

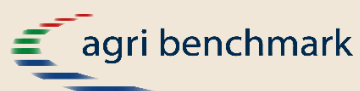


Cash Crop Conference 2023

Nairobi, Kenya

Jointly managed with
Tegemeo Institute of Agricultural Policy &
Development and National Potato Council

Conference Highlights



***agri benchmark* Cash Crop Conference 2023**
Nairobi, Kenya

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Editorial

Dear Friends and Partners,

we herewith would like share with you the key outcomes from our 2023 annual conference, which was held in Nairobi, Kenya. We would like to thank our Kenyan partners from Tegemeo and NPCK for excellent conference preparation and an exciting farm tour.

As you will notice, the topics in this report are rather diverse and cover many different aspects of global crop production. Among others we are looking at land rents, African crop production, sugar beets economics and greenhouse gas emission mitigation policies.

Of course, in this report we present only the key findings and conclusions – if you are interested, we are happy to provide more detailed insights into the individual topics. Just let us know.

We hope you will enjoy reading it.

A handwritten signature in blue ink, appearing to be 'Y/1110' or similar, is centered on the page.

P.S.: We would love to know your views on what we publish here. Please send us an e-mail: catrin.hahn@agribenchmark.net

Global crop production: Skyrocketing profitability in 2022 – and a positive outlook for 2023

Yelto Zimmer

One of the key outcomes from agri benchmark-based analysis is an overview of the profitability of individual crops as well as the overall profitability of crop production in different countries or regions. Furthermore, we use future market prices as of June 2024 to assess the likely economic outcomes from the 2023 cropping season.

After a strong increase in 2021, we observed another boost for farm gate prices in 2022 in most of our typical farms. Of course, there is some variation among regions and crops: Across all the European farms in our database, compared with 2021, wheat prices rose by about 20% or 44 USD/t. However, typical farms in North and South America as well as in Australia experienced an increase of only about 14% or 28 USD/t.

In global corn production, the increase was +16%. This figure does not include Ukrainian farms, which suffered very badly from the implications of the Russian war: Farm gate prices for corn were as low as 70 USD/t – almost 60% less than in 2021.

In soybeans, the increase was a little less percentagewise (+11% or more than 50 USD/t). Again, in the Ukraine, we saw a picture similar to that in corn: Prices dropped by 300 USD/t to 200 USD/t.

The poorest price improvement was observed in rapeseed: +3% or 18 USD/t. However, the initial values in 2021 were very high, with prices of more than 600 USD/t.

Bottom line

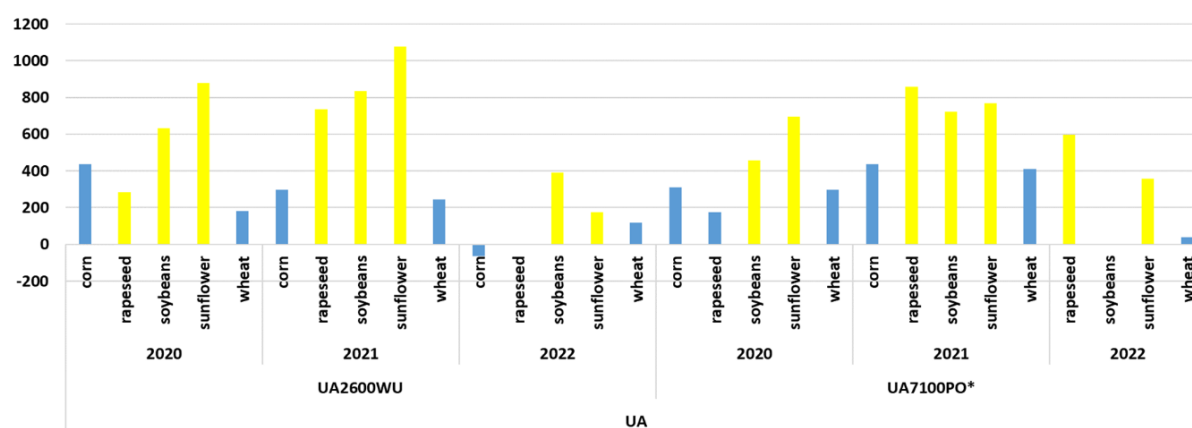
Of course, these improvements on the revenue side were partially offset by a respective increase in input cost, in particular in nitrogen prices (+135% vs. 2021), which were driven by the steep increase in energy prices. But some other key input prices also went up. In particular, plant protection products increased fairly steeply in the USA. For example, in soybeans, those costs rose by about 50%.

Considering the entire spectrum of crops produced in the various typical farms across the globe, the vast majority were able to grow their profitability. When using the return to land (gross revenue minus total cost, excluding land cost) as the relevant parameter, our European typical farms on average improved their return to land by about 24% or 75 USD/ha. Compared with 2021, our typical farms in Brazil, Argentina, Australia, USA and Canada were able to boost their return to land by 21% or 30 USD/ha.

Ukraine – the new oilseed country?

The only important exception to this rather bright picture, of course, is Ukraine. Here, return to land figures went south by about 60%, to 200 USD/ha, which however is still not too bad compared with pre-boom (2018 to 2020) levels. Interestingly enough, the key driver for this relatively positive picture were oilseeds in general. In Figure 1 we present a comparison of return to land figures for different crops of our Ukrainian typical farms. It can be seen that over a period of three years, on average, oilseeds outcompeted grains by a margin of about 100%.

Figure 1: Return to land for oilseeds vs. grains at typical Ukrainian farms (in USD/ha)



Source: agri benchmark Cash Crop 2023

While grains generated an average return to land of 230 USD/ha, in oilseeds the respective value was 530 USD/ha. Under the conditions of war times, this advantage became more pronounced due to (a) lower fertilizer cost – at least in soybeans and sunflowers and (b) lower logistics cost per hectare due to lower yield levels. In view of the already existing trend of strong economic performance of oilseeds, we conclude that in future years they will become even more pronounced as the economic backbone of Ukrainian crop production.

2023 – Yet another profitable year for crop producers?

At the end of 2022 and in 2023 we saw both shrinking output prices – albeit coming from extreme heights in 2021 – and lower input prices as well. Hence the question: How this new set of relative prices will impact overall profitability of crop production. In order to get an impression, we used average CBOT future prices for 9/23, 12/23 and 5/24 in wheat and corn to create an expected revenue for the 2023 harvest. With regard to fertilizer cost, we used average world market prices from 9/22 to 3/23 to create an estimate. The outcome from this exercise: wheat prices of 230 USD/t and corn prices of 200 USDD/t. Furthermore, we assumed that all other input prices have been unchanged compared with 2021; we calculated a simple three-year average for yields.

The result of this exercise: Overall profitability goes drop for these two crops because the reduction in cost was not strong enough to compensate for lower revenue. However, for most of our typical farms, the profitability will still be significantly higher when compared to the pre-boom phase of 2018 to 2020. In corn, the return to land will be around 200 USD/ha higher; in wheat, the gap is even greater, with values of 350 to more than 600 USD/ha. So, provided normal yield levels have been realized, it is very likely that 2023 will be a yet another rather successful crop year for most crop producers in the world. As regards European crop producers, one has to consider that European futures markets have been much higher than the CBOT: A comparable wheat price projection is 40 USD/t higher than based on CBOT; in corn the advantage is 35 USD/t. This implies that one has to assume that European producers will be much better off in 2023 than their overseas peers. Of course, one major exception from this rule is Ukraine.

Main outcomes

- Economically, 2022 was a very successful year for global crop producers. Rising input costs have been by far overcompensated by high commodity prices.
- The outlook for 2023 results is less bright than in 2022 but still well above previous years in many cases.
- Crop production conditions in Ukraine – enhanced by the implications of the war – very much favor oilseeds.



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The return of sugar beets as the cash cow in arable farming

Thomas de Witte

In 2022, sugar beet regained its position as the cash cow of the field crops in many regions, at least temporarily. The main driver for this is the development of EU sugar prices, which have risen from 450 €/t in May 2022 to over 812 €/t in May 2023. How long the increased profitability of beet cultivation will last depends on whether and to what extent EU beet cultivation is expanded again. The agri benchmark partners suspect that this could happen, especially in France, as the factories there are not working at full capacity.

