

CEREAL CROP MONITORING & AGRONOMY GUIDE

**Precision Nutrient Management for Sustainable Cereal
Production.**



MAXIMIZE YIELD

Improve productivity
and grain quality



MANAGE SALINITY

Monitor EC, TDS &
salinity in real time



OPTIMIZE NUTRIENTS

Balanced nutrition for
efficient crop growth



SMART IRRIGATION

Efficient water use for
resilient crops



SUSTAINABLE FUTURE

Data-driven decisions for
sustainable agriculture

Measure, Understand, Act.

Reliable instruments for every stage of
cereal crop management.

LAQUAtwins

Pocket size meters to
help you increase your
yield in the field



Introduction:

Healthy Crops. Higher Yields. Sustainable Future.

Modern cereal production requires integrated nutrient management, irrigation optimisation, salinity control, and precision crop monitoring to achieve sustainable yield improvement.

This agronomy guide provides practical insights into:

- Nutrient management
- Crop monitoring
- Root-zone agronomy
- Salinity management
- Stress detection
- Precision agriculture
- Sustainable cereal production

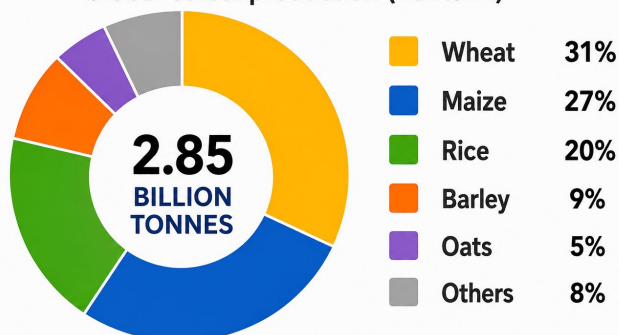
HORIBA LAQUA twin portable meters support rapid field measurements for nutrient monitoring, irrigation assessment, salinity evaluation, and precision agriculture decision-making.

SECTION 1

CEREALS FEED THE WORLD

CEREALS FEED THE WORLD

Global cereal production (2023/24)



Cereals provide more than **50%** of the calories consumed globally.

The chart highlights the major contribution of wheat, maize, and rice to global cereal production and food security. Maize dominates due to its use in feed and industrial applications, while wheat and rice remain essential staple foods worldwide. Smaller cereals continue to support regional agriculture and specialised markets.

Cereal crops are among the most important agricultural commodities worldwide and form the foundation of global food security.

Major cereal crops include:

- Wheat
- Maize

- Rice
- Barley
- Oats
- Sorghum
- Millet
- Rye

These crops support:

- Human nutrition:

Cereals are a major source of carbohydrates, protein, dietary fibre, and energy for billions of people worldwide. Products such as bread, rice, pasta, flour, and breakfast cereals are produced from cereal grains. In many regions, cereals form the foundation of daily food consumption and nutritional security.

- Livestock feed production

A significant portion of global cereal production is used in animal feed systems. Maize, barley, wheat, oats, and sorghum are commonly used in poultry, dairy, beef, and swine nutrition. Feed cereals play a major role in supporting global meat, milk, and egg production.

- Industrial processing

Cereals are widely used as raw materials in industrial manufacturing. They are processed into starch, sweeteners, food additives, bioplastics, and pharmaceutical ingredients. Industrial cereal processing contributes significantly to the global food and biotechnology sectors.

- Biofuel production

Several cereal crops are used in renewable energy production. Maize and wheat are important feedstocks for bioethanol and biogas systems. Biofuel production supports energy diversification and sustainable fuel development.

- Brewing industries

Barley, wheat, maize, and rice are essential ingredients in brewing and fermentation industries. These cereals are used in beer production, whisky distillation, and fermented food processing. High-quality malting cereals are especially important in premium brewing markets.

- International grain trade

Cereals are among the most actively traded agricultural commodities worldwide. International grain trade supports food security, livestock industries, and industrial supply chains. Stable cereal production is essential for maintaining global agricultural markets and economic stability.

Cereals contribute more than half of the calories consumed globally and are cultivated across a wide range of climates and production systems.

SECTION 2

CHALLENGES IN MODERN CEREAL PRODUCTION

MAJOR CHALLENGES THREATENING CEREAL PRODUCTION Environmental and agronomic stresses reduce yield potential, increase costs, and threaten long-term food security.		
 DROUGHT STRESS Water deficits reduce germination, stunt growth, and limit yield potential.	 SOIL SALINITY Excess salts in soil reduce nutrient uptake, inhibit root growth, and lower crop productivity.	 NUTRIENT LOSSES Nutrient leaching, volatilization, and erosion reduce fertilizer efficiency and increase costs.
 CLIMATE VARIABILITY Rising temperatures, erratic rainfall, and extreme weather events increase production risk.	 WATER SCARCITY Limited water availability restricts irrigation and reduces crop yields, especially in arid regions.	 SOIL DEGRADATION Loss of soil organic matter, erosion, and compaction reduce soil fertility and long-term productivity.

Why These Challenges Matter

Modern cereal production faces increasing pressure from drought, salinity, nutrient losses, climate variability, water scarcity, and soil degradation. These challenges can significantly reduce grain yield, nutrient-use efficiency, root development, and overall crop performance while increasing production costs and environmental impact. As global demand for cereals continues to rise, sustainable production practices are becoming increasingly important to improve resource efficiency, protect soil and water quality, reduce nutrient losses, and maintain long-term agricultural productivity.

