МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
Центральноукраїнський національний технічний університет

НАУКОВІ ЗАПИСКИ

Випуск 31

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Using Google Search Algorithm for Internet Search

This article is dedicated to Google's search algorithm, definition of this algorithm, how does it work, stages of the search process, how many and what ranking factors the algorithm uses and for what reasons this information is not public. This article also raises the issue of algorithm updates, their differences and the principle of operation.
algorithm, search, ranking factors, websites, webpages, updates, Google

Google's algorithms are a complex system used to retrieve data from its search index and instantly deliver the best possible results for a query. The search engine uses a combination of algorithms and numerous ranking factors to deliver webpages ranked by relevance on its search engine results pages (SERPs) [1].

The search process consists of three stages:

1. Crawling. The first stage involves Google's bots, also known as "spiders", crawling the web and looking for new or updated web pages. Pages need to be crawled and indexed in order to rank.

2. Indexing. This step is to analyze the content contained in URLs and try to figure out what each page is about. It does this by looking closely at the content, images, and other media files on the page, and then stores this information in a huge database known as the Google index.

3. Searching and ranking. The user enters a query, and the search engine ranks and returns content in relation to the query.

Exact information about how Google algorithms work is not public information and nobody knows outside of Google's inner circle. There are several compelling reasons for this. One of them is that if the algorithm becomes publicly available, everyone will be able to exploit it and doctor the system in their favor. As a result, this will generate useless search results for users and certainly create a worse internet.

Also, one of the reasons it would greatly diminish the company's value, since the algorithm is a closely-guarded business secret, and releasing it would lead to this consequence [2].

Google keeps the details of its search ranking algorithm private but uses a lot of specific criteria to rank content. It's believed that there are well in excess of 200 ranking factors—and nobody knows them all. Even if someone knows all these factors, they will not remain relevant for long, since the algorithm is always changing. On average, Google releases updates for its update six times per day. Despite all of the above, Google still provides some information [3].

The algorithm categorizes information based on many factors, but some of the key factors, which can be found on Google's "How Search Works" page, include the following:

1. Meaning of query. The meaning of the query relates to the intent of the searcher. For Google to provide the most helpful answers, they need to fully understand what you're looking for. Google uses their proprietary language models to decipher the words in a query to match up to useful content. This involves steps as seemingly simple as recognizing and correcting spelling mistakes, and extends to trying to our sophisticated synonym system that allows to find relevant documents even if they don't contain the exact words that used.

2. Relevance of content. Google's systems analyze the content to assess whether it contains information that might be relevant to what is being searched for. The most basic signal for this is matching keywords in content to keywords in the query. If the page contains an exact match, that sends a strong relevance signal to the system. Besides assessing the types and number of keywords, the ranking systems also analyse the relevancy of the content in other ways, such as using aggregated and anonymised interaction data to determine the relevancy of similar search results from before to search queries. Such data is then transformed into signals that allow Google's machine-learning algorithms to predict relevance more accurately in the future. The only drawback of this system as of now is that as it uses objective ranking signals, it fails to analyse subjective concepts such as the viewpoint or gist of a page's information [4].

3. Quality of content. The system looks for signals of expertise, authoritativeness and trustworthiness. One of several factors is understanding if other prominent websites link or refer to the content.

4. Usability of webpages. The algorithm prioritizes more user-friendly websites. Google also considers factors such as page loading speed, mobile responsiveness, and the overall user experience when evaluating the ranking of a web page.

5. Context and settings. The algorithm looks at information such as location, search history and search settings to return content based on the specific user profile. Search also personalizes results based on previous activity on the Google account. Furthermore, other user-specific factors such as previous search history and search settings are all assessed to provide the most valuable and relevant information specific to the searcher.