Decline in EU sugar beet production in recent years

Since the 2017/18 sugar marketing year, beet acreage in Europe has declined by almost 15%. The main driver of this development was the EU sugar market crisis in 2018 and 2019. Furthermore, climatic conditions and new agronomic challenges have significantly increased the risk of beet production compared with other crops. Due to drought events and an increased occurrence of yellow viruses after the ban on neonicotinoid seed dressings as well as the new disease Syndrome Basse Richesse (SBR), there have been significant yield losses in recent years, especially in the southern growing regions of France, southwest Germany and England. In Austria, several thousand hectares of beet fields had to be replanted due to damage caused by the incidence of the beet weevil. As a result, farmers in these regions have cut down beet acreage.

Another drought in the 2022 growing season

In the 2022 crop season, drought events again led to yield losses in the important growing regions. The national average yields in France, Germany, England and Austria were 10% to 20% below the five-year average of the previous years. Average yields were achieved only in Poland, the Netherlands and Scandinavia. However, the resulting tight sugar supply, combined with increased sugar prices on the world market, led to sugar prices of over 800 €/t in the EU.

Increased profitability of sugar beets on typical farms

In contrast to the national averages, the beet yields of the typical *agri benchmark* farms were predominantly at the average level for the years 2017 to 2021. The farm in the Magdeburger Börde was particularly affected by the drought. Here, the sugar yield was 20% below the five-year average. Sugar yields on typical farms in the Köln-Aachener Bucht (DE250KAB), the Bayerisches Gäu (DE120BG) and in Szczecin (PL2100ST) were also 5% to 10% below the multi-annual average. Since 2010, the typical farms in the Magdeburger Börde (DE1500MB) and Stargard (PL2100ST) continue to show average annual yield increases of 1.2% and 2.3%, respectively. For the farm in Picardy (FR230PICB), on the other hand, yields fell by an average of 1.1% per year over the same period. This indicates why French beet acreage has declined since the EU sugar market reform came into force.

In 2022, higher sugar beet prices had a much greater impact on the profitability of sugar beets than yield changes. On most farms, beet prices were above 50€/t and, in the case of the typical

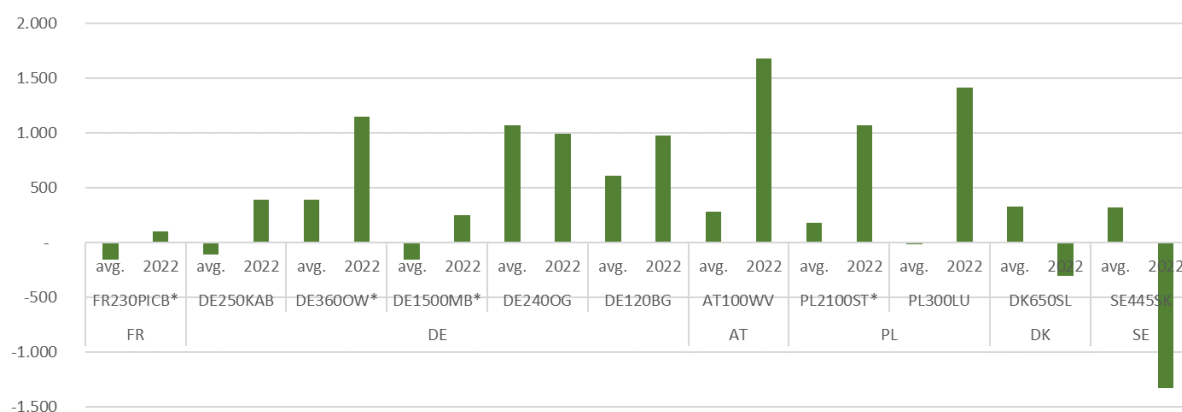
farm from Austria (AT100WV), reached a peak of over 66 €/t. Compared with the five-year average, beet prices have thus increased by 60% to 100%. Beet prices on the Scandinavian farms (DK650SL and SE445SK) were significantly lower, at 37 and 32 €/t respectively. The reason for this is that the farmers mainly chose a price model with a fixed beet price and thus did not benefit from the price increase on the sugar markets.

However, direct costs per hectare also increased by 40% on average. On some farms (PL2100ST, DK650SL) there was even a 60% increase in direct costs. The main driver is higher nitrogen costs, which have more than doubled compared with the five-year average. But also, the costs for phosphate and potassium have increased by 30% to 60% for the typical farms. In contrast, cost increases of about 10% for herbicides and seeds are less significant.

However, the higher beet prices more than made up for the increased costs. The gross margins on most farms were between 2,000 and 3,000 €/ha. Only on the Scandinavian farms (DK650SL and SE445SK) and the farm in the Magdeburger Börde (DE1500MB) the gross margins were below 1,500 €/ha due to the lower beet prices and yields.

Due to the high sugar beet prices, the on-farm competitiveness of beet cultivation has increased significantly again. The gross margins generated in sugar beet were, on average, about 500 €/ha above those of wheat cultivation (cf. Figure 1). However, the gross margin advantage of sugar beets varies among the farms and ranges from 100 €/ha (FR230PICB) to about 1,000 €/ha on some German farms as well as the Austrian and Polish farm.

Figure 1: Gross margin differences: sugar beets vs. wheat (2022 vs. Ø 2017-2021 in €/ha)¹



Source: *agri benchmark* Cash Crop 2023

Uncertainty about the future development

In principle, the high profitability of sugar beet cultivation should incentivize farmers to expand their beet acreage again. However, it is difficult to assess whether this will happen, as the above-mentioned agronomic challenges in beet production remain. The *agri benchmark*

¹ The farm names have to be read like this: letter code in the front: country of origin, figure: size of the farm in ha; letter code at the end indicate the region (e.g. MB stands for Magedburger Börde).

partners see the greatest potential to expand beet acreage in the short term in France, where many factories are not working at full capacity.

Climate change reduces the value of sugar beets before another crop

If sugar prices drop again in the future, the value of sugar beets as a crop preceding other cash crops will become more important again for farmers' growing decisions. In many growing regions of Western Europe, wheat yields after sugar beet were generally higher than from stubble wheat as summer precipitation was able to compensate the higher water demand of beets. In the light of climate change, however, the *agri benchmark* partners are increasingly observing yield disadvantages of beet wheat compared with other preceding crops due to increasing drought events. This is likely to negatively impact the preceding crop value of sugar beets in the future.



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Land rents – still connected to return to land?

Jannik Aaron Dresemann

For several years – if not decades – rising land rents and land costs have been monitored all around the globe. At the same time, there is increasing discussion about investors from outside the agricultural sector being blamed for outcompeting agricultural entrepreneurs on land markets. Thus, there is the fear of farmland prices being increasingly disconnected from the return to land that can be generated from growers by producing and selling crops. In general, the return to land describes the remuneration of the production factor land and is calculated by subtracting the total cost, excluding land cost, from the revenue.

We took this trend as a motivation to put a light on (a) the methodology of how land rents and prices are calculated in the TYPICROP model, (b) analysis of historic trends, and (c) recent developments in land markets for different regions based on our data. The international group of experts attending the workshop also enabled us to create land-market spotlights from all relevant production regions.

Methodology of *agri benchmark* for land rents & prices

Since we distinguish between rent for old contracts and rent for new contracts, the figure for rented land used to calculate average farm level land rent cost is calculated as a weighted average of both numbers based on the contract duration – e.g., the weighted average for a 12-year contract is based on 11 years times the old land rent and one year taking the new land rent into account. Further, the rent for new contracts in arable land is considered as opportunity costs for the owned arable land. Hence, the total land rent cost is calculated based on the land rent times the share of rented land and opportunity costs times the share of owned land.

agri benchmark land cost & land rent data

To understand short- and mid-term developments of land markets, it is crucial to know about the types of land rent contracts in different regions of the world. This paragraph condenses the different contract types for different regions. In the Americas, the traditional crop-share lease is meant to reflect how income, expenses, and risk are shared between the tenant farmer and the landlord. The sharing levels should be determined by each party's contributions to the business.

