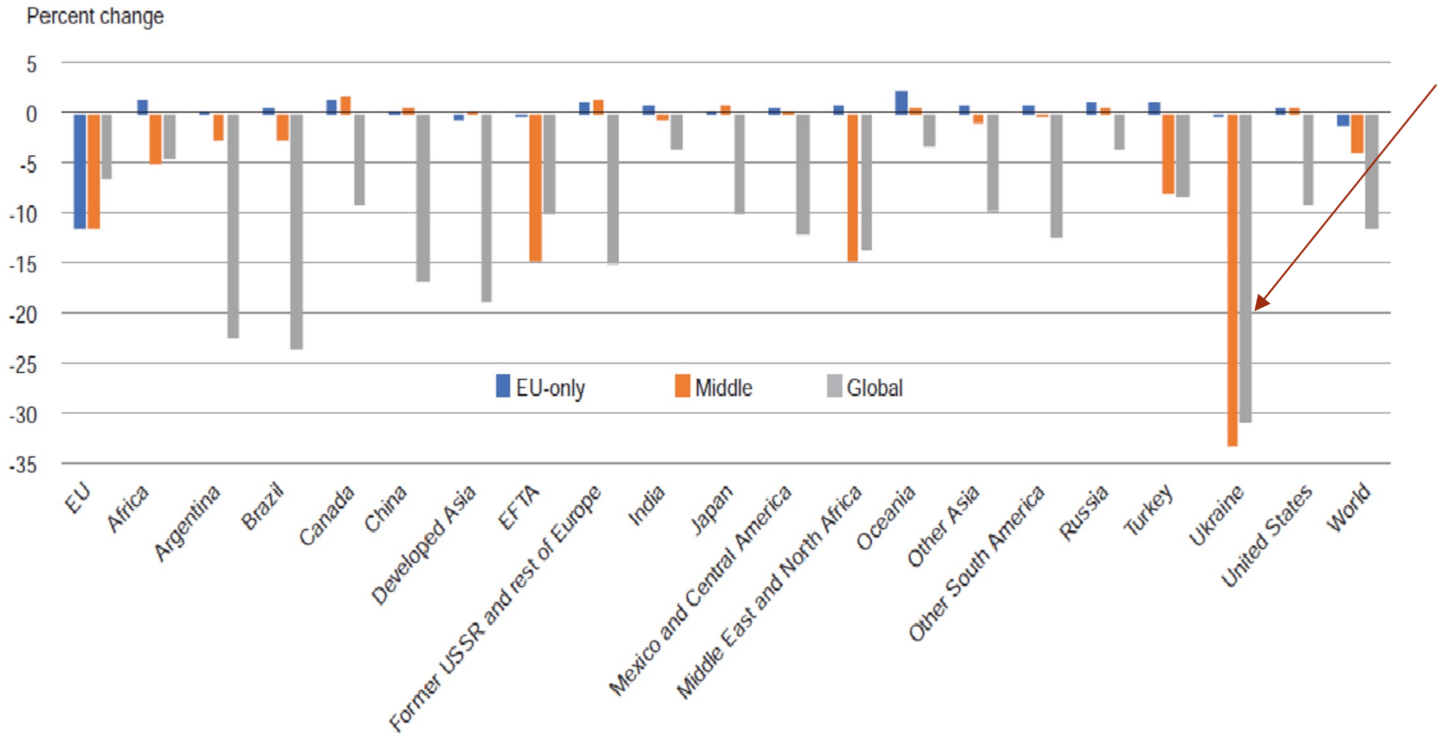
- Mining and energy sectors are prioritized by several decrees, whereas specific actions related to agriculture are not developed yet
- Using agriculture to mitigate climate change is not a priority in INDCs (subject to obtaining grants from other countries)
- Lack of strategic vision for application of CSA to increase energy security (by reducing the use of energy, gas, and oil) and maintain market access for agrifood products to the EU market under the EU Green Deal

