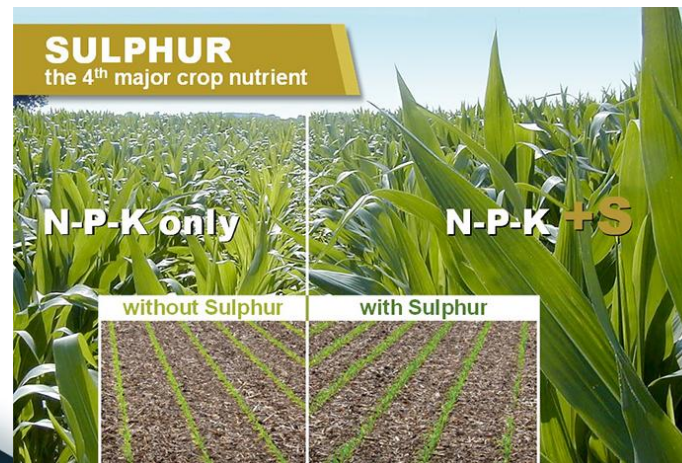


The Sulphur Institute at 65

FRST Collaborator Meeting
September 12, 2025

Ron Olson, Senior Agronomist
rolson@sulphurinstitute.org



The Sulphur Institute at

Established in 1960; 65 years of continuous advocacy to the Sulphur industry. TSI was formed to:

**Transform Sulphur's
Value globally**

**Advance Research and
Technological Innovation**

**Facilitate Industry
Collaboration and
Knowledge Sharing**

**Establish Safety and
Environmental Practices**

**Conduct Educational
Outreach and
Workforce Development**



Each of these contributions has been instrumental in evolving the Sulphur industry, ensuring that it remains dynamic, innovative, and sustainable in today's ever-changing industrial landscape