Climate Variability

Climate variability is increasing production uncertainty in many cereal-growing regions. Key risks include:

- Irregular rainfall
- Extended drought periods
- Heat stress during flowering
- Waterlogging
- Extreme weather events

Stress during reproductive stages may significantly reduce grain set and final yield.

Soil Health Challenges

Long-term intensive production may lead to:

- Soil compaction
- Reduced organic matter
- Reduced biological activity
- Poor infiltration
- Nutrient imbalance

Maintaining healthy soils is essential for stable cereal productivity, efficient nutrient uptake, and long-term sustainability.

Importance of Sustainable Production

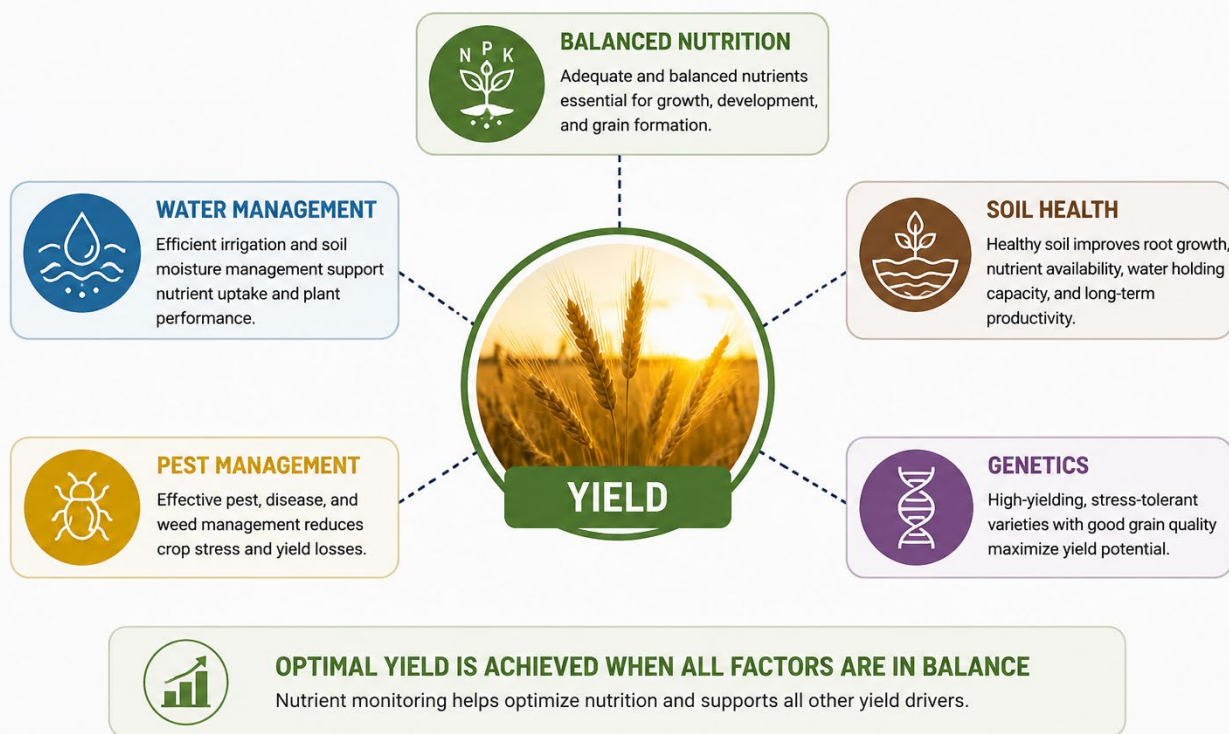
Modern cereal production must balance high productivity with resource efficiency, environmental sustainability, climate resilience, and soil conservation. Improved nutrient management and precision monitoring are becoming increasingly important as growers face rising fertiliser costs, changing climate conditions, and stricter environmental regulations. Sustainable production practices help improve nutrient-use efficiency, protect soil and water quality, and support long-term agricultural productivity.

SECTION 3

WHY NUTRIENT MONITORING MATTERS

YIELD DRIVERS IN CEREAL PRODUCTION

Multiple factors work together to determine yield potential and grain quality.



Cereal crops require balanced nutrient availability throughout the entire crop cycle.

Nutrient demand changes rapidly between:

- Germination
- Tillering
- Stem elongation
- Flowering
- Grain filling
- Maturation

Even small nutrient imbalances may significantly affect:

- Grain yield • Grain quality • Protein content • Root growth
- Water-use efficiency • Stress tolerance • Crop uniformity

Routine nutrient monitoring allows growers to identify deficiencies, stress conditions, and salinity problems before severe yield losses occur.