In a fixed cash rent, the cash tenant pays the landlord a fixed amount, usually part in advance, for the use of farm real estate, and receives all of the resulting production. The tenant pays all costs of production and thus assumes all production risks (drought, insect, hail, etc.) and all price risks. In an indexed cash lease, the lease is indexed to a pre-determined parameter and changes each year. In a flexible cash lease, the tenant and landowner agree to set their cash rental rates based on figures such as prices or yields.

In North America, different short-term (1-2 years) types of crop share and cash rents are common. Surprisingly, about 50% of the land rent contracts in the Corn Belt are still based on

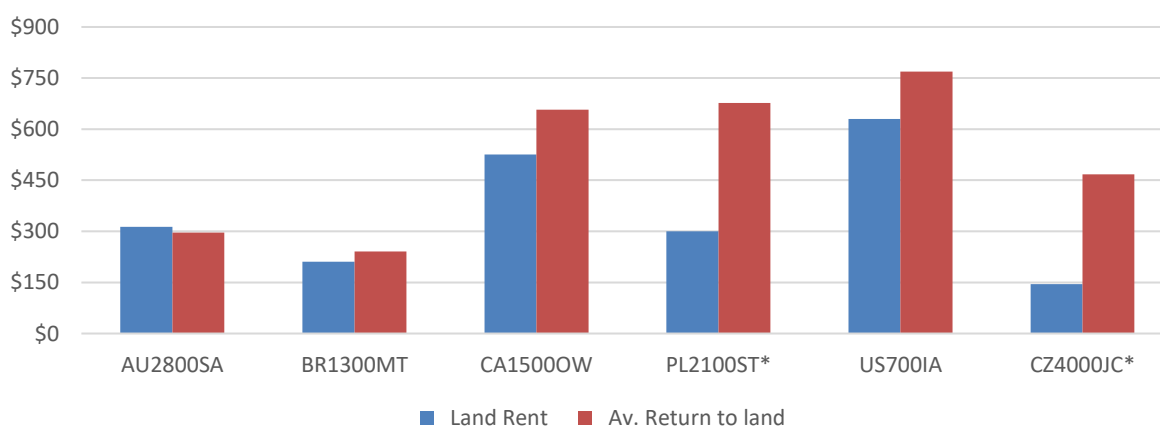
handshake agreements. The flexible, yearly land rent contracts based on current conditions such as share of yield are widely applied in Brazil, too. In Australia, short-term (around three years) land rent contracts are characteristic. Contrary to these regions, mainly relying on short-term land rent contracts, the European Union is characterized by long-term, fixed rental rates of 5-10 years.

Our data show substantial differences among the regions, with more than 600 USD/ha between Australian and German land rents, but no clear overall up- or downward trend over the past 10-12 years on a USD basis. However, the lease prices per ton are fairly similar, reflecting the 6-8t/ha difference in yield expectations depending on the region. Since different countries experience different evolutions of their exchange rates to the USD, this finding needs to be considered with some care. Nonetheless, the comparison of land costs and return to land for different typical farms in the past years provides a clearer picture on mid-term developments.

Figure 1 shows the weighted average of the return to land based on crop acreage compared with the land rent between 2016 and 2022. In almost all farms, the return to land at farm level covers landlords' expectations for land rents. Hence, in most cases the land rent still seems to be connected to the return to land. Hypothesis for the exception: South Australian mid-term return to land is heavily downgraded by two major droughts in the analyzed years.

The leading-edge farms achieve a return to land level that is 300 USD/ha above the land rent – which seems to be extremely profitable considering that only a portion of the land has to be leased. Decoupled payments for the respective regions are included in all calculations, since they can be seen as one driver for land rent levels.

Figure 1: Average return to land vs. land rent 2016-2022 [USD/ha]²



Source: *agri benchmark* Cash Crop 2023

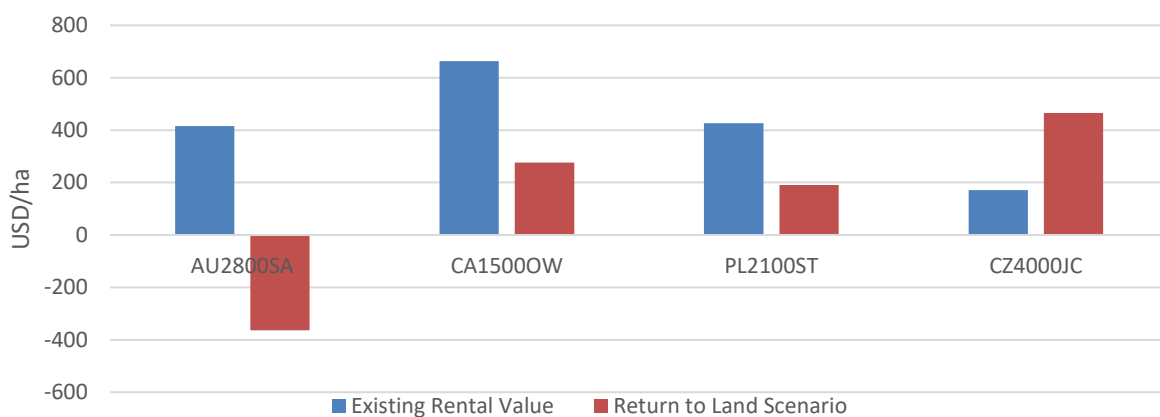
The last years, determined by the disruption caused by the Covid-19 pandemic and the Russian invasion of Ukraine, show a mixed picture in the different regions and years. The volatile

² The farm names have to be read like this: letter code in the front: country of origin, figure: size of the farm in ha; letter code at the end indicated the region (e.g. MT stands for Mato Grosso; IA for Iowa).

market conditions caused highly diverse profit margins – e.g., Australia saw a very profitable season in 2021 but a significant drop in 2022. However, most farms took advantage of these conditions. Also, the very high margins of recent years have played a significant role in ensuring that land costs are covered in almost all regions in the medium term.

The question is, will land rents rise further if there is no disruption? The answer was approached using a scenario calculation estimating wheat's 2023 return to land in comparison to the 2022 land rents for a selection of typical farms. In this case all selected farms grow a significant share of wheat and, thus, wheat is taken as a proxy for the overall farm situation. To reflect 2023 season prices, fertilizer prices were adapted to the prices in the pre-purchase timeslots, pesticide costs were increased by 16%, and diesel cost was increased by 20%. The yield level referred to a five-year average and for prices futures prices were used.

Figure 2: Existing rental rates vs. forecasted return to land [USD/ha wheat]



Source: *agri benchmark* Cash Crop 2023

The scenario indicates a significant gap between land rents and return to land for wheat in the 2023 crop year on most farms. This primarily will be attributable to grain prices, which have skyrocketed in recent years, more than offsetting increased input costs, but have fallen significantly since 2022 – e.g., wheat had highs of over 400 USD/ton and has fallen back to around 200 USD/ton. The 2023 update will show if and how fast land rents in the regions with short-term leases will follow this development.

Land market spotlights

In a roundtable discussion, all partners equally reported on long-term rises in land costs for their region, fearing a growing disconnection between the land value and the earning capacity from that land. Reasons were, for example, external investors adding land to their portfolio and thus having a significant impact on land costs in the area, or other industries converting agricultural land into industrial real estate. In the Magdeburger-Boerde region, an industrial park was to be created for a company from the computer chip industry. A consolidated area of 400 hectares was needed. The prices offered by the authority for the land had a substantial impact on the regional land market, causing a significant disconnection between earning capacity and land prices in the entire region. A second example is the solar industry, not only

in Europe but also in North America. Solar power plants are increasingly competing with producers for agricultural land, generating margins that can be achieved only in specialty crops, if at all. As a result, rental rates well in excess of 1,000 USD/ha per year are the norm.