Freeport Sulphur Company
Hoskins Mound, Texas. May 1943

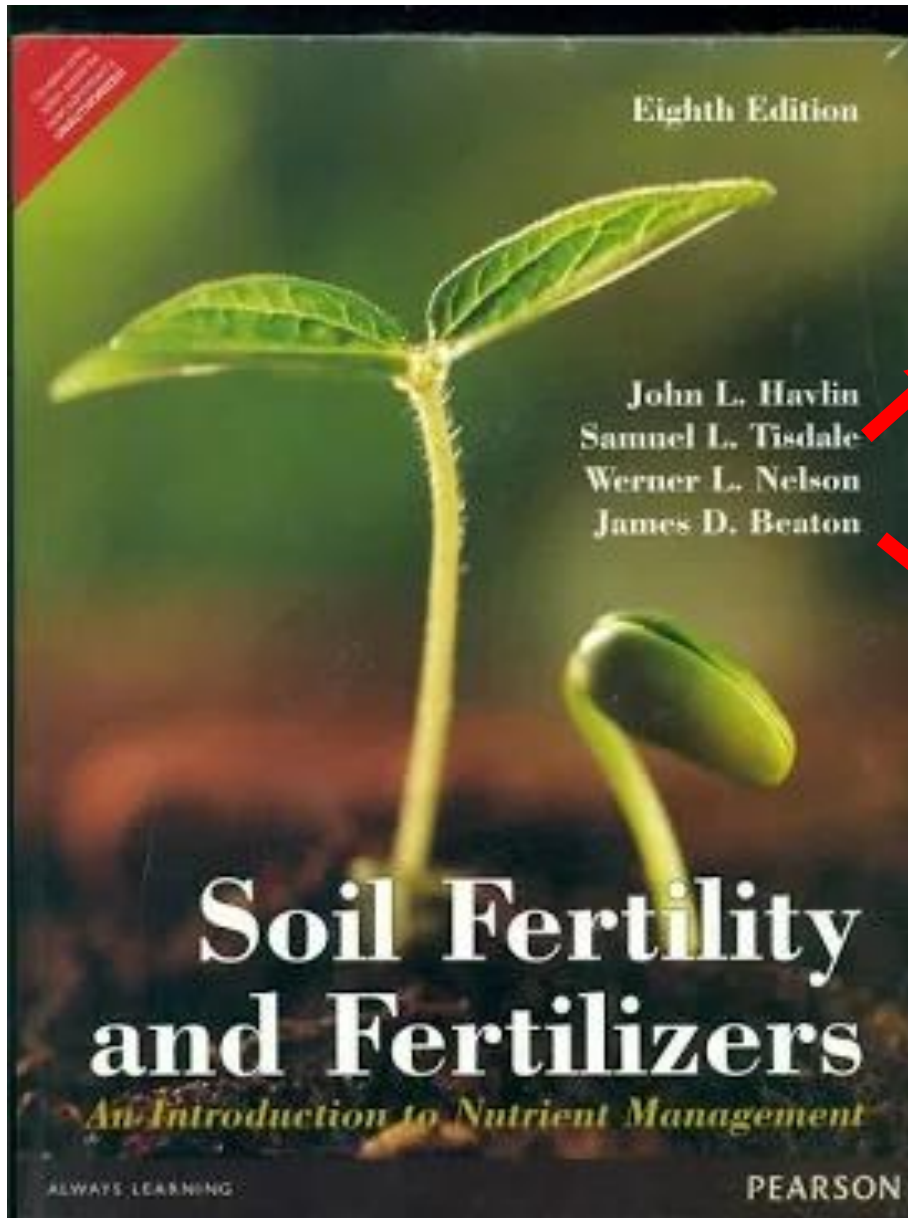


TSI Photo Archive, 2012



TSI Photo Archive, 2017

Agronomy has lead The Sulphur Institute...



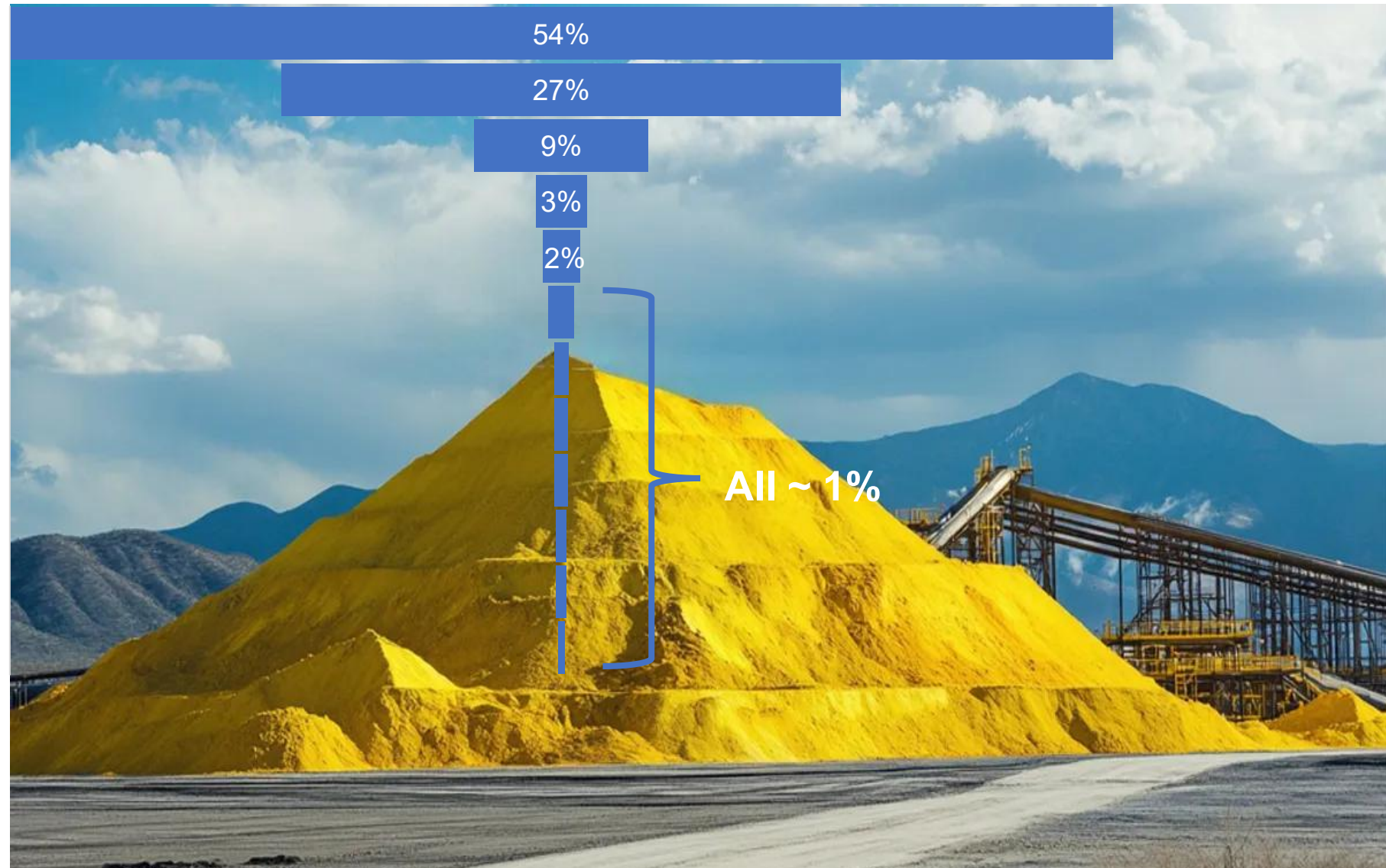
Dr. Samuel L. Tisdale joined TSI in 1960 as its first Director of Agricultural Research and later served as President of TSI from 1979-1984 when he retired after 25 years at TSI.