Within these 5 categories are the aforementioned ranking factors. In addition to their complete list, the weights of each ranking factor is also unknown, but each aims to validate one of the above five principles in content. It's better for content creators to optimize for many of the factors rather than just a few. Some specific factors that they can directly measure include content organization, content length, website structure, backlinks, domain authority, meta descriptions, keywords etc. Five most prominent ranking factors can be highlighted:

1. Backlinks – backlinks, or links from other sites, show Google that other sites trust your content;

2. Freshness - refers to how “fresh,” or recent, the content on webpage is;

3. Keyword mentions - keyword variations in the headings of posts, the title of posts, at least one subheading, the intro paragraph, the page’s URL;

4. User experience - encompasses a lot of different things, including the page load speed, mobile-friendliness, website design etc;

5. Topical authority - means sites that have additional, valued content about queries relevant to the one being searched.

As mentioned before, Google updates its algorithm regularly. Daily updates make minor tweaks. Algorithm updates that do significantly affect the search engine results page are called core algorithm updates. Google doesn’t always announce updates, so SEO specialists have to look for signs of an update. Usually a sign that Google is reworking things on its end is unexplained drops in traffic metrics and conversions.

Core algorithm updates usually occurs once a year. Some are designated catchy names by the SEO community or Google itself to

help notify people about them, prepare for them and make them easier to refer to. The eight major algorithm updates are: Panda, Penguin, Hummingbird, Mobilegeddon, RankBrain, Medic, Bert and Helpful Content.

Panda was first introduced on February 23, 2011 and is the most popular algorithm now. It works on a permanent basis and is a full-fledged component of the Google search algorithm. The most pervasive myth about Panda is that it is about duplicate content. John Mueller (Google Search Advocate) has clarified that duplicate content is independent of Panda. Google employees have stressed that Panda encourages unique content, but this goes deeper than avoiding duplication. What Panda is looking for is genuinely unique information that provides outstanding value to users [5].

The penguin algorithm can be termed as a focused version of the panda but it relatively checks for the micromanagement which is done on the website. In 2012, Google officially launched the "webspam algorithm update," which specifically targeted link spam and manipulative link-building practices. The webspam algorithm later became known (officially) as the Penguin algorithm update via a tweet from Matt Cutts, who was then head of the Google webspam team. Google Penguin's objective is to down-rank sites whose backlinks look unnatural. This update put an end to low-effort link building, like buying links from link farms and PBNs.

Hummingbird is a significant update to Google's search algorithm introduced in 2013. It emphasises the meaning behind a user's search query rather than just the individual keywords. It uses this information to return more relevant and accurate search results. Hummingbird is considered to be the beginning of Google's transition from keyword to topic. This update led to the fact that Google can show the user content relevant to his query, even if the text does not have an exact key, but uses, for example, synonyms or describes the necessary concept in other words. The mechanism of machine learning and artificial intelligence analyzes the semantic content of pages, the search behavior of users and gradually begins to rank higher those sites that are better suited to users.

Mobilegeddon, also has nicknames such as mobilepocalyse, mopocalypse, mobocalypse, it's a fairly simple but very important update to Google's algorithm. It is part of the search engine algorithm that evaluates the mobile version of websites. This update provided no

gray area. Your pages were either mobile-friendly, or they weren't. There was no in-between.

RankBrain is a system by which Google can better understand the likely user intent of a search query. This can be taken as an extension of the Hummingbird algorithm which will be providing more focus on the delivery of relevant content and it is a major factor when the page ranking is considered.

Medic update made expertise and topical authority a strong ranking factor for health, wellness and personal finance sites. Many sites that had non-experts share advice on these topics dropped in SERP ranking following this update.

BERT added natural language processing capabilities to help the algorithm understand complex language in search queries. Unlike RankBrain, BERT doesn't rely on past search data to interpret intent. With more than 15% of queries each day being new, Google needed BERT to address the challenges posed by the increasing number of natural language queries. This meant the Google Search algorithm required understanding the context and meaning of the query, regardless of the spelling and word combinations used. In 2018, Google launched the open-source neural network-based system BERT to train their natural language understanding models. BERT works by processing words in relation to the other words in a sentence instead of going one by one in order. Essentially, BERT can understand the complete meaning of a word in a search query by looking at the words that come before and after.