Other hypotheses for rising land rents which were not part of the workshop are:

- (1) Farmers tend to rely on gross margin calculations instead of total costs as long as machinery and labor are available.
- (2) Farmers want to spread the fixed costs of machines as far as possible over their utilization threshold. Higher prices are accepted in order to avoid having to bear disproportionately high expenses for fixed costs when leases expire.
- (3) At least in Germany, tax law can be one driver. Income from land sales is discounted when reinvesting in land and thus higher prices are paid as long as these are covered by the tax concession.
- (4) Due to the EU nitrate directive, application of organic fertilizers is restricted in a lot of EU member states. Hence, in livestock intensive regions (e.g., North-West Germany) the distribution capacity for organic fertilizers drives land rent prices, which get cross-subsidized by the livestock revenue.

Main outcomes

- Highly diverse types of land rent contracts worldwide.
- Large absolute differences between land rents but comparable on an output basis – EU subsidies are one driver.
- Expected decline for 2023 in the substantial increases in return to land seen in recent years; the question is how land markets will react to this.
- Examples of the disconnection between land value and earning capacity in all cropping regions – additional external drivers.



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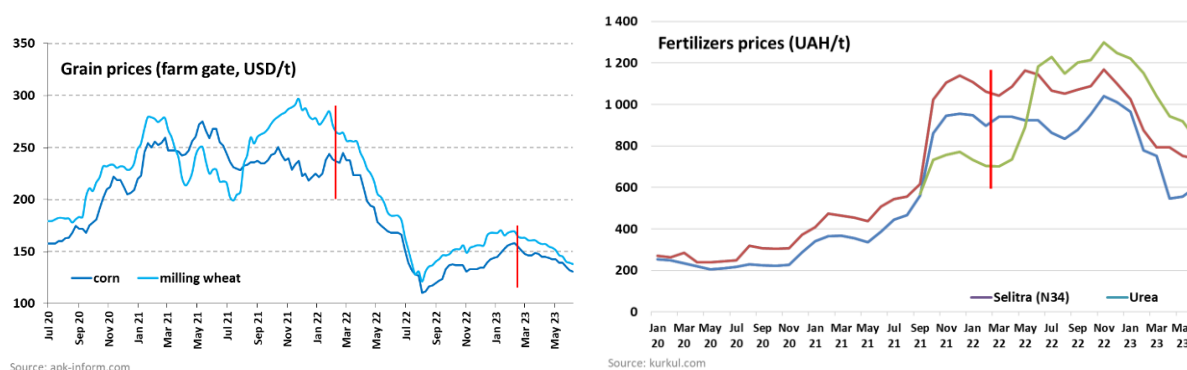
Cash crop production in Ukraine during the war: Is there the light at the end of the tunnel?

Andriy Tovstopyat

For more than 1.5 years, the agricultural market of Ukraine has been under extreme stress. All players at all levels were badly impacted by the war, including small- and large-scale farmers, input suppliers, traders, local processors, and the entire agricultural infrastructure. Yet, under hard circumstances, Ukrainian farmers managed to sow, take care of and harvest crops sufficient for local needs and moderate exports.

Farmers are facing two negative trends: Input prices continuously rise, while farm-gate prices are significantly lower than at the corresponding markets of international counterparts.

Figure 1: Price scissors for Ukrainian farmers



The state of war caused a number of drawbacks for Ukrainian farmers; namely:

- High prices and shortage of key inputs, including fertilizers and plant protection chemicals. This has led to decreased usage of these products and, as a result, decreased yields.
- Diesel supply in 2022 was challenging; in 2023 this issue was not that harsh apart from constantly rising prices.
- Availability of seeds was the least affected. The vast majority of seed is produced locally and stocks from previous seasons were available for use.
- Up to 16% of Ukraine's territory is now occupied, making it not possible to produce any agricultural products there.
- Those de-occupied lands in many cases need demining, which will take a lot of time; meanwhile this land is abandoned.

Low or negative profitability in grain production in the past two seasons resulted in changes in crop rotation toward higher margin crops, such as sunflowers and soybeans. Wheat usually was substituted by sunflowers – the price ratio for these two crops stayed in favor of sunflower around its usual level of 2.2. In the "corn – soybeans" pair of crops, which can be substituted on the same land, the price ratio changed from the usual level of 2.2 to 3.3, meaning that farmers had a strong economic incentive to grow more soy instead of corn. One of the key drivers of the improved on-farm competitiveness of soybeans is high transport cost: While

corn is a bulky, low-price product, soybeans are (at least in relative terms) high priced. Hence, the impact from higher logistic costs are much more important to corn than to soybeans.

At the same time, on-farm competitiveness of crops also is affected by the different impact of input cost increases, especially as far as nitrogen is concerned., given that corn requires a lot of nitrogen and soybeans need only a small amount of this input. This – in addition to the improved price ratio – causes an increase in on-farm competitiveness of soybeans. A respective analysis of *agri benchmark* farm data for typical Ukrainian farms can be found in Figure 1 in the article "Global crop production..." in this report. The key message: For Ukrainian producers, oilseeds have been and are increasingly more profitable than grain products.

Agriculture infrastructure is key – but often badly impacted

Some elements of agriculture sectors were hit particularly badly. For instance, in the regions close to the front lines and around seaports, a lot of critical infrastructure has been destroyed. Grain storage facilities, warehouses, food processing plants, roads, bridges, railroads, stations, seaport terminals, locomotives and rolling stock, fuel depots and machinery repairing stations, used to be powerful supports to agriculture; now the logistic chain is fragmented and cannot operate cohesively.

The ability to export grain, oilseeds and seed-oils is absolutely crucial for Ukrainian farmers, being a key source of income (and – what is very important – foreign currency income). In this regard, the possibility to export agricultural products during the so called "Grain Corridor" agreement was a big relief for Ukrainian farmers and traders. After termination of the agreement in September 2023 by the Russian side, Ukrainian authorities and military forces made a lot of efforts to rebound grain exports. In October 2023, Ukraine was able to export by sea around 1 million tons of agricultural goods versus around 4 million tons a month during the Grain Deal. Twenty five percent of the previous volume is still small, but there is hope that exports will gain momentum in the coming months.

Main outcomes

- Production of key crops dropped drastically, especially against the background of the record-high production figures of 2021.
- Disrupted exports from Ukraine lead to a shortage in global supply and thereby cause an increase of commodity prices worldwide.
- Input prices remain high; also there is high dependence on imported inputs.
- Disparity in crop prices and individual crop profitability leads to the shift from grains to oilseeds.
- Demining of the fields will take years.



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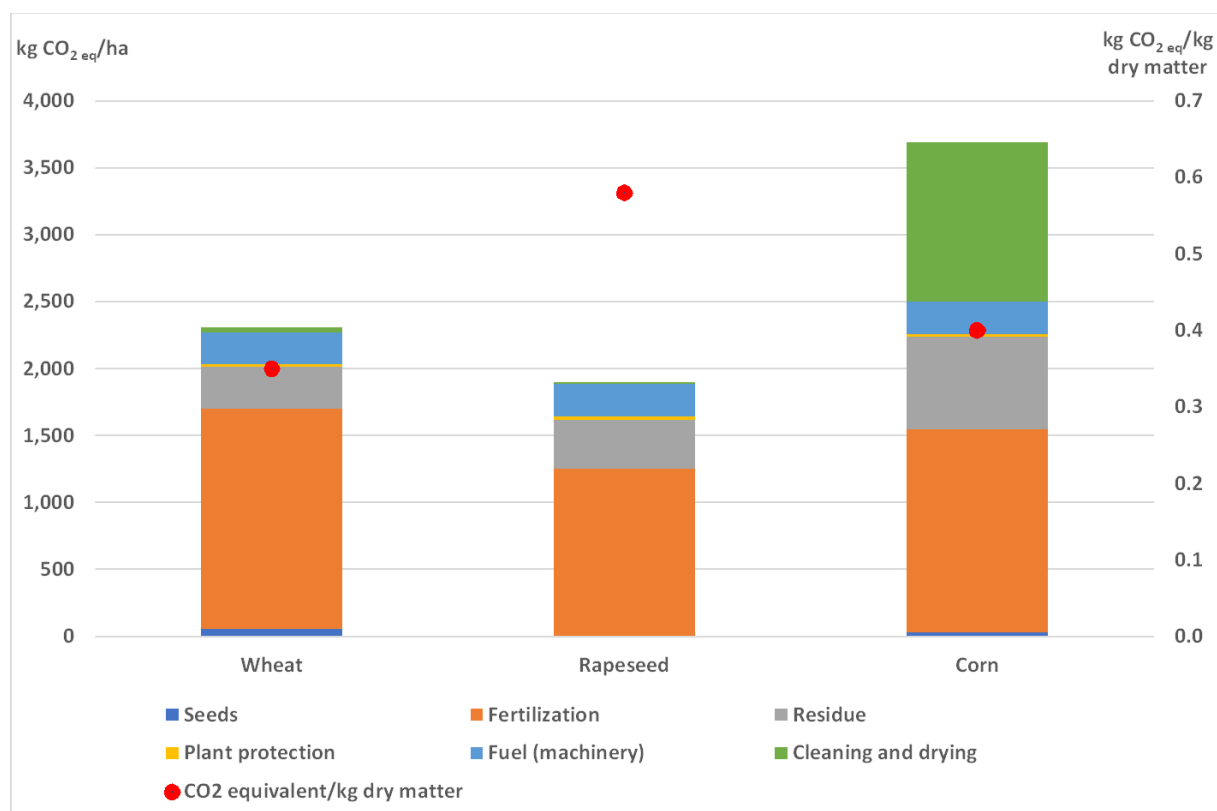
International comparison of greenhouse gas emission mitigation policies in crop production