Dr. James D. Beaton was the Director of Agricultural Research at TSI from 1973-1978. He became Western and Northwest US Director of PPI in 1978 -1988; in 1988 he became President of PPIC until he retired in 1994. He was a leading Sulphur crop nutrition advocate for western Canada. He is credited with first calling **Sulphur the 4th Major Crop Nutrient** in a 1980 presentation.

Sulphur use in Ag & Industrial applications

Percentage of US sulphur used in industrial applications

Phosphate Fertilizer Production
Petroleum refining alkylation
Other agricultural chemicals
Copper ores
Nitrogenous fertilizers
Pulp mills and paper products
Storage batteries (acid)
Other inorganic chemicals
Paints and pigments
Other ores
Other chemical products
Water-treating compounds





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THE SULPHUR INSTITUTE

The global association for sulphur and sulphuric acid professionals.

<https://www.sulphurinstitute.org/>

FY24-25 Member Companies

Governing Members (32)

Producers

BP Products North America
Chevron Products Supply and Trading
ExxonMobil Oil Corporation
Jupiter Sulphur LLC
Koch Sulfur Products Company
Phillips 66
Shell Sulphur Solutions
Valero Marketing and Supply
Veolia North America

Consumers

AdvanSix
CHS Industries
Freeport McMoRan
Interoceanic Corp.
ITAFOS
Nutrien
JR Simplot
Tessenderlo Kerley
The Mosaic Company

Marketers

Chemtrade Logistics
ICEC; an HJ Baker Company
International Raw Materials
Martin Operating Partnership
Mitsui & Co. (U.S.A.), Inc.
NorFalco
Rio Tinto
SATCO
Trammo, Inc.
TRICON Energy

Service Providers

Savage Services Corporation
Sultran Ltd.

Sulphur Associates (16)

Small Companies

CITIS, S.A.
Georgia Gulf Sulfur
Ioneer, Inc.
Lithium Nevada Corp
Montana Sulphur
SRx Sulfur

Transportation Associates

Aztec Marine
CSX Railroad
Gulf Transport
Iron Horse Services
Schiber Truck Company
Tengiz Trans Group
The Greenbrier Companies
Trinity Rail
Union Tank Car Company
Zwaans van der Heuvel Tankvaart

Sulphur Affiliates (12)

Consultants / Publishers / Non-Profits

Acuity Commodities
Argus Media
Con-Sul
CRU
ICIS
IFA
IHS Markit

Equipment Suppliers

Carboline Coatings
Penflex Hoses
TransQuip USA
Durlon Sealing Solutions
SBS Steel Belt Systems

The Sulphur Institute – Agronomy Steering Committee/ASC

Company

Nutrien

The Mosaic Company

Shell
Consulting

ConSul, Inc

Invited Guest

InterOceanic Corporation

AdvanSix

Tessenderlo Kerley

Simplot

CHS

EZ Sulphur

The Sulphur Institute

Representative

Alan Blaylock – Chairman / Mike Howell

Tryston Beyrer

Kent Martin – Martin Agronomic & Env.

Rafael Garcia – Shell Canada

Gerard “Jerry” d'Aquin

Greg Schwab/Elevar Partners

Bob Hartman

Mercedes Gearhart

Zack Ogles

Bobby Golden

Jake Niederer

Charles Ingoldsby

Ron Olson/Staff Lead



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SULPHUR IN AGRICULTURE

TSI'S PROMOTION OF SULPHUR FERTILIZER USE

Sulphur – The Fourth Major Crop Nutrient

Nitrogen (N), phosphorus (P) and potassium (K) are critical components of a well-fertilized crop. But to achieve yields and more nutritious foods, crops need sulphur (S). This website is an introduction to sulphur and its important role in agriculture.