Slow green transition could lead to the loss of the EU markets

Ukraine's agrifood export to the EU accounts for >25% of total agrifood export and has been rising

Slow green transition could lead to the loss of the EU markets

Changes in agricultural/food output volumes for the three scenarios

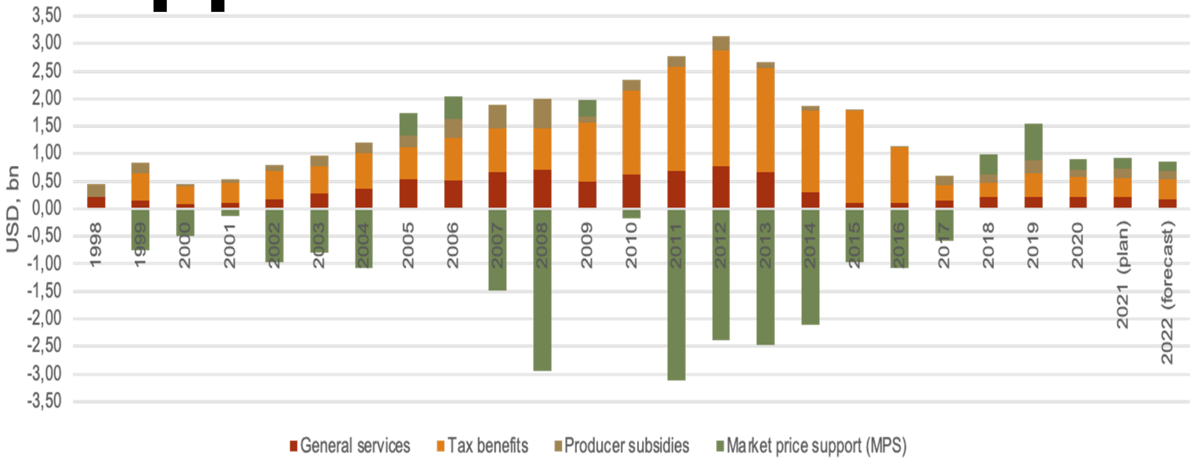


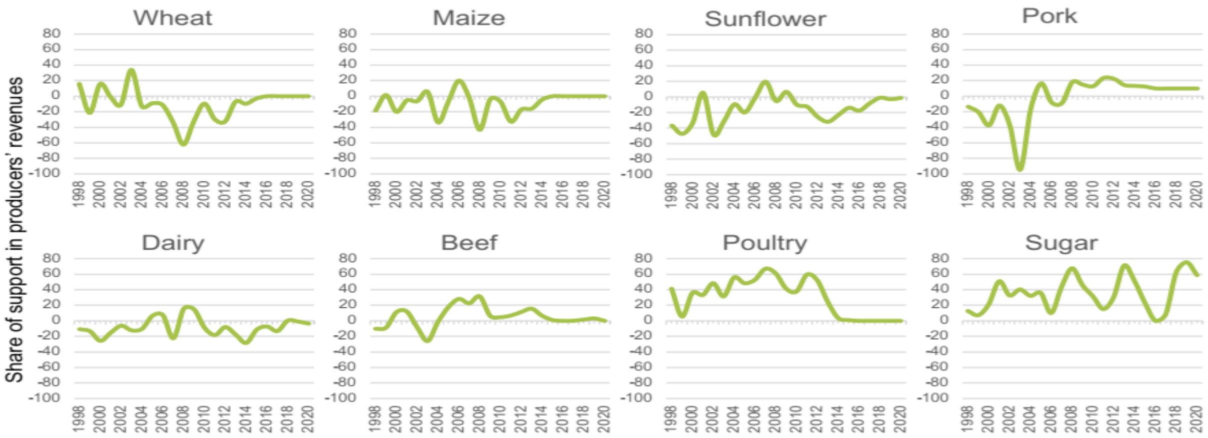
Non-compliance with the EU Green Deal could lead to the loss of the EU market and a very large production decline

Note: EU-only is defined as only the European Union (EU) implementing the Strategies; in the middle scenario, trade partners who depend on food and agricultural exports to the EU also adopt the Strategies; and global is defined as all regions adopting the Strategies. EFTA refers to the European Free Trade Association.

