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RESEARCH ARTICLE

Agrotechnological and marketing evaluation of urea-ammonia nitrate application in growing crops in Ukraine

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Abstract

Using Urea-Ammonia Nitrate (UAN) remains a profitable option for farmers in Ukraine during wartime in Ukraine when growing crops. However, there are potential risks in the coming years. The stable demand for UAN relies on an optimal price, as well as dependable logistics, and transportation. Agro-industrial companies that utilize modern technologies for crop cultivation can achieve greater profitability by applying UAN through methods such as foliar feeding, drip irrigation, or Y-drop techniques. Conversely, farmers with smaller arable land areas find the use of UAN to be unprofitable. Additionally, if European countries impose new restrictions on the export of agricultural products or if prices for grain and seeds decline, the return on investment for fertilizers may be limited.

Keywords: Nitrogen, Yield, Liquid fertilizer, Profitability, Logistics, Cereals crops, Corn

Introduction

Urea-ammonium nitrate is one of the most used liquid nitrogen fertilizers, containing three forms of nitrogen (nitrate, ammonium, and amide), ensuring prolonged action and uniform plant nutrition.
In the list below there are crops typically fertilized with UAN:

Cereal crops

Winter and spring wheat – UAN is used for early spring fertilization and at the beginning of stem elongation (Radchenko et al., 2024). *Barley* – ensures rapid nitrogen uptake during early growth stages (Thomason et al., 2012; Barczak et al., 2019; Hasanova et al., 2023). *Maize (corn)* – UAN is applied at the 5-7 leaf stage and later stages using Y-drop technology (Liu et al., 2019; Kharchenko et. al., 2021; Adamchyk et al., 2023; Kravchenko et al., 2023).

Oilseeds crops

Winter and spring oilseed rape (canola) – UAN is applied in autumn before winter dormancy and in spring after vegetation resumes (Paye et al., 2021). *Sunflower* – UAN is used in the active growth phase, particularly at the 6-8 leaf stage (Graham & Varco, 2017).

Leguminous Crops (limited use)

Soybeans – UAN is not typically used directly due to the risk of nitrogen fixation suppression, though foliar application with micronutrients is possible (Moro Rosso et al., 2020). *Peas* – UAN is used rarely but may be applied in the early growth phases (Karbivska et al., 2022; Weiner et al., 2024).

Industrial crops

Sugar beet – nitrogen supplementation supports leaf mass development and yield increase. Potatoes – can be used in early growth stages, but are often applied in a diluted form to avoid leaf burn. *Cotton* is applied in drip irrigation in growing regions (Pabuayon et al., 2021).

There are some application methods for UAN: a) root application (using sprayers or Y-drop systems); b) foliar feeding (in diluted form, sometimes combined with crop products); c) fertigation (applied via irrigation systems). Fertilizer rates vary depending on the crop, weather and climatic conditions, and the growing technology (Zakharchenko et al., 2023, 2024). So, our article aims to examine the role of urea-ammonia nitrate among the primary nitrogen-containing fertilizers and to identify trends in its usage in recent years, including during the war period in Ukraine and in the world. Based on our data analyses, we will provide farmers with recommendations on the effective application of UAN in the future.

Materials and Methods

The article presents the grouping and ranking of procurement data for some common nitrogen fertilizers, analyzing FAO, IFA, UniServise Capital, DAFM, Fertilizers Europe/Eurostat, and Illinois Production Cost Report statistical data. Excel with an extended feature package was used to display the data. Information about UAN is analyzed using publications and the main features are highlighted.

Results and Discussions

Of all nitrogen fertilizers, anhydrous ammonia has the highest active ingredient content (Tab. 1). Urea and ammonium nitrate have good nitrogen content in amide, ammonium, and nitrate forms. These two fertilizers are widespread worldwide. UAN stands in third position in the world and Ukraine ranking of using for crop growing. The ecological level of risk has ranged from the 7 fertilizers analyzed from the table. The highest risk of application is ammonium nitrate, ammonia hydrate, and anhydrous ammonia.