Helpful Content implemented to further prioritize high-quality content that is more likely to meet readers' needs. It penalizes websites that produce low-quality content or rely heavily on automation tools to create content.

The recurring theme in Google's algorithm updates is that Google wants to provide the most in-depth, authoritative, and high-quality content possible. As AI chatbots become more competent, Google can incorporate them into search and update its algorithm accordingly to handle the types of queries coming through that interface.

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The Importance of CAPTCHA for Cybersecurity in Internet

The article is devoted to the role and importance of the Completely Automated Public Turing test to tell Computers and Humans Apart. A variety of the tests and its history are presented in the article. The importance of using CAPTCHA in the Internet to protect users and information. Highlighting the problem of vulnerability this technology before modern artificial intelligence.
captcha, cybersecurity, artificial intelligence, security in the Internet

CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) is a computer test used to determine whether a user of a system is a human or a computer. It is a security measure known as challenge-response authentication. A verification code is employed to protect against spam and password theft. To verify, users must complete a simple test to confirm that the actions are being performed by a human rather than a computer program attempting to gain access to a password-protected account [1].

CAPTCHA was originally developed by researchers from Carnegie Mellon University and was primarily associated with a technique where a person identifies distorted characters in a raster image and then enters those characters into a web form. This approach is widely recognized by Internet users. Eran Reshef, Jili Raanan, and Eilon Solan, who worked at Sanctum on the Application Security Firewall, first patented CAPTCHA in 1997. Their patent application states that “the invention is based on the application of human strengths in the application of sensory and cognitive skills to solve simple problems that are too difficult for computer software. Such skills include, but are not limited to, the processing of sensory information such as the identification of

objects and letters in a noisy graphic environment." One of the earliest commercial applications of CAPTCHA was in the Hausebeck-Levchin test. In 2000, idrive.com began protecting its registration page with CAPTCHA and prepared to file a patent. In 2001, PayPal used such tests as part of a fraud prevention strategy in which they asked people to "re-enter garbled text that programs have difficulty recognizing". PayPal co-founder and CTO Max Levchin helped commercialize this use. [2].

In the most common variant of the test, users are required to enter characters typically displayed in a distorted manner on a provided image, sometimes with added noise or transparency. This is done to prevent computer programs from recognizing the content of the image. Images can contain objects, such as cars or streets, and the user needs to select all images that contain a certain object. The user is required to select certain images from a set that meet certain criteria. Text type CAPTCHA is widely used, it requires active intervention and understanding of the text from the user. The user is prompted to enter the text displayed on the image or audio file. It can print garbled text or garble characters, making it difficult for bots to automatically recognize. Less frequently, tests based on speech recognition (primarily as an alternative for people with visual impairments). Audio CAPTCHA uses audio files to verify that the user is a real person. The user is prompted to listen to an audio and enter its duration or content. The audio may contain voice instructions or codes that the user must enter to verify their human nature.

The most widely used service is Google's reCAPTCHA, originally developed at Carnegie Mellon University and used for helping recognize words during text digitization, as well as protecting websites from bot access to restricted resources. On September 16, 2009, Google acquired this technology. In 2013, reCAPTCHA began implementing behavioral analysis of browser interactions to predict whether the user was a human or a bot. The following year, Google introduced a new "invisible" reCAPTCHA, where the verification happens in the background, and challenges are not displayed if the user is considered low risk [1].

CAPTCHAs based on text reading or other visual perception tasks prevent access for blind or visually impaired individuals to protected resources. Since websites may use CAPTCHAs as part of the registration process or even for every login, this issue can block access.

Thus, the use of CAPTCHAs excludes a small percentage of users from utilizing significant subsets of popular web services such as PayPal, Gmail, Orkut, Yahoo!, many forum systems, and weblogs. An alternative method involves displaying users a simple math equation and requiring them to enter the solution as a verification. While these are much easier to overcome with software, they provide much higher accessibility for blind users than image-based test. However, they may be challenging for users with cognitive impairments, such as dyscalculia [1,2].