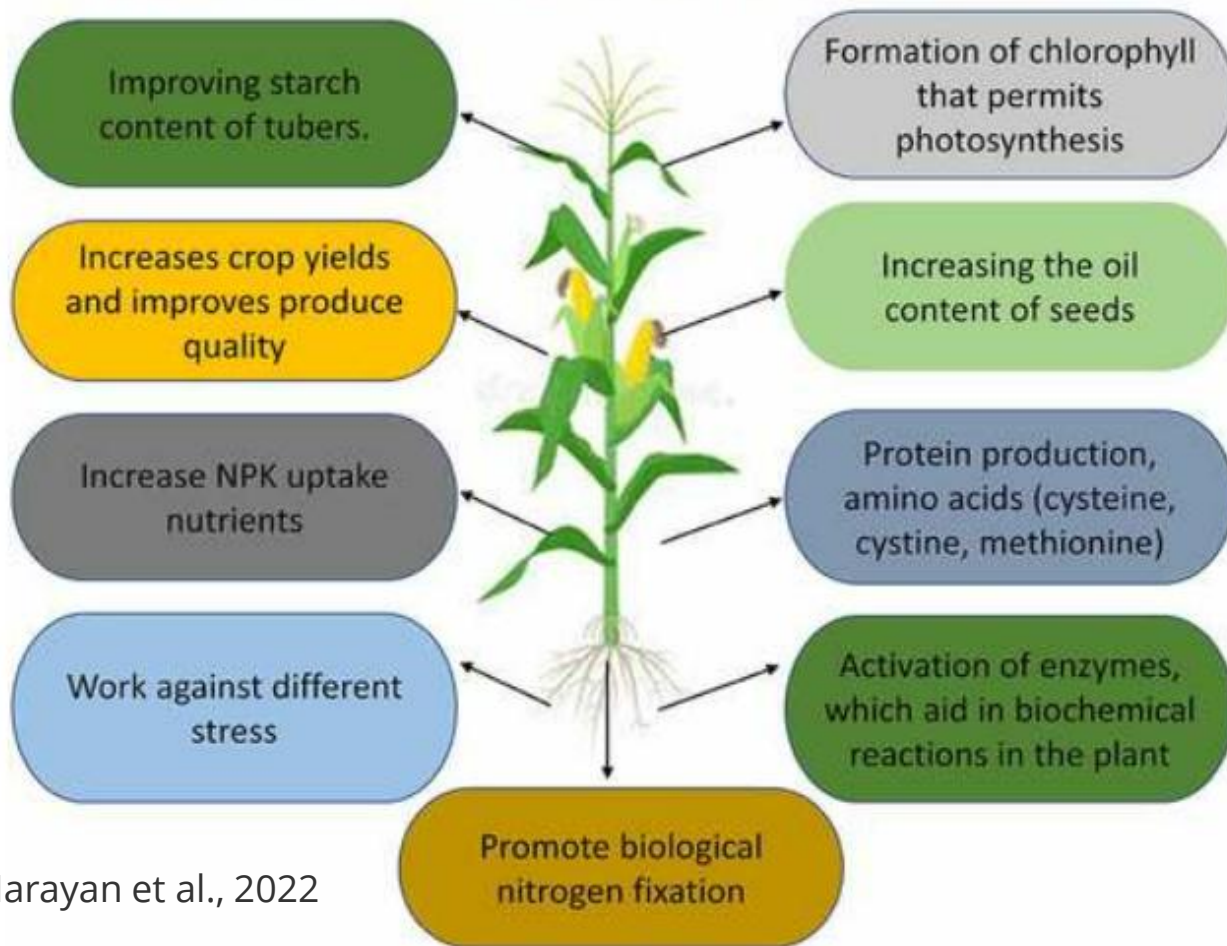
<https://www.sulphurinstitute.org/sulphur-in-agriculture/sulphur-the-fourth-major-crop-nutrient/>