Friedrich Wüstemann

Many countries have set climate protection targets and plan to drastically reduce their greenhouse gas emissions (GHG) in the coming decades. Therefore, at least in the long run, emissions from arable farming must be reduced to reach the overall goal of no net emissions.

Figure 1 shows the emissions of selected crops in Germany. In contrast to climate reporting, not only field emissions but also upstream chain emissions are taken into account. As you can see, fertilization is the largest source of GHG emissions in crop farming. On top, drying of corn causes high emissions under German climate conditions. The share of emissions from crop residues and fuel is relevant, but much smaller. So, these emission sources are possible starting points to reduce emissions. To find out how different countries try to reduce GHG emissions from arable farming, *agri benchmark* conducted a project. The aim was to provide an overview of climate policies with impact on arable farming in Australia, Brazil, Canada, France, Germany and USA. The aim was to get an insight into what policies are planned or implemented to reduce emissions in arable farming.

Figure 1: CO₂ Emissions of selected crops in Germany



Source: Own illustration based on data from the Bavarian State Research Center for Agriculture

Methodology

A questionnaire was prepared that asked some qualitative questions on climate protection policies with their impact on arable farming. This questionnaire was sent to selected experts to answer these questions for their respective country. The responses were then compared and summarized to answer the following questions:

- (1) What measures are implemented or under development to reduce emissions from arable farming?
- (2) What differences exist among the countries?
- (3) What impacts on arable farming/crop rotations are seen?
- (4) Which farm types are affected most?

Overview of policies and measures in the different countries

For this overview, we considered not only measures that have a direct impact on crop farming (e.g., new fertilization rules), but also measures with indirect effects such as fuel taxes. The following measures are the most important in the selected countries:

- Reduce GHG emissions from fertilization (production and on field)/reduction of fertilizer use/use of urea with inhibitor
- Increase efficiency of organic fertilizers
- Restore wetlands/peatlands
- Reforestation
- Research and Development funding (e.g., development of climate-resilient crops or new tillage methods)
- Renewable energy production
- Grant program for new technologies (e.g., soil testing, variable-rate application, precision farming technologies)
- Increase of organic farming
- Carbon credit programs/carbon markets – a lot of private initiatives
- Carbon taxes

These measures are implemented or planned in at least some of the countries. However, only Germany and France have explicit reduction targets for agricultural emissions. The other countries considered only targets for total reduction of GHG emissions and not for the single sectors. Next, in Australia, Brazil and Canada concrete policies to reduce emissions from arable farming are not yet implemented.

Impact of selected policies on crop production

Many countries have (planned) restrictions or are considering to require growers to increase the efficiency of nitrogen fertilization. These measures can have quite a large impact on crop farming as crops with lower nitrogen requirements (e.g., pulses) become more attractive. In many farms, a substantial improvement in nutrient use efficiency can be achieved, provided

the programs create a respective incentive and include relevant trainings for growers. Moreover, reduced nitrogen fertilization leads to lower yields and, especially for wheat, to a lower product quality (lower protein content).

Carbon taxes usually have a smaller impact. First, the impact of carbon taxes on fuel cost is usually manageable and second, by now, no alternatives exist.

Moreover, especially in Europe, organic farming is strongly subsidized to increase its area. In theory, makes it attractive for more and more farmers; however acreage expansion is well below political targets. Converting a farm to organic farming usually affects the whole rotation and production system and creates a substantial leakage because yields go down by as much as 50%.

Re-wetting of peatlands does not have an impact on a large amount of acreage, but after the restoration, arable production often is not possible any longer.

In the USA, huge programs to produce biodiesel, in addition to the current ethanol production, are planned. This will lead to a higher acreage of soybeans instead of corn. This also might have an impact on national nitrogen fertilization because soybeans are a legume. However, the reduction in corn output will be compensated by an increase in corn production elsewhere.

Especially in Australia, the promotion of afforestation as a means to offset emissions from the mining industry has the potential to become a serious competitor for crop production. However, as of now the absolute number of acres being converted is limited.

Many countries provide funding for new technology and other measures aiming at a reduction of emissions by efficiency gains.

Main outcomes

- It appears that leakage effects (shifting GHG emissions from country A to country B) are not at all considered by policy makers. On the contrary, many current measures in place are prone to lead to higher emissions elsewhere due to lower yields or even reduced crop acreage.
- All considered countries have overall national GHG emission reduction targets, but only the Europeans have sector targets for agriculture.

- There are big differences between the countries, regarding how far developed climate protection measures are – from early planning stages to fixed laws. Most considered countries are still at the very beginning regarding developing and implementing GHG mitigation policies.
- Although many countries are still in the beginning of climate protection measures in arable farming, discussions showed that climate protection most likely will become more important in the next years.
- Nitrogen fertilization is key to reducing GHG emissions.



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Developments and outlook in corn production

Tom Arthey

During the *agri benchmark* cash crop conference 2023 in Nairobi, Kenya, scientific partners of the *agri benchmark* cash crop network held a workshop to look at current and future opportunities and threats in corn production. The session included a global overview of trends in corn production and exports, as well as a deep dive into trends in the economic performance of corn production in the *agri benchmark* typical farms dataset for the 2022 year against the previous three-year average, with comparison of the competitiveness of corn grown on those farms vs potential competitor crops. Snapshots of issues facing corn production in Brazil, USA and Germany also were given by the respective scientific partners of those countries.

When looking at the global evolution in corn production over the past decade, the main trend has been stagnation in acreage in the USA, while significant increases in acreage and production in Brazil and Argentina took place. Whereas, in Brazil, corn is grown mostly as a double crop (known as safrina) after soybeans, the increase in acreage in Argentina is made all the more significant by the fact that it mostly is grown as a single-season crop.

China has expanded its corn acreage over the past decade to be the largest producer by area, but since 2015 has seen a dip of circa 4 million hectares by 2020 – out of an initial total of 45 million ha. However, they are climbing back to that acreage now. However, China still remains comfortably the biggest importer of corn in the world and there is no evidence that its requirement for importing corn will diminish any time soon. China recently has increased its import of Brazilian corn, which may be a factor behind the expansion in acreage there.

Is corn the Cash Cow option for farmers?