CAPTCHA plays a significant role in cybersecurity and protecting information on the Internet. It is used to prevent various bots and automated programs from impersonating humans and carrying out actions such as automated account creation, subscription to offers, harvesting email addresses, creating email accounts, breaching privacy, password cracking attempts, spam emails, or messages. The importance of using CAPTCHA from the point of view of cyber security is that it allows you to protect sites and services from various types of cyber-attacks that can harm their functioning, reputation, and users. For example, attacks on passwords, where automated programs are used to select or crack passwords to user accounts on websites or services. A CAPTCHA helps prevent such attacks because it limits the number of password attempts and requires an additional human presence check. Also, this test helps prevent DDoS attacks, as it limits the number of requests or downloads from a single IP address and requires confirmation of human presence.

Unfortunately, this technology also has vulnerabilities and bugs that allow CAPTCHAs to be bypassed or recognized without human intervention. This can lead to a breach in the security of sites and services that use this technology to protect against automated attacks. For example, if the CAPTCHA image has low resolution, low distortion, a uniform background, or readable text, it can make it easier to recognize using artificial intelligence, machine vision, or image processing. Also, if a site or service uses a limited set of CAPTCHA images that are repeated with a certain frequency, this may allow creating a database of already recognized pictures and using them to bypass the check. This can allow clustering, classification, or nearest neighbor search techniques to be used to identify similar images. The use of weak generation algorithms can allow hacking or imitating such

algorithms and predicting or simulating the results of their work. Also, it may allow using methods of reverse engineering, decoding or feature extraction to identify rules or regularities in the generation.

Artificial intelligence can pose a threat to CAPTCHA if they are able to bypass verification and mimic human behavior. This can lead to a breach in the security of sites and services that use this verification to protect against automated attacks. For example, artificial intelligence may use machine learning, machine vision, or natural language processing techniques to recognize the text, images, or sounds used in tests and enter the correct answer. AI can also use planning, search, or optimization techniques to perform more complex tasks that require logic, contextual understanding, or creativity. AI-powered bots are rapidly advancing and can now outsmart the reCAPTCHA methodology used to verify the authenticity of users on various websites. They do so by mimicking the human brain and visual recognition processes. Experts from Microsoft, the Swiss Federal Institute of Technology Zurich, the University of California, Irvine, and the Lawrence Livermore National Laboratory, involving 1,400 participants who tested websites using CAPTCHA puzzles, experimented. 120 out of the top 200 websites in the world used these puzzles. The accuracy of bots ranged from 85% to 100%, with most exceeding 96%. Some tests required humans 9 to 15 seconds to solve with an accuracy of approximately 50% to 84%, while bots could solve them in less than a second and do so almost perfectly [3].

Although CAPTCHA is used primarily for security reasons, it can also serve as a benchmark for artificial intelligence technologies. And this fuels the race to improve artificial intelligence and methods for distinguishing humans and machines. When a new program manages to solve a problem in an automated way, it is an improvement in artificial intelligence. But the method of distinguishing a person from a robot is losing its reliability and is also starting to improve.

In summary, CAPTCHA helps prevent automated attacks such as forum spam, server resource abuse, fake account creation, and safeguarding against attacks on registration, login, comments, surveys, and other malicious activities. This technology also helps protect user’s confidential information from interception or theft. Furthermore, this technology can improve data quality and services by converting handwritten text into digital format or recognizing objects in images. However, it's important to note that some types of CAPTCHAs can be

cumbersome for users, so it's important to use them cautiously and in a balanced manner to avoid creating excessive obstacles for legitimate users.