Source: USDA, Economic Research Service calculations using the Global Trade Analysis Project–AgroEcological Zones (GTAP-AEZ model.

Agricultural public expenditures have become more aligned with potential for CSA support





- Taxation of farmgate prices (negative MPS) discontinued after 2018
- Sugar remains the only sub-sector with large MPS (distortion)
- Share of ag public expenditures in GDP is moderate (0.2%)
- Half of the public expenditures are allocated to general support services
- Cap of 60 million UAH of direct payments per farm
- Some direct farm payments indirectly promote CSA

Source: KSE (2021). Agricultural support review Ukraine. Issue 1

Agricultural Public Expenditures

	2018	2019	2020	2021
Direct farm support, billion UAH	3.94	4.94	4.00	4.67
General support services, billion UAH	6.01	5.73	6.03	7.06
Total agricultural support, billion UAH	**9.95**	**10.67**	**10.03**	**11.73**
Total agriculture support in % of GDP	*0.28*	*0.27*	*0.24*	*0.21*
Total agriculture support in % of national budget	*1.00*	*0.98*	*0.79*	*0.81*

Source:
State Statistics Service of Ukraine (2021-2014): Crop production, http://www.ukrstat.gov.ua/
The Parliament of Ukraine (2020-2018): https://zakon.rada.gov.ua/

CSA are not conditions for accessing the agricultural direct payments

	2020	2021	CSA support
Partial reimbursement of the cost of domestically produced ag machinery and equipment	**1,457**	**1,000**	No
Support to agriculture via interest rate subsidy	**1,048**	**1,200**	No
Support for horticulture, viniculture and hops	**292**	**450**	
matching grant for the costs of materials, construction and drip irrigation, machinery and equipment	200	200	Yes
matching grant for the costs of construction and reconstruction of refrigirators, shop floors, purchase of lines	91	250	No
Support for development of individual farms	**135**	**200**	
matching grant for farm expenditures on agricultural advisory services	0.3	15	Yes
subsidy per ha for recently established farms	34	60	No
subsidy for cows (of any production type)	35	100	No
support of the service cooperatives	0.5		No
compensation of social security payments		25	No
Support for development of livestock production and processing	**1,047**	**1,150**	
matching grant for purchase of breeding animals, bees, semen and embroys	300	350	Yes
subsidy for existing bee colonies	240	240	Yes
matching grant for investment in livestock facilities	431	350	No
reinbursement of cost of facilities financed by bank loans	7	60	No
subsidy for doelings, does, ewe lambs, and ewes		50	No
subsidy for increase in the number of cows of own reproduction		100	No
matching grant for investment in silos	69		No
Compensartion of losses from damages to ag crops from natural emergencies		**240**	Yes
Support for niche crops		**50**	No
Support for potato producers		**50**	No
Total	**3,968**	**4,500**	
% of expenditures supporting CSA			***18%***