TSI Strategy

Value Statement and Value Drivers



Role of Sulphur in Plant Growth and Development



Narayan et al., 2022



Immobile in the plant symptoms occur in new growth

Education and Training Advocacy Papers




Sulphur Fact Sheet

An Introduction to Sulphur

- Sulphur is a non-metallic chemical element identified by the letter S.
- 85 million tonnes of sulphur in all forms are produced annually around the globe.
- Approximately 97% of elemental sulphur is produced worldwide from natural gas processing and oil refining. As a result, sulphur production is mainly concentrated in areas with significant sour gas processing and/or oil refining capacity, including North America, throughout Asia, the Middle East, and the former Soviet Union region. Approximately 2% of the global sulphur supply is produced from Frasch mining with the remaining 1% in other forms.
- Without sulphur, our modern agricultural system would not be possible, nor would the affordable refining of economically critical metals like copper, nickel, and lithium, which are important today and are increasingly important for the energy transition. Since antiquity, sulphur has played an essential role in everyday life. It has been used to bleach linens, mix pigments, disinfect, fumigate, make gunpowder, and support wellness and agriculture in the form of Epsom salt.
- Sulphur occurs naturally in the environment in a variety of compounds and is the thirteenth most abundant element in the earth's crust.
- Over half of the world's annual elemental sulphur production is traded internationally.

Understanding The Chemical Properties of Sulphur



COMPOUNDS

Familiar compounds are sodium sulphite, hydrogen sulphide (a toxic gas that smells like rotten eggs) and sulphuric acid.

OXIDATION


The common oxides are sulphur dioxide (SO₂) and sulphur trioxide (SO₃), which when dissolved in water make sulphurous acid and sulphuric acid, respectively.

REACTIVITY

It is chemically reactive, especially upon heating, and combines with almost all the elements.

The correct spelling for the chemical element is "sulphur" in American English, while "sulfur" is the preferred spelling in British English.

FACT SHEET www.sulphurinstitute.org



Sulphur, a Chemical Element that Improves People's Lives

Sulphur removed from oil and gas provides a critical manufacturing input for hundreds of everyday products

BACKGROUND

Sulphur compounds removed from refined petroleum products improves air quality. Since the early 1970's, countries worldwide have been reducing sulphur dioxide emissions from gasoline to help control the effects of "acid rain". This increase in sulphur supply eliminated Frasch Mining, which is more environmentally destructive. Sulphur is an essential product that is used in numerous agricultural and industrial applications that support our everyday lives.

The Numbers ⁽¹⁾

Worldwide **85 million tonnes** of sulphur is produced annually



The largest sulphur producing countries are **China, USA, Saudi Arabia, UAE, and Russia**

The US produces **over 8 million tonnes** of sulphur annually.

The US imports **1.3 million tonnes** of sulphur and exports **1.8 million tonnes**

US Domestic Sulphur Trade

- Liquid sulphur is produced at refineries and gas plants then loaded into tank cars and tank trucks
- Sulphur moves safely across all Class I railroads in 24,000 tank car shipments annually⁽²⁾
- The largest sulphur producing states are Texas, Louisiana, California, Illinois, and Wyoming⁽³⁾
- The largest sulphur consuming states are Florida, North Carolina, Louisiana, Texas, and Idaho⁽⁴⁾



The Sulphur Institute champions the essential scientific & social benefits provided by sulphur - an element that improves people's lives.
www.sulphurinstitute.org



Sulphuric Acid Fact Sheet

An Introduction to Sulphuric Acid

Sometimes referred to as the "King of Chemicals," sulphuric acid is a strong inorganic acid (H₂SO₄) that is soluble in water at all concentrations and is produced in greater amounts than any other chemical besides water.

Sulphuric acid, the world's most widely used chemical, is a key intermediate in chemical and manufacturing industries, supporting processes from metals to fertilizers.

Primary uses include: Ore processing (copper, nickel, lithium), Phosphate manufacturing, Nitrogen, potassium, and sulphate fertilizer production, Oil refining, Wastewater treatment, Chemical synthesis.

Sulphuric acid is preferred over acids like HCl, HNO₃, and HF because it is strong, low-volatility, recyclable, and safer for large-scale use.

Used sulphuric acid is often recovered and recycled in metal refining, fertilizer production, and chemical manufacturing, supporting a circular economy.

Understanding The Chemical Properties of Sulphuric Acid

Sulphuric acid is also used in many other industries, metal production (including lithium and other non-ferrous metals), fertilizer manufacturing, pharmaceuticals, water treatment, and the production of pigments, fibers, rubber, and personal care products.

Strong Acidity

Sulphuric acid is a very strong acid — It ionizes completely in water to give hydrogen ions (H⁺) and hydrogen sulfate ions (HSO₄⁻).