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Development of Agriculture in England

The article is dedicated to the development of agriculture in Great Britain. The area of agricultural land is decreasing due to land acquisition for urban development and mining. Great Britain is characterized by the presence of large landowners - landlords, who lease parts of their land to farmers (although some farmers have already bought their allotments and own them with permanent rights).
agriculture, land, economy, grain production, farmers, food

The World War of 1914-1918 undermined the agriculture of all warring European countries, including England. England got rid of a huge number of workers, lost a huge number of horses. The switch from agricultural machine building to military production and a sharp reduction in the import of agricultural machines led to inventory wear. The decline of agriculture caused huge food shortages, which were one of the characteristic features of the economy of the First World

War. In England, agriculture occupied a relatively small specific weight. Before the war, food needs were covered mainly by imports. Therefore, Germany, attacking English merchant ships, sought to disrupt its imports and leave the country without food and raw materials. This forced England to begin to expand the cultivated area, which allowed to increase the collection of grain on its own territory. To stimulate the growth of cultivated areas and increase the gross grain harvest, the British government established incentive prices for agricultural products, increased their supply of agricultural equipment, artificial fertilizers and labor. Meadows and gardens were cultivated for grain crops. During the war, the number of horses increased by 2.2%, cattle - by 3%, the number of sheep decreased by 2.1% and pigs - by 15% [1].

On August 5, 1914, a government committee was established to set firm prices and collect data on food stocks. In August of the same year, a commission was created for the purchase of food and military supplies. It was also forbidden to export food, and a few months later this ban was extended to feed for livestock. In October 1916, a state commission was created to control the delivery of flour and grain from overseas countries, and in January 1917, control was established over trade in corn, and in the future, over other grain products. Meat consumption by the working population was also limited and brought under control. In the spring of 1917, measures were developed to deliver 60,000 horses to agriculture, import fertilizers and livestock, as well as to increase the sown area from 7.8 million acres in 1916 to 12 million acres in 1918. But these measures were not implemented due to a lack of workers [2].

On April 25, 1917, the House of Commons adopted a bill on grain production, which includes laws: 1) on minimum prices; 2) on minimum wages; 3) on limiting the right of landlords to increase land rent; 4) on granting the Ministry of Agriculture the right to control over agricultural production. [3].

The bill was not fully implemented, which is explained by the unwillingness of the government to infringe on the interests of landlords and large farmers. However, the law on minimum prices was put into practice, providing producers of commodity bread with high profits, which made it possible to expand the acreage under grain crops and potatoes. But still, imports from the USA and the dominions (Canada and Australia) remained the main source of food for England during the

war. Therefore, the solution to the food problem was the struggle against the German navy, which was attacking the transport of England. And only after this the United States entered the war, the British government was able to create food reserves, thereby restraining the rise in prices and speculation. But the complete food problem in England during the First World War was never solved.

At the current stage of the country's development, agriculture in Great Britain is traditionally characterized by a small number of workers and very high intensity. Only 290,000 people work in it, together with forestry and fishing. Average yields of wheat exceed 70 t/ha, potatoes — 360 t/ha, sugar beet — 420 t/ha. Great Britain has produced many high-performance animals, and the country is now a leading exporter of breeding stock. Many world-famous breeds of cattle, sheep, pigs and horses are named after English counties. This phenomenon was caused by the limitation of land resources, the early development of trade relations, the possibility of improving production in a rich country (as early as in the first half of the 19th century, Chilean saltpeter and Peruvian guano were used in English fields), traditional attention, including by the state, to breeding.

UK farms are large (average size over 70 hectares). They enjoy extensive government support. The share of state subsidies in the value of agricultural products is more than a quarter and is one of the largest in the world.

About 17 million hectares of land are used for agricultural purposes, of which 5 million hectares are arable, 7 are under sown grasses, and 5 are rough pastures (heath wastelands on the highlands). In terms of agricultural production, Great Britain is one of the leading countries in the world, and in terms of sheep population, it is the first in Western Europe.

More than 70% of the value of agricultural products is accounted for by meat, milk and dairy products, eggs and wool. Cattle, pigs, sheep are bred bird They grow wheat, barley, potatoes, rapeseed, sugar beets, vegetables and fruits, and flowers. The best agricultural lands and the most intensive farms are located on the plains. In the east and south, arable land and intensive fattening of animals predominate, in the west and north, sheep graze on rough pastures. The allocation of land for numerous parks, estates, and hedges is characteristic [4,5].