Benefits of Real-Time Monitoring

Portable field monitoring enables:

- Faster agronomic decisions

- Improved fertiliser timing
- Reduced nutrient losses
- Better irrigation management
- Early stress detection
- Improved crop uniformity
- Higher nutrient-use efficiency

Agronomic Benefits Table

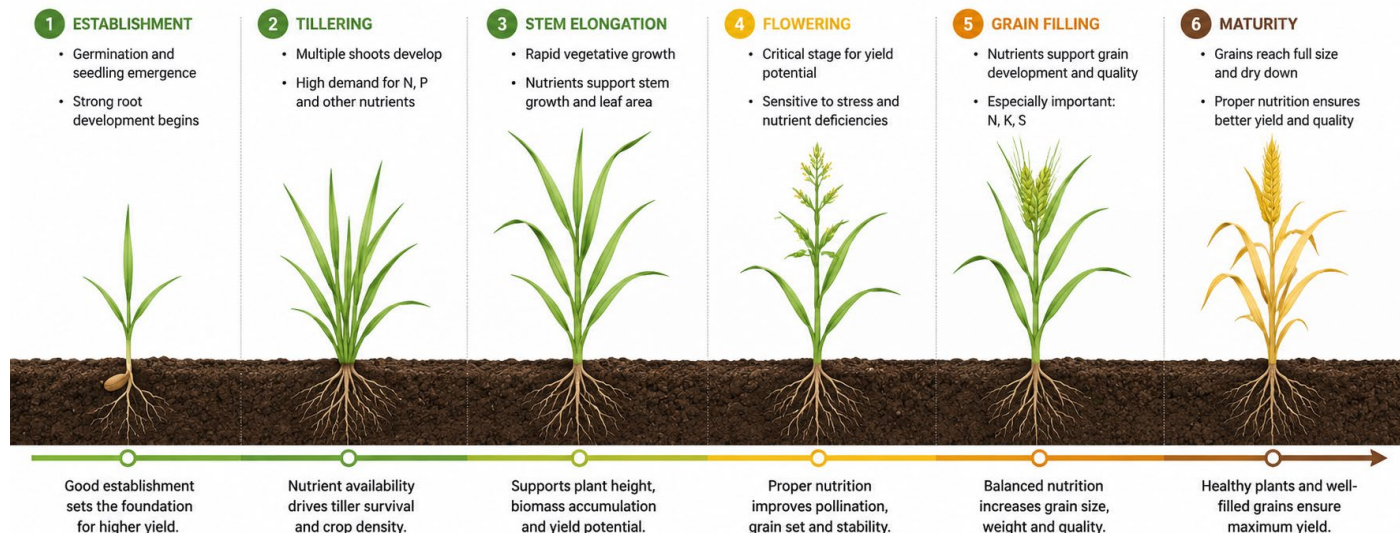
Benefit	Agronomic Impact
Improved nutrient-use efficiency	Reduced fertiliser waste
Better irrigation management	Reduced salinity risk
Early stress detection	Improved yield stability
Precision fertilisation	Improved profitability
Improved root-zone management	Better nutrient uptake
Balanced nutrition	Improved grain quality

SECTION 4

CEREAL GROWTH STAGES & NUTRIENT DEMAND

CEREAL CROP GROWTH STAGES

Nutrient demand changes throughout the crop cycle – monitoring at each stage supports better decisions and higher yields.



Cereal nutrient demand changes continuously throughout the crop cycle, with each growth stage requiring different levels of nutrients, water, and environmental stability to support optimal development. Early growth stages focus primarily on root establishment, seedling vigour, and canopy formation, where adequate phosphorus and nitrogen availability are essential for strong plant development and uniform crop establishment. As the crop progresses toward stem elongation and flowering, nutrient uptake increases rapidly and plants become more sensitive to drought, salinity, heat stress, and nutrient imbalance. During grain filling and maturation, nutrient demand shifts toward supporting grain size, grain weight, protein accumulation, and overall grain quality. Stress conditions during these reproductive stages can significantly reduce final yield potential and crop uniformity. Monitoring nutrient availability, salinity, irrigation quality, and crop condition throughout the growth cycle helps growers optimise fertiliser timing, improve nutrient-use efficiency, reduce environmental losses, and maintain stable cereal productivity.

Growth stage	Agronomic Focus	Key Nutrient Priority	Monitoring Focus
Establishment	Germination, emergence, early root growth	Phosphorus, Zinc, moisture balance	pH, EC, soil moisture, irrigation quality.
Tillering	Canopy expansion and tiller survival	Nitrogen, Phosphorus, Potassium	Leaf nitrate, crop vigour, EC
Stem elongation	Biomass production and stem strength	Nitrogen, Potassium, Sulphur	NO_3^- , K^+ , EC, Plant height
Flowering	Pollination and grain set, disease management	Potassium, Boron, Zinc	Stress, moisture, Leaf K^+ , disease pressure
Grain filling	Grain size, weight, and quality	Potassium, Nitrogen, Magnesium	Chlorophyll, leaf K^+ , soil moisture, grain development.
Maturity	Grain dry-down and harvest quality	Balanced nutrition	Grain moisture, protein, test weight

SECTION 5

ESSENTIAL NUTRIENTS IN CEREALS

Nitrate - Nitrogen (N)

Nitrogen is the primary nutrient responsible for vegetative growth, chlorophyll production, biomass accumulation, and grain protein development. It plays a critical role in canopy formation, photosynthesis, and overall crop productivity, particularly during tillering and stem elongation stages when nutrient demand increases rapidly.