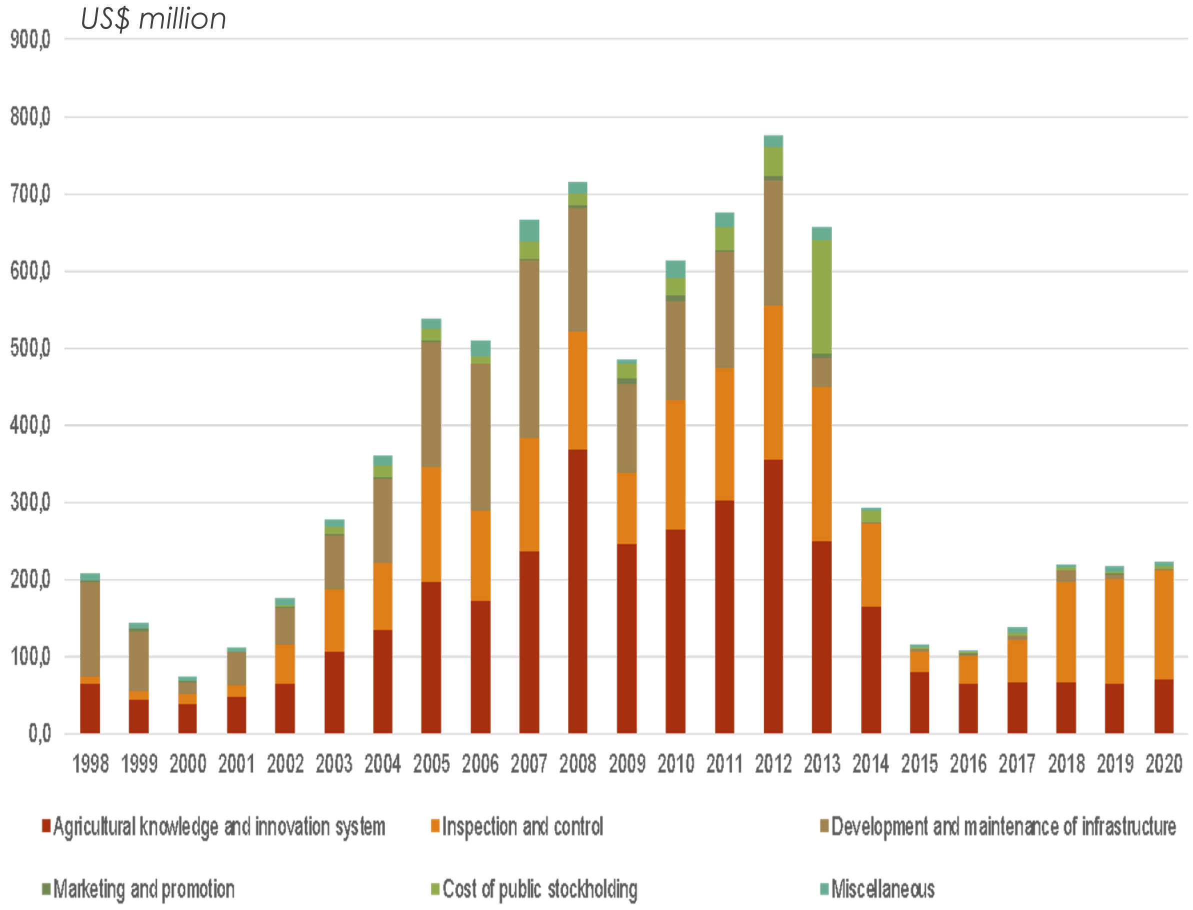
Green and carbon-related requirements are not incorporated in state support programs

Lack of cross-compliance measures:

- Climate and green standards are not the subjects of state support programs in Ukraine yet
- Climate impact assessment is not applied in any selection criteria in state support programs
- Fuel standards are not included in selection criteria in the program of agricultural machinery partial reimbursement
- Livestock and processing support programs criteria do not distinguish recipients in terms of carbon footprint or require manure treatment facilities (biogas) for livestock farms