Great Britain's agriculture is one of the most mechanized in the

world and has extremely high productivity with a minimum of involved labor resources (1.4%). The country has a developed system of farms (about 250,000) and powerful livestock complexes. The level of self-sufficiency in own agricultural products of the temperate climate zone has increased from 68 to 85% over the past 20 years. Production volumes of such products as grain, beef, pork, poultry, eggs, and milk meet or exceed consumption needs. But many important UK products have to be imported from other countries, including oil, sugar, wheat, bacon, beef and veal. Thus, modern agriculture provides only 75% of the country's population with food.

The soils of the south of the country are fertile, provided a significant amount of mineral and organic fertilizers are applied. In terms of mechanical composition, clay and loamy soils prevail. Brown forest and podzolic soils are common here. Humus-carbonate soils are found on limestones. The land of Great Britain is cultivated and produces high yields. On the marshy lowlands, brown, azolized forest soils have been preserved. Peat fertile soils are common in the Fenland lowlands, in the valley of the River Trent. In the north-western and western regions there are podzolic brown soils, therefore grasses, oats, barley are grown in this part and they specialize in animal husbandry. Turf-podzolic soils are common in the mountainous regions of the Pennines, the Lake District, Cornwall and Scotland. They often become waterlogged and form peat bogs. Pastures with a grass stand prevail here [6].

Intensive agriculture causes arable land to lose about 40-60% of its organic carbon. In England and Wales, almost 4 million hectares of soil are prone to compaction, and more than 2 million hectares are in the zone of increased risk due to erosion[7].

The country's government promises to reward British farmers who protect the soil. The Ministry recognized that farmers need a greater incentive to manage agriculture in such a way as to leave healthy soil for future generations. Such a move is part of state support for British farmers, as opposed to the system used in the EU. After Brexit, farmers will not be paid for land ownership, but funds will be provided for environmental protection and ecological approaches in economic activity [8].

The area of agricultural land is decreasing due to land acquisition for urban development and mining. Great Britain is characterized by the

presence of large landowners - landlords, who lease parts of their land to farmers (although some farmers have already bought their allotments and own them with permanent rights).

Crop production is dominated by the cultivation of cereals (over 30% of arable land), dominated by wheat (18%) and barley (11%), as well as oats. The main breadbasket of Great Britain is East Anglia and especially the South East, as well as the suburbs of Greater London. Technical crops are represented by sugar beet and potatoes (England), long-stemmed flax. Areas of flower growing, hop growing, vegetable growing, fruit growing, and berry growing were formed around large cities. More than half of the sown areas are occupied by perennial forage grasses [9].

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Corn Production IN the USA

The article is dedicated to the theme of corn production in the USA. U.S. corn is competitive and available, high-quality and sustainably produced. The U.S. is a reliable and consistent shipper of U.S. corn that meets the contracts our global customers sign. This transparency allows U.S. corn to remain competitive in the international marketplace.

corn, production, reliable, high-quality, economic growth

Corn is grown in most U.S. States, but production is concentrated in the Heartland region (from the Great Plains through Ohio). Iowa and Illinois, the top corn-producing States, typically account for about one-third of the U.S. crop. Here is the list of major states in the United States in the corn industry [2].

1) Iowa – Out of the United States 13.7 billion bushels, Iowa produces 2.5 billion bushels. Iowa is the biggest corn producer in the United States, with 90% of its land being used for agriculture. Illinois follows Iowa as the second largest corn producer, and Nebraska and Minnesota follow afterwards. Combined, the four leading corn producers yield more than 54% of the nation's corn. The largest corn producer holds the title due to its high corn production, which can be credited to the state's soil which is the most fertile topsoil in the world. In addition to its soil, the state also has the top farmers in the world.