Key Functions	Deficiency Symptoms	Excess Risks
Supports tillering and canopy expansion	Pale green foliage	Lodging
Promotes chlorophyll production and photosynthesis	Reduced tillering	Delayed maturity
Improves biomass accumulation and crop vigour	Slow growth	Disease susceptibility
Supports grain protein formation	Low grain yield	Excess vegetative growth

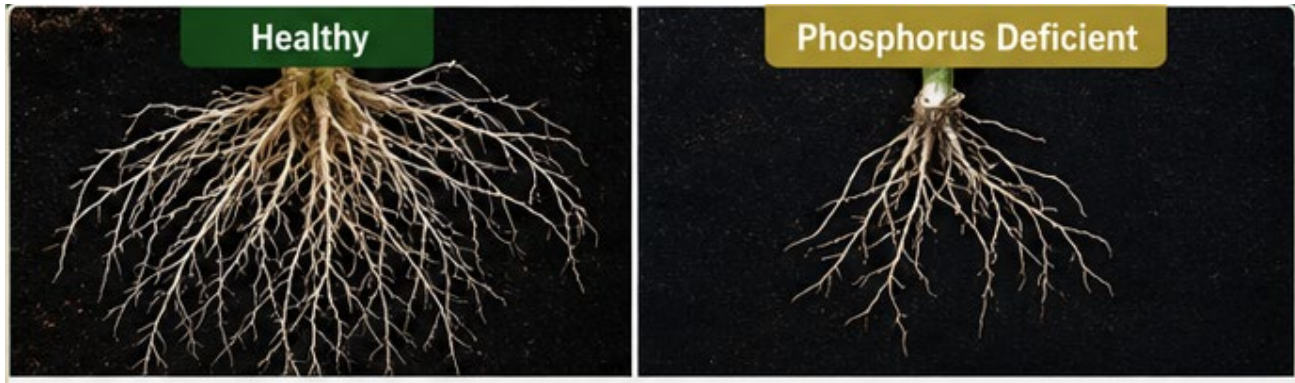


Phosphorus (P)

Phosphorus is essential for root establishment, energy transfer, early plant vigour, and strong crop establishment. It supports early root growth and helps cereals develop healthy root systems capable of efficient water and nutrient uptake during the early stages of development.

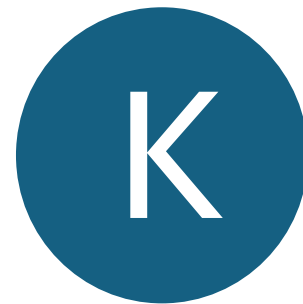


Key Functions	Deficiency Symptoms	Excess Risks
Supports root establishment and seedling vigour	Purple leaf coloration	Poor early vigour
Promotes energy transfer within the plant	Weak root systems	Reduced tillering
Improves early crop development	Slow growth	Reduced nutrient uptake
Supports tillering and crop uniformity	Poor establishment	Lower yield potential

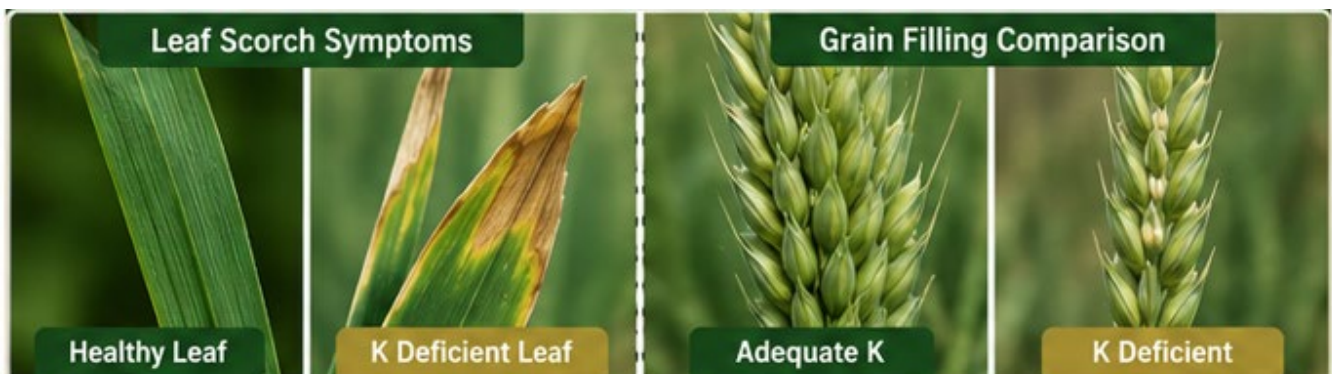


Potassium (K)

Potassium plays a major role in water regulation, stress tolerance, enzyme activation, and grain filling. It helps cereals tolerate drought, improves stem strength, supports grain development, and enhances the crop's ability to respond to environmental stress conditions.



Key Functions	Deficiency Symptoms	Excess Risks
Supports water regulation and drought tolerance	Leaf-edge scorching	Poor grain filling
Improves stem strength and stress resistance	Weak stems	Increased drought sensitivity
Supports grain filling and grain size	Reduced grain size	Reduced stress tolerance
Enhances enzyme activity and crop resilience	Poor canopy strength	Increased lodging risk



Sulfur (S)

Sulfur is important for protein synthesis, enzyme activity, chlorophyll formation, and efficient nitrogen utilisation. It contributes to grain quality and supports overall metabolic activity within the cereal crop.