Reacts with Metals

With active metals (like zinc), dilute Sulphuric acid produces hydrogen gas.

Strong Dehydrating Agent

Sulphuric acid removes water (H₂O) from substances. It can dehydrate sugars, paper, and even some gases.

Oxidizing Agent

Concentrated Sulphuric acid can act as a powerful oxidizer. It can oxidize metals (like copper) and non-metals (like carbon and sulfur).

Reacts with Bases and Carbonates

Reacts with bases (e.g., sodium hydroxide) to form salt and water (neutralization) and carbonates to form salt, water, and carbon dioxide.

FACT SHEET www.sulphurinstitute.org

Working on additional info graphics to support sulphur use

65 Ways Sulphur Improves People's Lives

The Sulphur Institute

1,677 followers

· Improves People's Lives

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Sulphur Improves People's Lives

Sulphur is a necessary component for the proper functioning of insulin in the human body

Sulphur plays a crucial role in the production of insulin. The two amino acids that make up insulin are joined together by disulfide bonds, which are formed by sulphur. Without sulphur, the body cannot produce insulin, which is essential for the proper functioning of the body.



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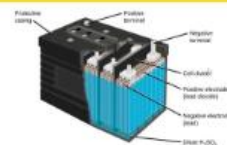
🌐 65 Ways Sulphur Improves People's Lives

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65 Ways Sulphur Improves People's Lives

3 Sulphuric acid is the key chemical that powers vehicle batteries

Sulphuric acid acts as the electrolyte in a lead-acid battery, allowing the chemical reactions to occur that generate electricity when the battery is discharged; essentially, the sulphuric acid facilitates the transfer of electrons between the lead plates within the battery. The lead-acid battery is the primary source of power for starting a vehicle by supplying electricity to the ignition system.



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65 Ways Sulphur Improves People's Lives

2 Sulphur is the primary industrial input used in the production of phosphate fertilizers

Approximately 55% of global sulphur production is used in the manufacturing of phosphate fertilizer. This multistep process involves burning sulphur to make sulphuric acid (H₂SO₄), which then reacts with phosphate rock to produce phosphoric acid. The phosphoric acid then reacts with ammonia to create phosphate salts like diammonium hydrogen phosphate (DAP) and monoammonium dihydrogen phosphate (MAP), which are commonly used as phosphorus-based fertilizers.



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4 NUTRIENT MANAGEMENT PRACTICES FOR COTTON PRODUCTION

Benefits of sulphur in cotton

- Required for amino acid and protein synthesis.
- Increases chlorophyll production.
- Improves root growth and nitrogen uptake.
- Essential for healthy green plants.
- Sustains high cotton yields.

SULPHUR
the 4th major crop nutrient



4 NUTRIENT MANAGEMENT PRACTICES FOR CANOLA PRODUCTION

Benefits of sulphur in canola

- Required for oil and protein synthesis.
- Increases chlorophyll production.
- Supports grain formation.
- Essential for healthy green plants.
- Sustains high canola yields.

SULPHUR
the 4th major crop nutrient



Six downloadable 4R Nutrient Management Guides for key Crops of Alfalfa, Corn, Canola, Cotton, Small Grains & Soybeans

<https://www.sulphurinstitute.org/sulphur-in-agriculture/tsis-promotion-of-sulphur-fertilizer-use/>

Sulphur's Secret: Boosting Nitrogen Efficiency in Diverse U.S. Crops

Greg Schwab, Ph.D., CPAg

ASA/CCA Webinar

February 13, 2025



ELEVAR
PARTNERS

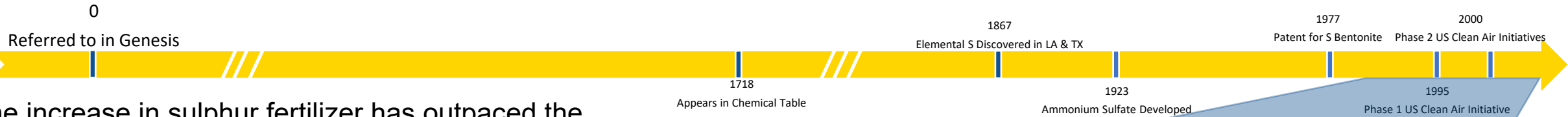
Sulphur's Emergence as an Essential Crop Nutrient