Source: KSE (2021). Agricultural support review Ukraine. Issue 1

Spending on general support services (GSSE) declined and small

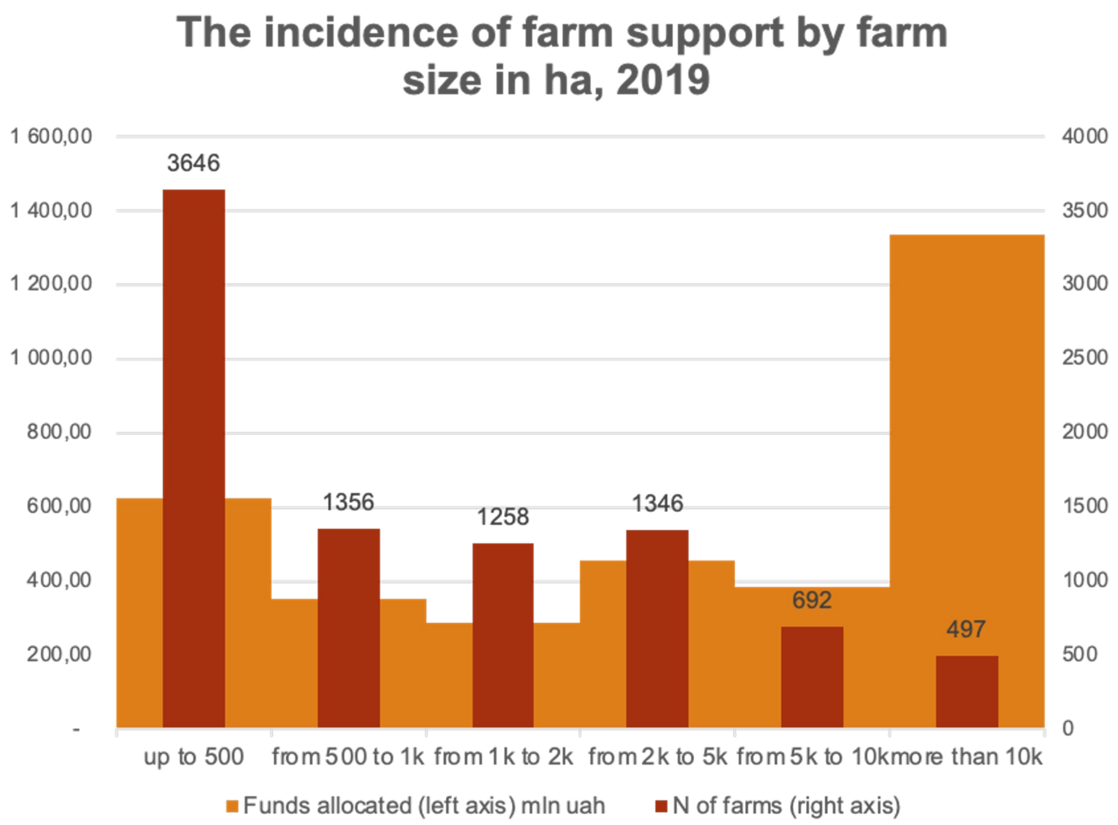


- Expenditures on AKIS dropped significantly
- Most GSSE funds to inspection and controls, but this is even in absence of farm cross-compliance
- Spending on development and maintenance of infrastructure declined substantially