Key Functions	Deficiency Symptoms	Excess Risks
Supports protein formation and grain quality	Pale young leaves	Reduced grain protein
Improves enzyme activity and metabolism	Uniform chlorosis	Reduced crop quality
Enhances nitrogen-use efficiency	Slow growth	Reduced nutrient-use efficiency
Supports chlorophyll production	Weak development	Lower productivity

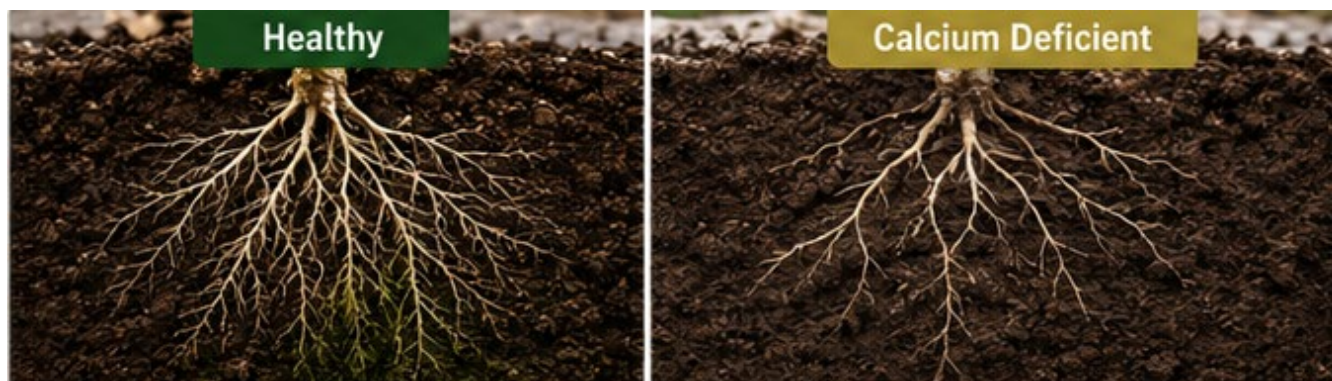


Calcium (Ca)

Calcium supports root development, cell-wall stability, structural strength, and stress tolerance. It is essential for maintaining healthy root activity and improving the plant's ability to tolerate salinity, drought, and other environmental stress conditions.



Key Functions	Deficiency Symptoms	Excess Risks
Supports root strength and root activity	Poor root development	Reduced nutrient transport
Improves cell-wall stability	Weak plant structure	Increased stress sensitivity
Enhances structural support and resilience	Reduced root activity	Poor crop establishment
Supports tolerance to salinity and stress	Weak growth	Reduced resilience under salinity



Magnesium (Mg)

Magnesium is the central component of chlorophyll and is essential for photosynthesis, carbohydrate transport, and energy transfer. Adequate magnesium nutrition supports healthy canopy development, biomass accumulation, and grain filling.



Key Functions	Deficiency Symptoms	Excess Risks
Supports photosynthesis and chlorophyll formation	Interveinal chlorosis	Reduced photosynthesis
Improves energy transfer within the plant	Yellowing between veins	Poor grain filling
Supports carbohydrate movement and metabolism	Reduced plant vigour	Lower biomass production
Enhances canopy activity and grain development	Reduced canopy activity	Reduced crop performance



Micronutrients

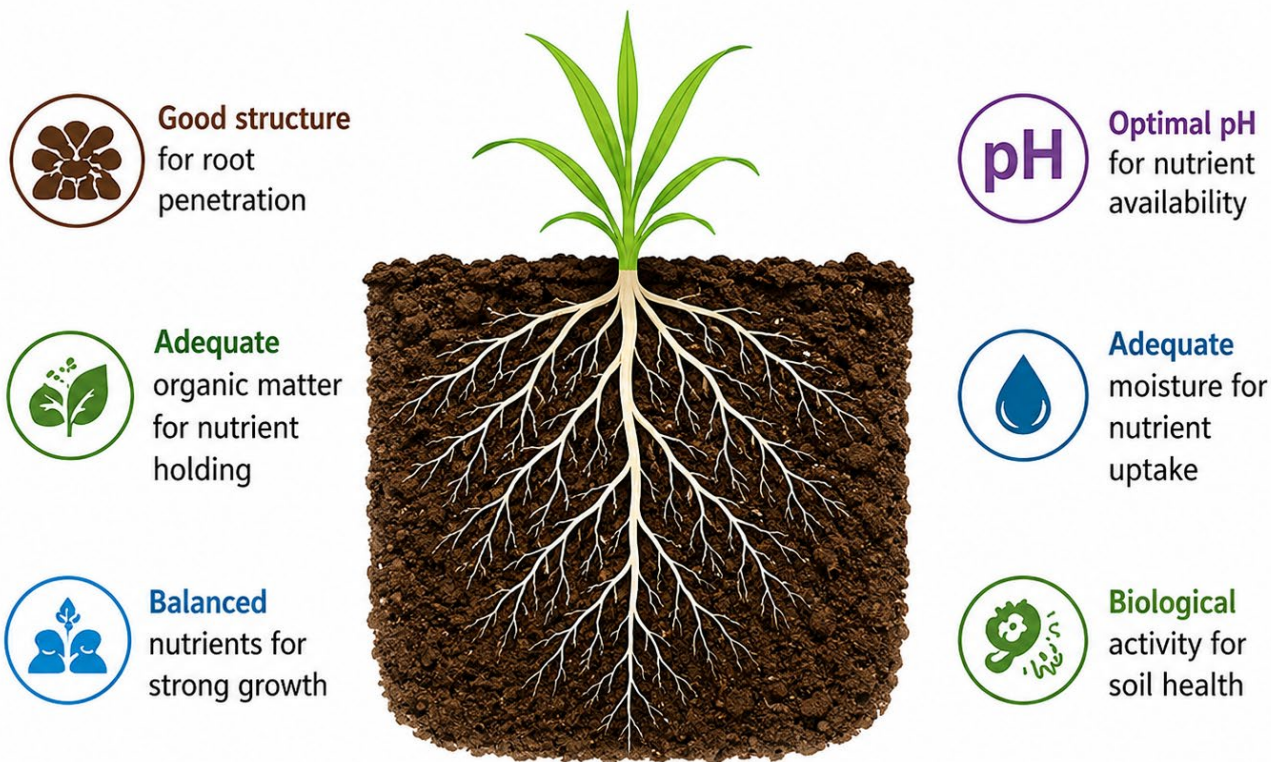
Micronutrients such as zinc, manganese, boron, copper, and iron are required in small quantities but are essential for enzyme activity, root development, hormone regulation, and grain formation. Balanced micronutrient availability supports efficient crop metabolism, stress tolerance, and overall cereal productivity.