Table 1. Characteristics of most used nitrogen fertilizers

Fertilizer	Nitrogen Content	Nitrogen Form	World Consumption [1-3]	Sales Ranking[1,2]	Ranking of Fertilizer Use in Ukraine[1,2]	Ecological Level of Risk[3]
Ammonia hydrate	20%-25%	ammonium	<1%	7	7	High - 5
Anhydrous ammonia	82%	ammonium	5%-7%	5	5	High - 5
Urea	46%	amide	50%	1	2	Medium - 3
UAN	32% 30% 28%	50% amide, 25% ammonium, 25% nitrate	10%-15%	3	3	Medium-high - 4
Ammonium nitrate	34%-35%	50% ammonium, 50% nitrate	20%-25%	2	1	High - 6
Ammonium sulphate	20%-21%	ammonium	5%-10%	4	4	Low - 2
Calcium nitrate	15%-17%	nitrate	1%-3%	6	6	Very low - 1

1.UniServise Capital. 2.International fertilizers Association (IFA). 3.FAO, IFA.

The Department of Agriculture, Food and the Marine (DAFM) reported that sales of N-content fertilizers have grown to eight percent in December 2024 compared with 2023 data.

Regarding the specifics of nitrogen fertilizer consumption in the EU countries during the 2020-2021 period the following trend is observed: nitrates – 47%, urea – 19%, UAN – 13%, compound fertilizers – 14%, others – 6% (data of Fertilizers Europe/Eurostat). Modelling the forecast for 2031, these organizations claim that there will be a decrease in global nitrogen consumption of approximately 5.7%.

As shown in fig. 1, urea has the highest consumption volume in the world and consistently holds the leading position. Ammonium nitrate is the second most significant fertilizer in the world. And in third place is urea-ammonia nitrate, slightly less used than ammonium nitrate, but remains an important product. The volumes of use of ammonia water and anhydrous ammonia are not much lower compared to UAN. The volume of ammonium sulfate is slightly less, but the lowest is calcium nitrate.

In Ukraine, the trend in fertilizer use is somewhat different (Fig. 2). Most of all, farmers use ammonium nitrate, then urea. Other fertilizers have significantly lower volumes, which may indicate the specifics of agricultural technologies, import-export processes, or local production capabilities. If the ratio of mentioned fertilizers consumption in the world has a more or less similar trend for the period 2012-2022, then in Ukraine, the choice of fertilizer and the volumes of use fluctuate significantly.