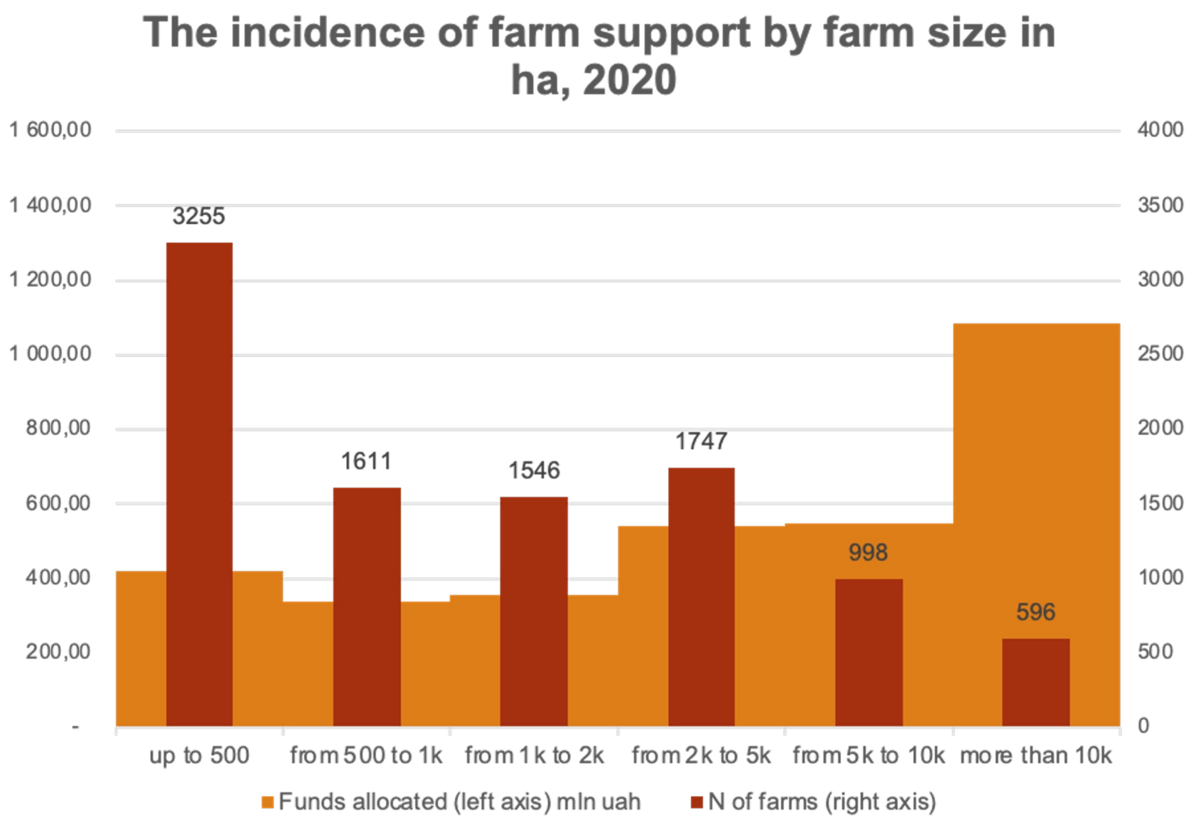
2017	GSSE	GAO	%
OECD	38,868	1,149,626	3.4%
Non-OECD	42,247	1,815,123	2.3%
EU	10,580	434,349	2.4%
USA	33,181	372,716	8.9%
Brazil	2,328	171,042	1.4%
China	34,937	1,396,971	2.5%
Columbia	512	25,590	2.0%
Kazakhstan	285	12,547	2.3%
Philipinnes	1,536	27,214	5.6%
Russia	1,359	77,147	1.8%
South Africa	310	20,844	1.5%
Ukraine	140	28,488	0.5%
Vietnam	554	41,965	1.3%

Source: KSE estimates based on the OECD (2021)

Small farms receive the least state support



N obs. = 8,795 unique farms
Funds = UAH 3,440.7 million



N obs. = 9,753 unique farms
Funds = UAH 3,286 million

Source: KSE estimates based on MAPF and SSSU data.

… for multiple reasons

2020	Null	Individuals and private enterpreneurs	up to 500	from 500 to 1k	from 1k to 2k	from 2k to 5k	from 5k to 10k	more than 10k	TOTAL
N of farms	1,424	-	3,255	1,611	1,546	1,747	998	596	**11,177**
Funds allocated mln UAH	446	296	421	337	355	543	547	1,084	**4,028**
Average per farm, UAH	-	-	129,374	209,067	229,465	310,549	548,322	1,818,076	**367,231**
Share in funds	11%	7%	10%	8%	9%	13%	14%	27%	**100%**
Av size of farm	-	-	226	730	1,433	3,233	6,901	28,026	**3,420**
Average per ha, UAH			1,866,303	461,265	247,618	167,836	79,296	38,663	**1,177,700**