Key Functions	Deficiency Symptoms	Excess Risks
Supports enzyme activation and metabolism	Chlorosis	Reduced grain formation
Improves root development and crop vigour	Poor vigour	Reduced nutrient efficiency
Regulates hormone activity and growth	Stunted growth	Lower stress tolerance
Supports grain development and canopy health	Poor canopy colour	Reduced yield potential

SECTION 6

THE ROOT ZONE: WHERE SUCCESS BEGINS

THE ROOT ZONE – WHERE SUCCESS BEGINS



Healthy soils = Healthy roots = Healthy crops = Higher yields

Healthy root systems are the foundation of successful cereal production. Root development is strongly influenced by soil structure, nutrient availability, moisture conditions, pH balance, and biological activity within the root zone. Well-structured soils with balanced nutrients and adequate moisture support efficient water and nutrient uptake, stronger plant growth, improved stress tolerance, and higher yield potential.

Importance of Root Health

Healthy roots are essential for:

- Nutrient uptake
- Water absorption
- Stress tolerance
- Yield stability
- Grain filling

Root systems determine how efficiently plants access water and nutrients from the soil profile.

Factors Affecting Root Development

Soil Structure

Compacted soils restrict: Root penetration, Oxygen movement and Water infiltration.

Salinity

High salinity reduces:

Water uptake, Nutrient transport and Root elongation.

Moisture Conditions

Irregular irrigation may reduce: Root activity, Nutrient mobility and Crop uniformity.

Biological Activity

Healthy soils with active biology support: Nutrient cycling, Root development and Soil structure stability

SECTION 7

NUTRIENT INTERACTIONS & BALANCE

Balance Is Key

Nutrients within the cereal crop do not function independently. The availability, uptake, and efficiency of one nutrient can directly influence the absorption and utilisation of another. Balanced nutrition is therefore essential to support healthy root development, efficient photosynthesis, grain formation, stress tolerance, and overall crop productivity. Understanding nutrient interactions helps growers improve fertiliser efficiency, avoid nutrient antagonism, reduce deficiency risks, and maintain stable crop performance under varying environmental conditions.

Nutrient Interaction	Agronomic Effect
Nitrogen (N) ↔ Sulfur (S)	Sulfur improves nitrogen efficiency and supports protein synthesis
Nitrogen (N) ↔ Potassium (K)	Potassium improves nitrogen utilisation and stress tolerance
Nitrogen (N) excess	Excess nitrogen may increase lodging and disease susceptibility
Phosphorus (P) ↔ Zinc (Zn)	Excess phosphorus may reduce zinc uptake
Phosphorus (P) ↔ Root Development	Adequate phosphorus supports strong root establishment
Potassium (K) ↔ Magnesium (Mg)	Excess potassium may reduce magnesium uptake
Potassium (K) ↔ Water Regulation	Potassium improves drought tolerance and water-use efficiency
Calcium (Ca) ↔ Salinity	Calcium helps reduce sodium toxicity and improves root stability
Calcium (Ca) ↔ Potassium (K)	Balanced calcium improves nutrient transport and uptake
Magnesium (Mg) ↔ Photosynthesis	Magnesium supports chlorophyll production and energy transfer
Magnesium (Mg) deficiency	Reduced photosynthesis and poor biomass accumulation
Sulfur (S) ↔ Grain Quality	Sulfur supports protein formation and grain quality
Zinc (Zn) ↔ Phosphorus (P)	High phosphorus soils may increase zinc deficiency risk
Iron (Fe) ↔ High pH	High pH may reduce iron availability and increase chlorosis
Manganese (Mn) ↔ Soil pH	High pH soils may reduce manganese availability
Sodium (Na) ↔ Potassium (K)	Excess sodium competes with potassium uptake under salinity stress
EC / Salinity ↔ Nutrient Uptake	High EC reduces water and nutrient absorption efficiency
Soil pH ↔ Micronutrients	Extreme pH limits micronutrient availability
Moisture ↔ Nutrient Mobility	Poor moisture reduces nutrient transport to roots
Root Health ↔ Nutrient Uptake	Healthy roots improve nutrient absorption efficiency

SECTION 8

SALINITY & IRRIGATION MANAGEMENT

Importance of Salinity Management

Salinity is one of the major limitations affecting cereal productivity, particularly in irrigated agricultural systems where dissolved salts may gradually accumulate within the root zone. Excess salinity reduces the plant's ability to absorb water efficiently, even when sufficient moisture is present in the soil, leading to physiological drought stress and reduced crop performance. High salt concentrations can negatively affect root development, nutrient uptake, tillering, grain filling, and overall plant growth. Salinity stress may also disrupt the balance between essential nutrients such as potassium, calcium, and magnesium, reducing nutrient-use efficiency and increasing crop susceptibility to environmental stress conditions.