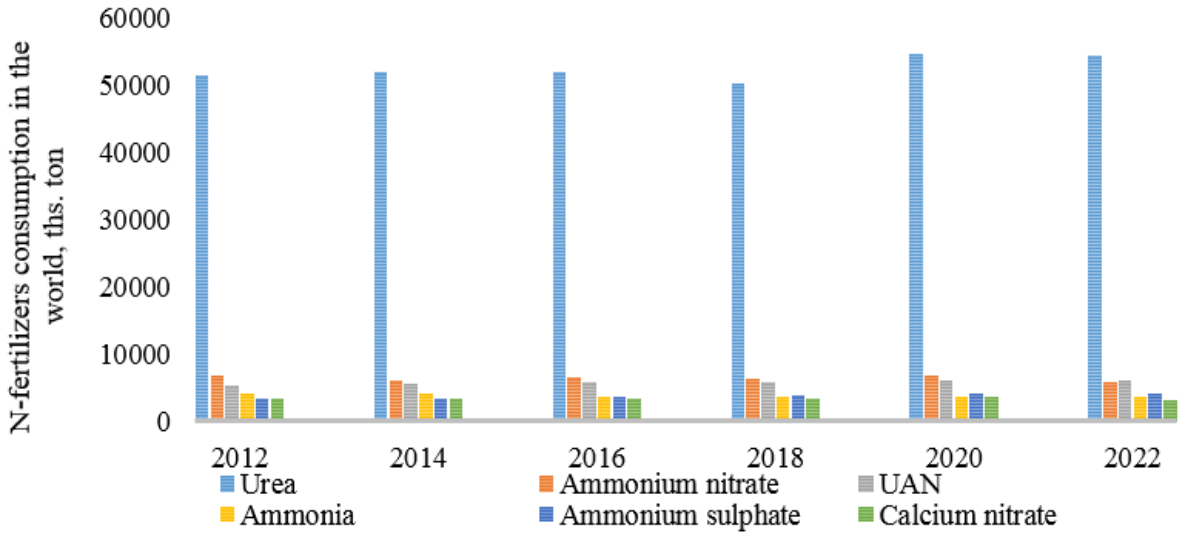

Figure 1. Consumption of N-fertilizers in the world

The largest amount of N-fertilizers was consumed in 2021, which is not reflected in fig. 2 – 1.4 times more UAN was purchased compared to the data in 2021. It was a golden time for agricultural producers and traders.

If farmers purchased more ammonium nitrate in 2012, then since 2014 there have been changes in the ratio of purchases of various nitrogen fertilizers. By the way, the volume of purchases grew until 2022, when a full-scale war with Russia began. In 2022, the lowest amount of nitrogen fertilizers was applied in the 2012-2022 period, the war adjusted the data due to the occupation of agricultural lands, difficulties in delivery and transportation, and high prices for fertilizers due to the devaluation of the hryvnia. Also, we need to note stable purchases of ammonia fertilizers.

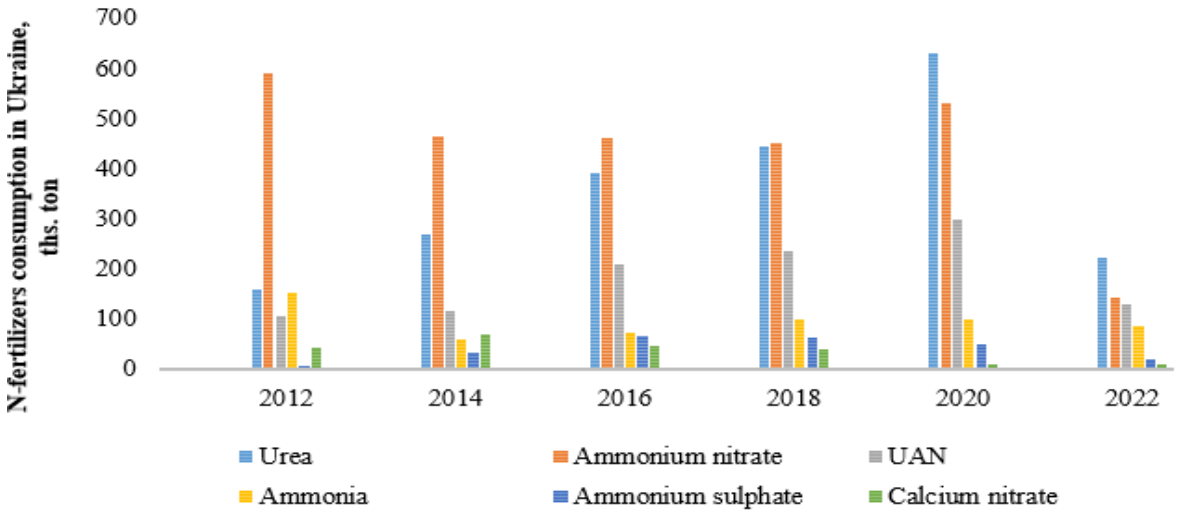

Figure 2. Consumption of N-fertilizers in Ukraine

Analyzing the key factors affecting UAN profitability during the war period in Ukraine we made a list of some advantages of using this fertilizer:

UAN has higher efficiency than granular fertilizers

Fertilizer provides more uniform nitrogen distribution, reducing fertilizer loss; the liquid form allows precision application using Y-drop technology, improving nitrogen uptake efficiency; it can be easier to mix, transport, and store this fertilizer in liquid form;

Economy on fuel and application costs

With limited material and technical resources, applying liquid fertilizers is more economical due to fewer passes over the field; UAN can be utilized together with pesticides, reducing application costs. UAN utilization is particularly advantageous during wartime logistics disruptions when railway and truck transport are restricted.