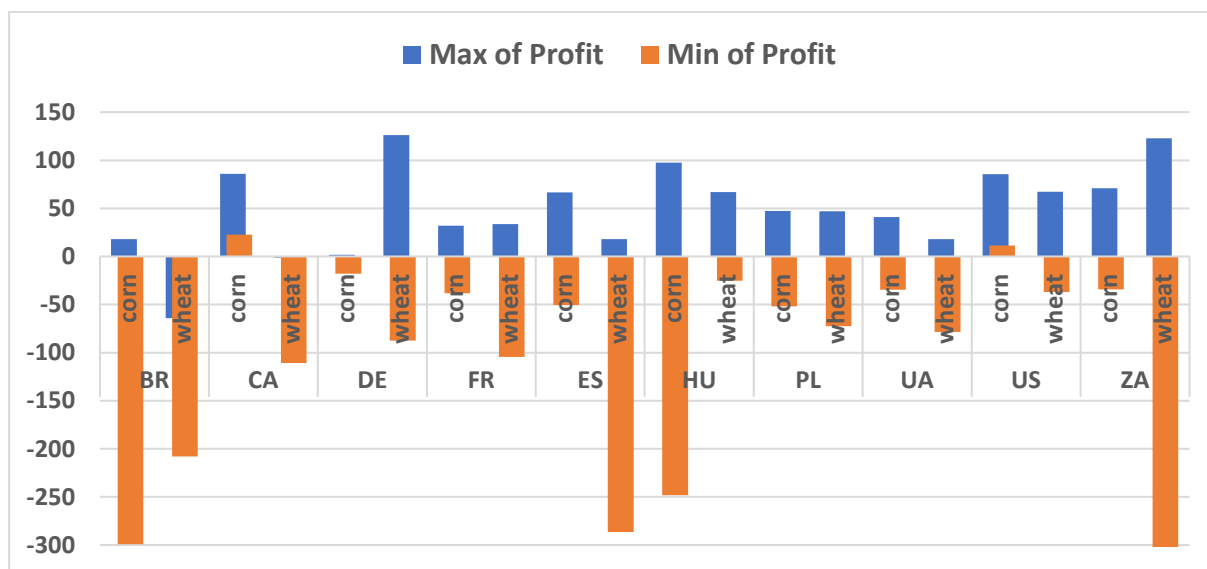
When looking at trends in the *agri benchmark* Typical Farm data, corn, like other crop commodities, saw 2020 as an exceptional year in terms of profitability across the board. This was attributed mainly to the price increase of crop commodities, including corn.

Although output price of corn has nearly doubled the previous three-year average, an increase was also seen for direct costs of over 50% in most instances, particularly N fertilizer and crop care costs. A major reason for this was energy cost inflation and the impact that had on fertilizer manufacture, which, for the most part, could be attributed to the Russian attack on Ukraine.

Corn, however, was considered to be better placed than many other grains to deal with the prospect of high fertilizer prices in the medium to long term because of its high fertilizer use efficiency. Indeed, when looking at the three-year average overall economic competitiveness of corn against potential competitor crops (such as wheat) within the Typical Farm dataset, it was quite clear that in most instances corn outperforms other crops that could potentially replace or take a share of the corn acreage.

Importantly, the volatility in the economic performance of corn showed a much smaller range, so although the maximum profit achievable by other crops may in some cases be higher in certain years, the potential losses in those competitor crops were much higher as well. In Figure 1 national average values across all typical farms have been calculated. The key take-home message from this exercise therefore was that corn represents a rather more stable cropping option compared with the alternatives.

Figure 1: Corn vs wheat maximum and minimum profit range (USD/t) (2019 – 2022)



Source: *agri benchmark* based on typical Farm dataset

Brazil is a growing influence in world corn, but is USA corn on the decline?

While corn continues to be mainly an opportunistic second crop after soybeans in Brazil, Mauro Osaki of CEPEA, *agri benchmark's* scientific partner in Brazil, explained that advancements in varieties and crop care now make corn a less risky crop for producers to grow. He showed how the significant acreage increase is because farmers have a greater degree of confidence in growing a second crop and seeing it through to harvest, whereas previously this would have been the case only when conditions were favorable. Of course, relatively high corn prices in recent years were supportive in that regard. Crop care costs have, however, seen a significant increase in the past decade of about 300%.

In the USA, Ron Haugen of North Dakota State University showed that the short-term challenge has been the lack of moisture in the 2023 planting period in many of the key Corn Belt states. Longer term evolution in yields has meant that although acreage has stagnated, production has increased across the USA.

However, the Conference session also learned that recent proposed changes to biodiesel policy in the USA and, in particular, limits on the quantity of corn-ethanol included in blending volumes, do have the potential to significantly impact corn acreage in the future. Farmers may switch to soybeans if soybean oils gain greater traction in the biofuels sector. The availability of corn for export would also likely increase as domestic use for ethanol production is reduced, which may lead to a greater supply on the international market and, hence, lower prices.

In Europe, Johannes Meyer, consultant to the *agri benchmark* network and farmer of 300 ha in northwest Germany who grows corn for grain and silage, explained that the prospect of continuing high fertilizer costs, and new policy regulation in Germany on quantities and timing of N fertilizer application actually increases the attractiveness of corn for him compared with other cereal crops. Not only does corn carry a lower N-nutrition demand than the other crops he grows, but the regulated limits of calculated N demand actually potentially allow the possibility to distribute N to other following crops. While corn is predominantly grown for silage as feedstock to biogas plants, the expected reduction in the number of plants and the decline in the size of the German dairy herd mean farmers are switching more to corn for grain. Drying costs do, however, pose the biggest threat in this regard.

Main outcomes

- The *agri benchmark* Typical Farm data suggest that corn is a rather competitive crop to grow when compared with possible alternatives within the dataset.
- Lower fertilizer demand in corn makes it an attractive option to other cereals if faced with continued high fertilizer prices and/or policy restrictions on fertilizer usage (Europe).
- However, high drying costs provide a potential drawback to grain corn, – provided energy used is subject to climate change policies such as taxation. Further investigation is required into the strategies for drying and the associated cost.
- In the USA, changes in biodiesel policy could have a significant impact on corn usage domestically. This then would impact global exports and prices and should be monitored.



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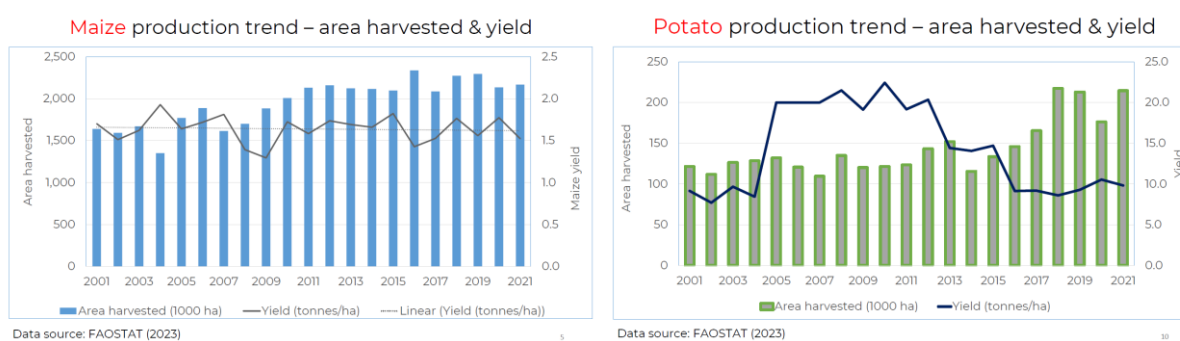
Agriculture in Kenya: Untapped potential – production status and challenges

Tanja Möllmann based on presentations from John Olwande, Tim Njagi and Joachim Lammel

The main crops grown in Kenya are corn, wheat, rice, potatoes and beans. Corn is the staple food of Kenya and it is grown by 90 percent of all Kenyan farms while the common bean and the Irish potato are the most important legume and root crops respectively.

John Olwande from the Tegemeo Institute described the production trends in the past 20 years for corn and potatoes, which show stagnating or even decreasing yields, while the production area was extended for both crops.

Figure 1: Production trends corn and potatoes



Smallholders dominate crop production

Crop production is dominated by smallholder farmers: 90% of corn and 85% of potatoes are grown on smallholder farms (<3 ha). The five-year average (2017-2021) corn yield reported was 1.6 t/ha, whereas experts see a potential of around 6 t/ha. Estimations for potatoes are similar: The five-year average is 9.5 t/ha, while a potential is seen around 35 t/ha. This enormous yield gap might be explained by the following factors:

Use of certified seed: While the adoption rate of new seed varieties is relatively high (80%) in corn production, there is an obvious need of improvement in potato production. Fewer than 2% of potato farmers plant certified seeds; 4% plant clean seeds but close to 95% plant farm-saved seeds (KEPHIS 2016).