Common Salinity Stress Symptoms in cereals include:

- Leaf tip burn and marginal scorch
- Poor germination and emergence
- Uneven crop establishment
- Reduced tillering
- Stunted root development
- Reduced grain filling
- Lower grain yield and crop uniformity

In severe conditions, prolonged salinity exposure may significantly reduce biomass accumulation, grain quality, and final economic yield.

Excess dissolved salts reduce:

- Water uptake
- Root growth
- Nutrient absorption
- Tillering
- Grain filling

Common Salinity Stress Symptoms

- Leaf burn
- Poor emergence
- Uneven growth
- Reduced tillering
- Reduced grain yield

Irrigation Quality

Irrigation water quality plays a critical role in long-term soil and crop health. Water containing high levels of dissolved salts or sodium can contribute to salt accumulation within the soil profile, increasing root-zone EC and reducing nutrient availability. Poor quality irrigation water may also affect soil structure, water infiltration, aeration, and root activity, particularly under arid and semi-arid conditions. Routine monitoring of irrigation water EC, sodium concentration, and soil salinity helps growers optimise irrigation management, reduce salinity risks, and maintain sustainable cereal productivity.

Recommended Monitoring Parameters

Parameter	What It Indicates	Agronomic Importance
Soil EC	Salt accumulation in the root zone	Salinity stress and nutrient availability
Water EC	Irrigation water salinity	Irrigation suitability and salt input risk
NO ₃ ⁻	Nitrogen availability	Vegetative growth and canopy development
K ⁺	Potassium availability	Water regulation and grain filling
Ca ²⁺	Calcium availability	Root strength and stress tolerance
Na ⁺	Sodium concentration	Salinity and excessive Na ⁺ risk
pH	Soil acidity/alkalinity	Nutrient availability and uptake efficiency

SECTION 9

STRESS DETECTION & VISUAL DIAGNOSIS

Importance of Early Stress Detection

Early stress detection is essential for maintaining cereal productivity, grain quality, and crop uniformity throughout the growing season. Environmental and nutritional stresses can rapidly affect photosynthesis, root development, nutrient uptake, tillering, and grain filling, often before severe visual symptoms become visible in the field.

Common Agronomic Problems

Common agronomic challenges in cereal production include nutrient deficiency, salinity stress, drought, heat stress, waterlogging, soil compaction, and lodging. These stress conditions may significantly reduce canopy development, root activity, nutrient-use efficiency, and overall crop performance, particularly during sensitive reproductive stages such as flowering and grain filling.

Nitrogen Deficiency

commonly causes pale green foliage, reduced tillering, slow vegetative growth, and lower biomass accumulation. Severe deficiency may significantly reduce grain yield and final grain protein content.

Potassium deficiency

Potassium deficiency may result in leaf-edge scorching, weak stems, poor grain filling, and reduced drought tolerance. Crops affected by potassium deficiency are often more susceptible to environmental stress and lodging.

Salinity stress

Salinity stress may cause poor emergence, uneven crop establishment, leaf burn, reduced root development, and reduced nutrient uptake efficiency. Prolonged salinity exposure can significantly reduce biomass accumulation and final yield potential.

Chlorosis

Chlorosis is characterised by yellowing between leaf veins and is often associated with micronutrient deficiency, high soil pH, root stress, or poor nutrient availability. Reduced chlorophyll content may negatively affect photosynthesis and crop vigour.

Lodging

Lodging occurs when stems weaken and collapse, reducing harvest efficiency and grain quality. Excess nitrogen, weak stem strength, poor root anchorage, and adverse weather conditions can all increase lodging risk.

Drought stress

Drought stress reduces water availability, nutrient mobility, photosynthesis, and grain filling. Symptoms may include leaf rolling, reduced canopy growth, poor grain development, and lower overall crop productivity.

COMMON STRESSES & SYMPTOMS



1. NITROGEN DEFICIENCY
Pale green to yellow leaves, reduced tillering and stunted growth.



2. PHOSPHORUS DEFICIENCY
Purplish leaves, poor root growth, delayed maturity.



3. POTASSIUM DEFICIENCY
Yellowing and scorching on leaf edges, weak stems.



4. ZINC DEFICIENCY
Yellow stripes between veins, common in alkaline soils.



5. WATER STRESS
Leaf rolling, bluish-grey leaves, poor grain fill.



6. SALINITY STRESS
Leaf tip burn, poor emergence, reduced growth and yield.

Routine crop monitoring and visual assessment are essential components of modern cereal agronomy. Regular field evaluation allows growers to identify nutrient deficiencies, salinity stress, drought effects, disease pressure, and other environmental stress conditions before severe damage and irreversible yield losses occur.

Early detection supports faster and more precise agronomic decisions, helping optimise fertiliser application, irrigation scheduling, and overall crop management throughout the growing season. Monitoring crop condition, canopy development, root health, and nutrient status also improves nutrient-use efficiency, crop uniformity, grain quality, and long-term productivity under changing environmental conditions.

SECTION 10

MONITOR WHAT MATTERS

Precision Nutrient Monitoring for Cereal Production

Routine monitoring is one of the most powerful tools for improving cereal productivity, nutrient-use efficiency, irrigation management, and crop resilience. Nutrient availability and salinity conditions can change rapidly throughout the crop cycle, particularly under intensive production systems, irrigated agriculture, and environmental stress conditions. Field-based monitoring using portable analytical tools such as HORIBA LAQUAtwin meters allows growers to make faster and more accurate agronomic decisions directly in the field. Real-time measurements help optimise fertiliser application, identify nutrient imbalance early, monitor salinity risks, improve irrigation management, and maintain healthy root-zone conditions throughout the growing season.