2) Illinois – Last year, Illinois accounted for the top five counties in the US with the highest corn production. McLean County held the leading spot for the country's corn yield, with around 71 million bushels of corn. The state's best-producing counties ranked as follows McLean County, Iroquois, Livingston, LaSalle, and Champaign counties (second to fifth rank).

3) Nebraska – Nebraska grows corn for various purposes, from feed ingredients to ethanol production feedstock. It has a competitive edge over other producers since it carries out a combination of corn, livestock and ethanol production, which adds great value to the production chain. The state has 21,500 corn farmers that produce, around 25 operational ethanol plants and the title for the second largest ethanol and distillers grains producer.

4) Minnesota – Corn cultivation in Minnesota ranks 4 in corn production and is also grown on Loess soil in southeast and southwest Minnesota. Corn in Southcentral, central and southwest Minnesota is mainly rotated with soybean and is cultivated in collaboration with confinement hog production or poultry production.

5) Indiana – In Indiana, corn production accounts for over half of the state's cropland. It is the top crop grown in the state, accounting for USD 3.28 billion in sales. Most of the corn produced in the state is used as feed for cows, pigs, and chickens. It also supplies more than 20% of the nation's popcorn supply and generates over USD 636 million, making Indiana the country's fifth largest exporter of corn.

6) Kansas – Corn is a crucial commodity for the agricultural economy in Kansas and aids the cattle industry for feed and also works as a raw material in ethanol production. They have operations on a 5.5 million acre land, ranking in the 6th position in terms of corn production in the country.

7) South Dakota – Farmers in South Dakota produce over 4 million acres of corn each year for a range of applications from plastic to ethanol production for fueling automobiles. It is also used in soda as a sweetener.

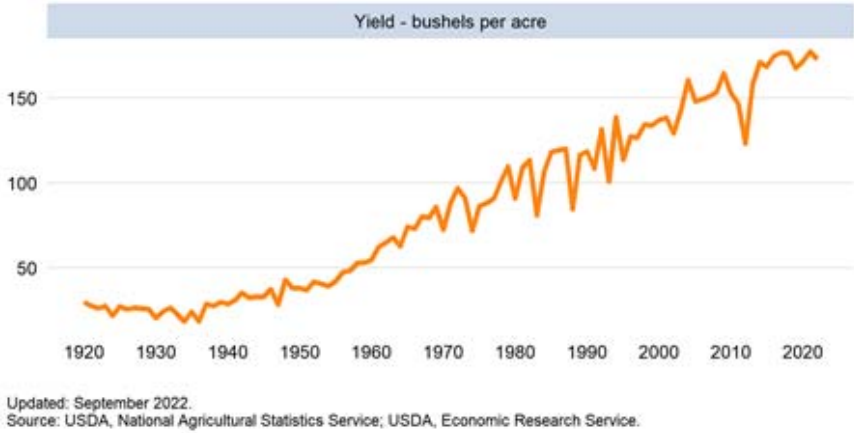
8) Ohio – Corn in Ohio, with their 2022 average corn yield coming at 187 bushels per acre lower compared to other years, but the state still remains a major producer of corn.

9) Missouri – Missouri has a Missouri Corn Growers Association (MCGA), which is a grassroots community of farming members that contribute to corn production and its profitability with a significant focus on the corn market, collection and distribution, forming alliances with other organisations and industries, and taking part in government processes. They pay close emphasis on boosting environmental stewardship as well as protecting producer rights to gain profits from farming.

10) Wisconsin – Wisconsin corn production is mainly used for ethanol production, feed for livestock and exports or food.

Corn production has risen over time on increased area and higher yields. Improvements in technology (seed varieties, fertilizers, pesticides, and machinery) and in production practices (reduced tillage, irrigation, crop rotations, and pest management systems) have significantly boosted harvest volumes over the past two decades.

Corn production is vital for the country's economic growth since it is a staple grain used in food, seed and industrial processes. The US is responsible for exporting around 38% of the total corn to other regions in the world.



Updated: September 2022.
Source: USDA, National Agricultural Statistics Service; USDA, Economic Research Service.