Improved crop yield and return on investment

If properly applied, UAN can lead to 5%-15% higher nitrogen efficiency, leading to increased grain yields; even with high fertilizer costs, yield increase may compensate for investment.

But there are also challenges and risks of using UAN, especially during wartime:

Price volatility and availability risks

The prices for UAN are highly volatile and influenced by the current geopolitical situation. High global prices for nitrogen fertilizers, coupled with reduced domestic production capacity, have resulted in higher costs for UAN.

Transport and storage risks

Russia's attacks on energy infrastructure have disrupted production facilities and logistics hubs. Additionally, the storage requirements for UAN, which necessitate corrosion-resistant tanks, can pose challenges for small farms.

Economic uncertainty for farmers

Many Ukrainian farmers are experiencing lower profitability due to increased costs of inputs, fuel, and transportation. Access to affordable credit is limited, making it difficult for them to invest in high-cost fertilizers. The instability of crop exports via Black Sea ports further affects farmers' income and their ability to recover UAN costs. In cases where grain prices decline, the return on investment for using UAN may decrease as well.

At the beginning of February 2025, nitrogen fertilizer prices exhibit regional variations due to factors, such as production costs, supply chain dynamics, and geopolitical influences. Summarizing the content prices of key nitrogen fertilizers (on average) in Ukraine and the United States is shown in tab. 2.

Need to say, the prices of N-fertilizers in Ukraine are very high, taking into account the purchasing power of Ukrainians; all this will be reflected in the price of vital agricultural products.

Nitrogen agroholding Ostchem announced an increase in fertilizer prices from 20.02.2025 by an average of $36 per ton. Therefore, the data table shows the maximum prices that have already been on the market and have already been raised.

Table 2. Prices of main N-fertilizers, February 2025

Fertilizer	Ukraine price (UAH/ton)	Ukraine price (USD/ton)	U.S. price (USD/ton)*	Application efficiency	Logistics & Storage	Suitability in wartime
Ammonium Nitrate	16700-22000	402-530	520-590	Fast-acting	Explosive risk	Restricted transport
Urea	24500-26000	590-626	510-575	Good efficiency	Easier to store	Price fluctuation risk
UAN-32	17900-27000	431-650	320-367	High efficiency	Requires tanks	Efficient but costly
UAN-28	14900-22000	359-530	284-375	High efficiency	Requires tanks	Efficient but costly

*Illinois Production Cost Report (Bi-weekly), 7.02.2025

Nitrogen agroholding Ostchem announced an increase in fertilizer prices from 20.02.2025 by an average of $36 per ton. Therefore, the data table shows the maximum prices that have already been on the market and have already been raised. Production is becoming more expensive due to changed logistics chains, constant damage to Ukraine's energy and gas systems by Russia, and deflation of the hryvnia (Kysylchuk et al., 2024). Globally, N-fertilizer prices have experienced fluctuations due to various factors, including natural gas prices, production adjustments, and geopolitical situations. As of January 2025, the Profercy World Nitrogen Index, which tracks key global nitrogen fertilizer prices, continues its ascent, registering a 4.18 point increase, reaching the highest data since January 2023.

Conclusions

Urea-Ammonium Nitrate (UAN) is a competitive alternative to ammonium nitrate, which is subject to transport restrictions due to its explosive nature, and urea, which often experiences price volatility. Applying UAN at optimal rates and timing is highly profitable for most crops. It offers higher nitrogen efficiency, lower application costs, and significant yield improvements compared to solid fertilizers. Using modern precision application technologies, UAN can help maximize farm profits while minimizing environmental impact. Here are some recommendations for farmers: monitor fertilizer prices weekly; purchase at the best rate; use variable rate application technology; reduce UAN overuse and enhance efficiency; apply UAN in multiple doses; consider alternative nitrogen sources, such as calcium ammonium nitrate and urea, if the logistics of using UAN become too challenging or expensive.

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