2019	Null	Individuals and private enterpreneurs	up to 500	from 500 to 1k	from 1k to 2k	from 2k to 5k	from 5k to 10k	more than 10k	TOTAL
N of farms	965	-	3,646	1,356	1,258	1,346	692	497	**8,795**
Funds allocated mln UAH	442	640	624	351	288	456	386	1,336	**4,522**
Average per farm, UAH	-	-	171,124	258,909	229,227	338,804	557,391	2,687,299	**463,945**
Share in funds	10%	14%	14%	8%	6%	10%	9%	30%	**100%**
Av size of farm	-	-	203	728	1,421	3,225	6,958	25,457	**2,878**
Average per ha, UAH			3,079,959	482,377	202,898	141,427	55,434	52,464	**1,571,271**

- **Per hectare support to small farms** (> 500 ha), who can receive support, is **the highest**
- In the absence of per ha payments in Ukraine, many reasons could explain the fact of most funds going to large farms:
  - Access to finance
  - Investment prepayment requirement
  - Livestock investments
  - Paperwork and bureaucracy
  - Corruption

Source: KSE estimates based on MAPF and SSSU data.

7. Recommendations for Mainstreaming Climate-Smart Agriculture in Ukraine’s Agricultural Policy

High-level strategic recommendations

1. Design public policy and programs to address the rapidly increasing volatility and uncertainty arisen from climate change
2. While climate adaptation is in farmers' self interest and they would adapt anyway, invest public funds in softening an adaptation lag and enabling adaptation for all farms, while providing a targeted support to small/medium farms
3. Consider climate mitigation as a strategic investment to achieve multiple objectives, such as a new income stream for farmers, enhanced agriculture export competitiveness/market access, and improved energy security, in addition to help achieve Ukraine its commitment to Paris climate agreement
4. Repurpose agricultural public programs to explicitly promote CSA adoption, especially supporting small and medium farms
5. Invest in agricultural research on CSA and facilitate advisory services to transfer CSA knowledge to farmers

Legal/regulatory enabling environment

1. Move from the Strategies to a specific Action Plan on using agriculture for climate, competitiveness, and energy security
2. Enable a carbon market, including through:
   - Establishment of climate standards and harmonization of a carbon footprint compliance with the EU (RED II)
   - Creation of a digital platform for crop receipts that would enable the access to climate finance (by approving the Law #2805-D), and harmonize various state registries (collateral, land cadaster, registry of rights, courts) to further lower the cost for MRV system
   - Harmonization of with international standards for soil laboratories
3. Amend the Law on Pesticides and Agrochemicals to formally recognize the EU conformity list of fertilizer types, per new EU regulations, and remove registration and testing requirements to import the EU-approved fertilizers
4. Create legal environment for irrigation investments (e.g., water user associations, water tariffs, operation & management of the main infrastructure and bulk water delivery)
5. Begin introducing a cross-compliance (good agricultural practices) required for market access, additional voluntary standards (low water, low carbon, decarbonized commodities)

Public Expenditures

1. Increase investment in agricultural research & development on climate change activities – create the CSA research center of excellence in partnership with private sector
2. Increase investments in capacity building of especially smaller farmers related to climate change:
   - More of better-quality advisory services through PPPs
   - Digital solutions (e.g., agro-meteorological information, soil diagnostic)
   - Adaptation of the global MRV tools for small farms to access carbon finance (verifiable tradable credits)
3. Repurpose the direct farm payments: introduce a CSA checklist into selection criteria
4. Increase the level of direct farm payments but only to finance CSA programs
5. Shift more of the state resources from larger to smaller farms, including through matching grant program to invest in adoption of CSA technologies
6. Accelerate an establishment of the Partial Credit Guarantee Fund, the State Agrarian Registry, and pilot a Risk Sharing Facility for increasing the supply of agricultural finance
7. Invest in irrigation/drainage water management infrastructure and support of water user associations