ASA/CCA webinar
January 11, 2024

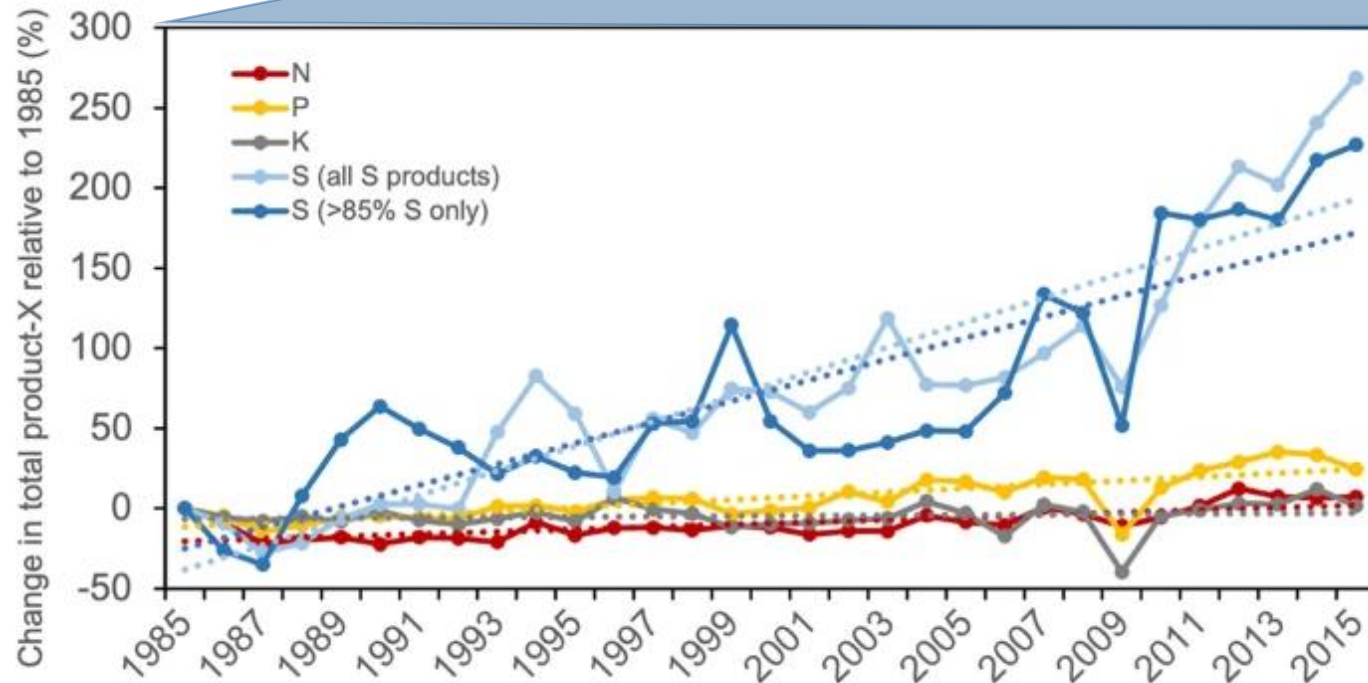


Sulphur...the 4th Major Crop Nutrient

Sulphur Fertilizer Through the Years



“The increase in sulphur fertilizer has outpaced the relative rate of change in other major nutrient fertilizers including nitrogen, phosphorus and potassium, by approximately 7-fold prior to 2009, and 29-fold after 2009.” – Hinckley and Driscoll





THE SULPHUR INSTITUTE'S
**SULPHUR WORLD
SYMPOSIUM 2026**
— APRIL 28 - 30 —
VANCOUVER, CANADA

- JW Marriott contract signed
- Panel on projects creating sulphur demand in North America
- Registration and sponsorship launch in Q4
- Tour of Pacific Coast Terminal