Fertilization: A Tegemeo survey from 2014 showed that around 70% of households apply fertilizer and that the application rate (kg/ha) has decreased by almost 50%, from 155 kg/ha to 80 kg/ha between 2000-2014.

Pesticide use in Kenya does not exist or is significantly lower compared with Asia or Europe.

Producer and retail prices of crops have increased tremendously in recent years. As a result, there is little incentive to increase yields to secure a sufficient household income.

Lack of mechanization

Tim Njagi from the Tegmeo Institute shared insights regarding the evolution of mechanization in Kenya. Other than in Asia, where during the Green Revolution, farm-level mechanization was adopted to address labor shortages, similar trends of mechanization have not been experienced in Sub-Saharan Africa. Smallholder mechanization has gained attention as a means to address labor shortages, improve farm operations, and increase agricultural output.

A driving factor of mechanization is increasing wages. During the past 10 years, daily (farm) wages increased by 60% from 250 KSH/day to 400 KSH/day.

The main challenges in the adoption of innovations and mechanization in Kenyan crop production are seen in supply constrains: The public sector strategy crowds out the private sector as it inflates mechanization prices. Furthermore, there is a lack of capacity building in terms of repair and maintenance. High costs of credits for farmer and land fragmentation also are obstacles preventing further mechanization.

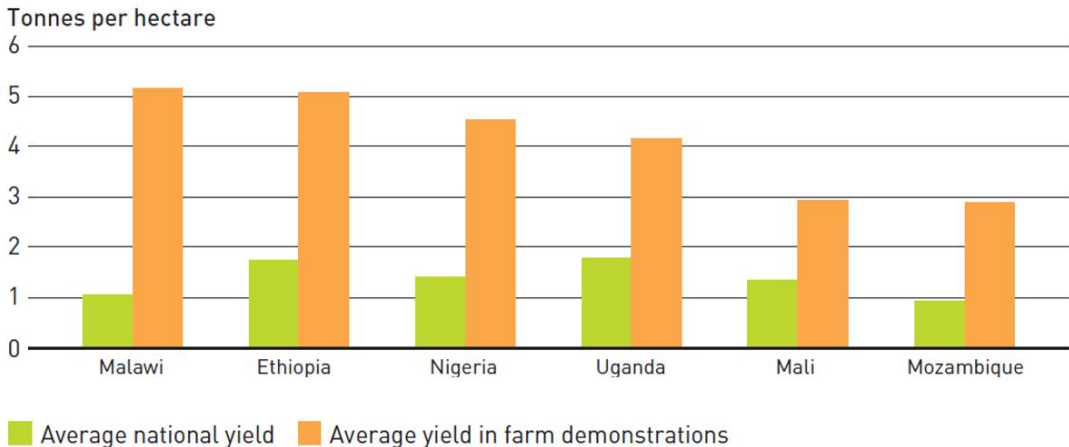
Tim Njagi reported that mechanization is adopted at any level only within wheat and rice. Wheat is grown by large-scale farmers. Mechanization in rice is concentrated to the Mwea region. Mwea has provided a good example of how a private sector cooperative can take the place of the public sector and adopt greater mechanization. Approximately 40% of the rice farmers are members of the cooperative. The cooperative provides services on credit. Today, Mwea has nearly 100% mechanization on farms.

Besides on-farm measures, key factors affecting mechanization also include supply of public goods, roads, irrigation infrastructure and access to credit.

Yield gaps – a significant issue in Africa

Joachim Lammel put the Kenyan situation into perspective, by showing drastic yield gaps between average national yield and average yield in farm demonstrations in other African countries.

Figure 2: Yield gaps on farms in other parts of Africa



Source: J. Lammel, Yara International

A case study in Tanzania (Sokoine University TZ Prof Mtengeti, Syngenta and Yara) has been elaborated to address increasing food demand due to increasing population: Crop production in Tanzania needs to increase significantly. Due to the impact of land use change on GHG emissions, this should not happen by an extension of production area. Improving (maize) yields is necessary to reduce land use change and to mitigate loss of carbon and biodiversity. The key to achieve higher yields was identified in a balanced and adjusted supply of plant nutrients. All trial sites of the case study in Tanzania showed that soils were low in all plant nutrients. The fertilizer rates in the trials with maize differed tremendously between the recommended (Yara) program and the average farmer practice.

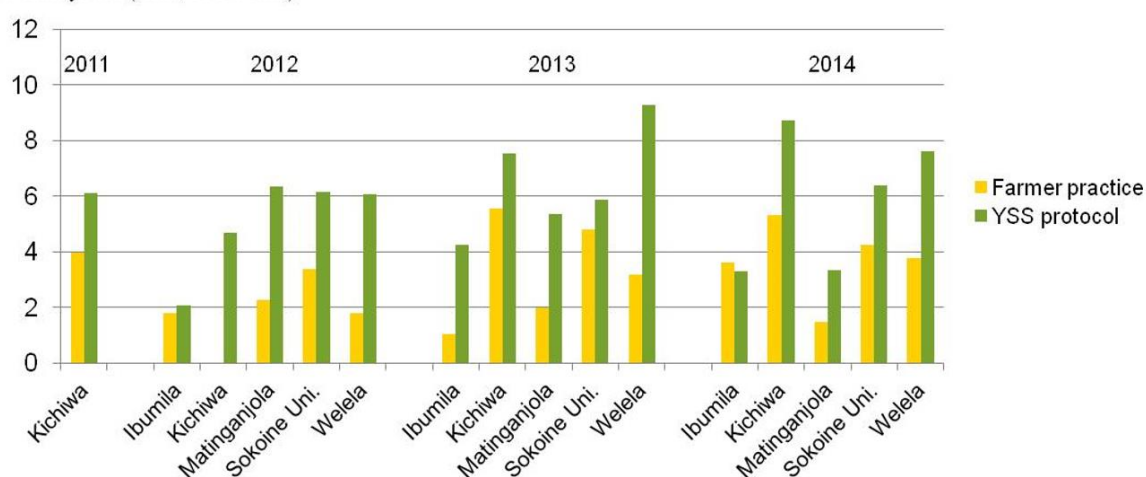
Table 1: Fertilizer rates in trials with maize

	Yara avg. (range)	Farmer practice avg. (range)	
N	138 (110-166)	44 (0-110)	kg N/ha
P	58 (46-70)	27 (0-86)	kg P2O5/ha
K	34 (27-40)	3 (0-12)	kg K2O/ha

Introducing a balanced crop nutrition led to significant increases in (maize) yields in all sites.

Figure 3: Grain yield increase because of a balanced crop nutrition

Grain yield (t/ha; 86% dm)



Source: Sokoine University TZ Prof Mtengeti, Syngenta and Yara)

The outcome and the example of the case study in Tanzania lead to the assumption that a high share of the yield gaps – also in Kenya – might be overcome by introducing an appropriate fertilization program.

Outcome and follow-up questions

The huge yield potentials in maize and potatoes for Kenyan farmers described by the Kenyan experts seemed to be caused by:

- lack of use of high-quality (certified) seed
- low fertilization and use of crop protection
- land fragmentation and little mechanization.

The *agri benchmark* Cash Crop network is always keen to understand the driving factors of farmers' decisions. After addressing the main limitation factors, closing yield gaps therefore will require understanding the main constraints of the decision-making process of the farmer:

- Why don't growers apply proper dosages of fertilizers?
- Why don't growers use proper seeds?
- Why do growers underutilize crop protection products?
- What can be done to reduce cost of mechanization?
- In what crops and on what operations can mechanization be advantageous?
- Are growers offered the right mechanization options?