Strong domestic demand for livestock feed and fuel ethanol coupled with growing exports has led to higher prices, providing incentives for farmers to increase corn acreage. In many cases, farmers have increased corn planted area by shifting acres away from less-profitable crops. Corn production has also expanded to nontraditional growing areas, especially in the north, as short-season hybrids have been developed.

Despite corn’s popularity on the dinner table, approximately 55-60% of the U.S. corn crop is actually used for livestock feed, 10-20% is exported, human food use accounts for 8-10%, and between 35 to 40% of the U.S. crop is used to produce ethanol [4].

Ethanol is considered a low-cost liquid transportation fuel. Dry millers in the U.S. account for more than 50% of the ethanol produced in the world, which is then exported to about 50 countries. Approximately one-third of the byproduct that is generated by the ethanol process becomes animal feed, most often in the form of distiller's grains, corn gluten feed and corn gluten meal.

Domestic sweet corn production is mainly concentrated in California and New York for fresh markets, whereas Minnesota, Wisconsin, and Washington state are the most common regions for processing markets. Domestic production accounts for ~85% of US fresh and processing sweet corn consumption. From 1987 to 2016, the amount of fresh sweet corn consumed per person in the United States increased from 2.7 kg/person to 3.6 kg/person. However, since 2017, fresh sweet corn consumption has decreased from 3.2 kg/person to 1.8 kg/person in 2021. From 1987 to 2021, per capita consumption of processing sweet corn has decreased from 8.6 kg/person to 5 kg/person, with the greatest proportion of that drop coming from sweet corn for canning [1].

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U.S. corn has many advantages. While price is a clear one, buyers also get built-in advantages including transparency in pricing, reliable delivery, the U.S. government's inspection service, contract sanctity, corn quality data and customer servicing offered by no other origin.

Corn is a major component of livestock feed. Feed use, a derived demand, is closely related to the number of animals (cattle, hogs, and poultry) that are fed corn and typically accounts for about 40 percent of total domestic corn use. The amount of corn used for feed also depends on the crop's supply and price, the amount of supplemental ingredients used in feed rations, and the supplies and prices of competing ingredients[5].

Corn also has food, seed, and industrial (FSI) uses, the most significant of which is fuel ethanol. Total FSI makes up close 60 percent of total domestic corn use.

Aside from fuel ethanol, corn is also processed for human

consumption and other industrial uses. During processing, corn is either wet or dry milled depending on the desired end products:

- Wet millers process corn into high fructose corn syrup (HFCS), glucose and dextrose, starch, corn oil, beverage alcohol, industrial alcohol, and fuel ethanol.
- Dry millers process corn into flakes for cereal, corn flour, corn grits, corn meal, and brewers grits for beer production.

Corn is the largest component of the global trade of feed grains (corn, sorghum, barley, and oats), generally accounting for about 80 percent of the total volume over the past decade. The United States is the world's largest corn exporter and exports between 10 and 20 percent of its total production volume. The largest international markets for U.S. corn are Mexico, China, Japan, and Colombia. Corn export competition from Brazil, Argentina, and Ukraine has grown over time in response to increased worldwide demand and total shipments from these countries comprise more than 50 percent of the global annual corn trade [3].

The goal of this study was to better understand national trends in corn production and sweet corn grown for processing. Using field-level, long-term commercial production data, the research used a scale much finer than the national or state level to gain new insight into processing sweet corn production in the United States, including hybrid lifespan and trends in yield, plant population density, and planting date.

In agreement with national trends, harvest area has been declining. Additionally, these data reveal downward trends in production for all but the Wisconsin-Irrigated production area. Corn grown under rainfed production systems is declining the greatest because the crop is susceptible to yield losses exacerbated by adverse weather. For the past 3 decades of processing sweet corn production, plant population density and planting dates have remained unchanged. Additional research to understand causal relationships between sweet corn yield and underlying climatic and nonclimatic variables to stabilize the processing sweet corn industry, particularly in a future with more frequent extreme weather events.

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