SWS 2027 – Candidate Cities

- Antwerp, BE
- Vienna, AT
- Lugano, CH





THE SULPHUR INSTITUTE'S
**SULPHUR WORLD
SYMPOSIUM 2025**
— APRIL 8 - 10 —
FLORENCE, ITALY

***Value Drivers at Work**

Agronomy Steering Committee Meeting – Round Table
April 8 – 13:00-17:00

**FAO Cropland nutrient
balance (Global,
regional and country
trends, 1961–2022)**

**Dr. Eve Hinckley –
University of Colorado at
Boulder – “Recognizing
Sulphur’s expanded Role
in Feeding the World”**

***Professional Connections**

**Sulfur shortage: a
potential resource crisis
looming as the world
decarbonises**

**Meena Chauhan – Argus
Media – Head of Sulphur
and SA Research –
“Sulphur Shortage-
Potential Resource Crisis”**

***Protecting how you conduct business**

**Dr. Zack Ogles –
Tessenderlo Kerley – U.S.
– “Thio-Sul & Nitrogen
Use Efficiency”**

***Industry Leading Practices**

**Tessenderlo Kerley Thio-Sul receives
double inhibitor registration in the EU**

**Dr. Roger Sylvester-
Bradley – Yield
Enhancement Network –
ADAS
“Measure to Manage”**

***Thought Leadership**

**Securing our food and
enhancing the environment**



Inaugural Sulphur Crop Nutrition Seminar

Dr. Greg Schwab – Moderator

Koch Agronomic Services, Inc.

Sulphur...

the 4th Major Crop Nutrient

Inagural Agronomy Round Table

Edinburgh, Scotland -April 26, 2023



Dr. Ismail Cakmak, Sabanci
University
Istanbul, Turkey



Dr. Alan Blaylock
Sr. Agronomist - Nutrien

Dr. Rob Mikkelsen
Agronomy Director – Yara



Dr. Malcolm Hawkesford
Rothamsted Research
Lead of the Designing Future Wheat Program

Dr. Shamie Zingore – Director of
Research and Development
African Plant Nutrition Institute



THE SULPHUR INSTITUTE AND IFA LAUNCH GLOBAL ASSESSMENT OF CROP SULPHUR BALANCE AND LIMITATIONS



University of Colorado
Boulder



For the first time in over two decades, a coordinated global effort is underway to evaluate sulphur balance and limitations in crop nutrition. The International Fertilizer Association (**IFA**), in collaboration with The Sulphur Institute (**TSI**), the **University of Nebraska**, and the **University of Colorado**, has launched a two-year project to improve understanding of sulphur dynamics in agricultural systems

This new two-year project, funded by TSI and IFA members, will cover a broad range of cropping systems across seven global regions. The study's three main objectives are to:

- Quantify emerging sulphur limitations to crop yields in key regions
- Develop a time series of atmospheric sulphur deposition and fertilizer use by country
- Add **sulphur as the fourth major nutrient** to the FAO global Cropland Nutrient Balance database.

Scientific committee

Patricio Grassini & Walter Carciochi (UNL)

Eve-Lyn Hinckley & Connor Olson (CU Boulder)

Achim Dobermann (IFA)

Ron Olson & Craig Jorgenson (TSI)



FAO committee on Cropland Nutrient Use

lead by Achim Dobermann – Chief Scientist for IFA – now to include **N_P_K_S**

<u>Researcher</u>	<u>Institution</u>
Cameron I. Ludemann	Plant Prod. Systems, Wageningen University & Research, The Netherlands
Achim Dobermann	IFA
Nathan Wanner	Statistics Division, FAO, Rome, Italy
Pauline Chivenga	African Plant Nutrition Institute, Benguerir, Morocco
Rasmus Einarsson	Dept of Energy, Swedish Univ of Ag Sciences, Uppsala, Sweden
Patricio Grassini	Dept of Agronomy/Hort, Univ of NE-Lincoln
Armelle Gruere	IFA
Kevin Jackson	Appalachian Lab, Univ of MD Center for Env Sciences
Luis Lassaletta	Dept Ag Production, ETSIAAB, Univ of Madrid, Madrid, Spain
Fredrico Maggi	Env Engineering School of Engineering, Univ of Sydney, NSW 2006, AU
Griffiths Obli-Laryea	Stats Division, FAO, Rome, Italy
Martin K. Ittersum	Plant Prod. Systems, Wageningen University & Research, The Netherlands
Srishti Vishwakarma	Appalachian Lab, Univ of MD Center for Env Sciences
Xin Zhang	Appalachian Lab, Univ of MD Center for Env Sciences
Francesco N. Tubiello	Stats Division, FAO, Rome, Italy
Eve-Lyn Hinckley	Cooperative Institute for Research in Environmental Sciences – University of Colorado-Boulder

Link to FAO Cropland Nutrient Global, regional and country trends 1961-2022

<https://openknowledge.fao.org/server/api/core/bitstreams/99e68874-eb31-416e-94ee-20a9093b4844/content>

65
YEARS

THE
SULPHUR
INSTITUTE