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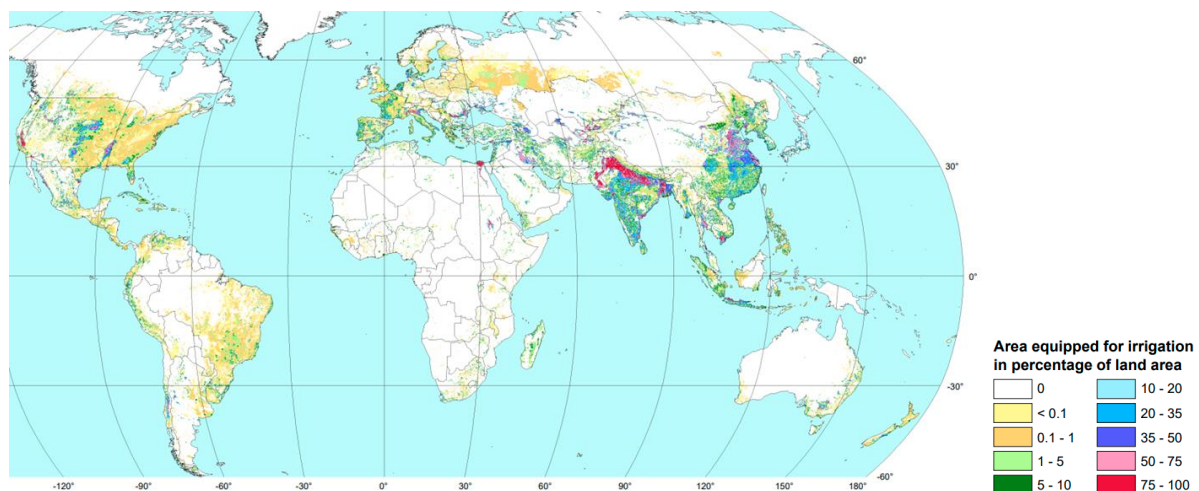
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Irrigation – new challenges and new technologies

Jonas Böhm based also on contributions from Ibrahim Wikedzi and Carlos García Rodríguez

Irrigation is key in crop production in some parts of the world. An astonishing 70% of the world's finite freshwater resources are allocated to irrigation. Only 18% of earth's arable lands benefit from controlled watering practices, yet this modest acreage yields a disproportionate 40% of the world's food supply. These figures underscore the key role of irrigation in sustaining food production. The relevance of irrigation globally is illustrated in Figure 1. It shows that irrigation is particularly important in India and China.

Figure 1: Regions of irrigation worldwide



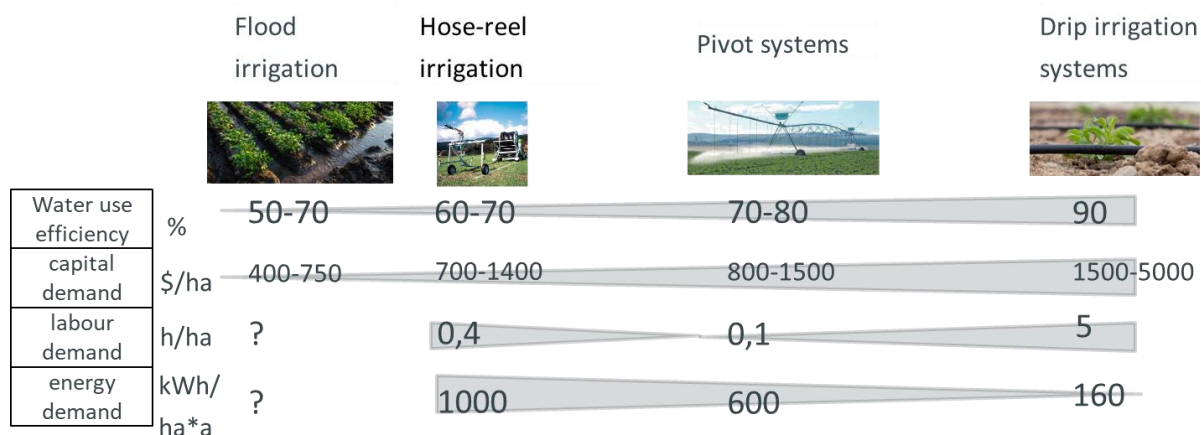
Source: <https://www.fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/latest-version>

Farmers are facing more droughts. In areas where there is less regular rainfall, the demand for irrigation rises. But the water supply in water bodies and rivers is becoming scarce due to the lack of precipitation; this additionally leads to shrinking of the groundwater table. In some countries, governmental regulations are designed to regulate water use, leading to less possibility for irrigation.

One option to solve this problem is the use of more efficient irrigation technologies. Globally, 90% of irrigation is flood irrigation. A comparison of the advantages and disadvantages of different irrigation systems (Figure 2) shows that more efficient irrigation systems could be used but are associated with higher costs.

But are there differences in how farmers will react in different areas? Examples from Tanzania and Spain provide some impressions.

Figure 2: Advantages and disadvantages of different irrigation systems



Source: figure according to Afazal (2016), Amoson (2019), Anter (2023), IFC (2023)

Tanzania

Tanzania boasts a rich tradition of traditional or informal irrigation systems, primarily established and managed by smallholder farmers through customary arrangements. Furthermore, Tanzania is endowed with substantial surface and groundwater resources, highlighting vast potential for sustainable agricultural development. Nine large water basins are spread over the area of Tanzania. These basins hold all the ground and surface water for all uses of water, including irrigation. The different aquifers are controlled by the government.

In Tanzania, the main irrigated crops are tea, sugarcane, coffee, flowers and grapes. Half of the 44 million hectares of arable land would be suitable for irrigation, but only 2.5% are currently under irrigation. Flood Irrigation is widely used, with a share of 85%. Several challenges lead to this low share: The responsibility of institutions for the development of irrigation systems is not clear and there is a lack of trained people for maintenance. The future development of irrigation of cash crops in Tanzania could be promoted by investing in farmer-managed irrigation schemes and tailored approaches with public investment.

Spain

In Spain, there have been several drought years in the past and especially the year 2023 was very dry. Because of water scarcity and the economics of irrigation, only 23% of the cultivated cropland is irrigated. The share of irrigated land in the regions of Spain ranges from 3% to 58%.

Also, the share of irrigated crops is different: 15% of cereals, 26% of forages, 78% of potatoes but only 4.5% of legumes are irrigated. The irrigation systems used are 22% flood irrigation, 15% sprinkler, 8% self-propelled and 55% drip irrigation. The adoption of more efficient technologies could be seen in the past with a large decline of flood irrigation systems and a rise in the share of drip irrigation.

In Spain one of the main challenges in irrigation is energy cost. The depth of ground water in aquifers (200-300m) results in high energy costs for water extraction. The solution to this problem could be irrigation communities. In this type of farmer organization, the

infrastructures of irrigation ponds and channels are shared. To stabilize the water supply, irrigation ponds are used. The use of solar energy can reduce energy costs for irrigation; respective data for two typical farms demonstrate this.

Spanish farmers are also modifying crop rotations – less corn silage and winter rye production have been observed. In addition, winter barley and winter wheat were switched from irrigation to rainfed to use water for irrigation in the most efficient crops.

The Spanish government is trying to improve the situation through an irrigation modernization strategy to increase storage capacity, add pressure to irrigation, be more energy efficient, and improve water quality. Automated controls could improve water management. Water storage ponds and solar panels are also seen as future developments to improve irrigation systems in Spain.

Main outcome

- Water scarcity is increasingly an issue for crop producers.
- In Tanzania, water availability is not the limiting factor. Improvements require new institutional design and new investments.
- In Spain, the main challenge is high energy costs; in recent years, some improvement in irrigation technologies have been realized.



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agri benchmark Working Papers and Reports

Challenges and Perspectives in the Direct Marketing of Crop Inputs

Report 2021/7

Dresemann, J. & Zimmer, Y.

www.agribenchmark.org/cash-crop/publications-and-projects0/reports/challenges-and-perspectives-in-the-direct-marketing-of-crop-inputs.html

Challenges and Perspectives in Global Rapeseed Production

Report 2020/6

www.agribenchmark.org/cash-crop/publications-and-projects0/reports/challenges-and-perspectives-in-global-rapeseed-production.html

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Report on the Workshop on the Southeast Asian *agri benchmark* Rice Network

Working Paper 2014/5, Nguyen NL.

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German rapeseed on the verge of collapse? Consequences of a new EU biofuel policy

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