MONITOR WHAT MATTERS

Parameter	What It Indicates	Agronomic Importance
pH	Nutrient availability	Root activity and nutrient uptake
Soil EC	Root-zone salinity	Salt accumulation and stress risk
Water EC	Irrigation salinity	Irrigation suitability
NO ₃ ⁻	Available nitrogen	Vegetative growth and canopy development
K ⁺	Potassium availability	Water regulation and grain filling
Ca ²⁺	Calcium availability	Root strength and stress tolerance
Na ⁺	Sodium concentration	Salinity and sodicity risk
Cl ⁻	Chloride concentration	Toxicity and salinity monitoring

SOIL MONITORING

Soil monitoring provides essential information about nutrient availability, salinity conditions, and root-zone health. Routine soil assessment helps growers optimise fertiliser programs, maintain balanced nutrition, and identify salinity or pH problems before severe crop stress occurs.

Recommended Monitoring Frequency

- Before planting
- During tillering
- Before flowering
- During grain filling
- After irrigation adjustments

Parameter	Agronomic Importance	Typical Soil Guideline*
Soil pH	Nutrient availability	6.0 – 7.5
Soil EC	Root-zone salinity	< 2.0 dS/m
Soil NO ₃ ⁻	Available nitrogen	Crop/stage dependent
Soil K ⁺	Potassium availability	Crop/stage dependent
Soil Ca ²⁺	Root-zone stability	Crop/stage dependent
Soil Na ⁺	Sodic risk	Low preferred

PLANT / SAP MONITORING

Plant sap monitoring provides real-time insight into nutrient uptake efficiency and the actual nutritional status of the cereal crop throughout the growing season. Unlike soil analysis alone, sap measurements reflect the nutrients actively absorbed and transported within the plant, helping growers identify nutrient imbalance, hidden deficiencies, and stress conditions before severe visual symptoms appear. Routine sap monitoring supports more precise fertiliser management, improved nutrient-use efficiency, and better crop performance during critical growth stages.

Parameter	Agronomic Importance	Typical Sap Guideline*
Sap NO ₃ ⁻	Nitrogen uptake efficiency	200 – 2000 ppm
Sap K ⁺	Water regulation and grain filling	1500 – 5000 ppm
Sap Ca ²⁺	Root activity and stress tolerance	100 – 1000 ppm
Sap Na ⁺	Salinity stress indicator	Low preferred

IRRIGATION WATER MONITORING

Irrigation water monitoring is essential for managing salinity risks, protecting soil structure, and maintaining long-term cereal productivity. Water containing excessive dissolved salts, sodium, or chloride may gradually increase root-zone salinity, reduce nutrient availability, and negatively affect root activity and crop development. Routine monitoring of irrigation water quality helps growers optimise irrigation practices, minimise salt accumulation, improve nutrient uptake efficiency, and support sustainable crop production under irrigated conditions.

Parameter	Agronomic Importance	Typical Water Guideline*
Water EC	Salinity risk	< 1.5 mS/cm
Na ⁺	Sodicity risk	< 70 mg/L
Cl ⁻	Toxicity risk	< 100 mg/L
Water pH	Nutrient stability	6.0 – 7.5

SECTION 11

PRECISION AGRICULTURE WORKFLOW

Modern Precision Agriculture

Routine field measurements provide immediate agronomic insight and support faster corrective action before severe stress symptoms and yield losses occur.

Modern cereal production increasingly integrates:

1. Soil analysis
2. Nutrient mapping
3. Sap monitoring
4. EC assessment
5. Precision irrigation
6. Variable-rate fertilisation
7. Drone monitoring

8. Satellite imagery
9. Yield mapping

Benefits of Precision Agriculture

Precision agriculture supports:

- Improved nutrient-use efficiency
- Reduced fertiliser waste
- Better irrigation management
- Improved sustainability
- Better crop uniformity
- Increased profitability

LAQUAtwin portable meters complement precision agriculture programs by providing direct field measurements that support data-driven agronomic decisions and improved resource-use efficiency. Combining routine field measurements with precision agriculture technologies helps growers improve crop uniformity, reduce fertiliser losses, optimise irrigation management, and maintain sustainable cereal productivity.

MONITOR. UNDERSTAND. ACT.

Routine monitoring with HORIBA LAQUAtwin meters helps cereal growers:

- Improve nutrient-use efficiency
- Optimise fertiliser application
- Reduce salinity risks
- Improve irrigation management
- Detect stress conditions early
- Support stable grain yield and quality
- Enhance long-term sustainability

Portable real-time monitoring supports more informed agronomic decisions throughout the cereal growth cycle, helping growers respond rapidly to changing field conditions and environmental challenges.



SECTION 12

SMART FIELD MONITORING WITH HORIBA

LAQUAtwin

From Measurement to Decision-Making

Modern cereal production requires rapid field-based decisions to optimise nutrient management, irrigation practices, and crop performance throughout the growing season. Portable monitoring tools allow growers and agronomists to evaluate crop conditions directly in the field and respond quickly to changing environmental and nutritional conditions.

HORIBA LAQUAtwin portable meters support fast and reliable measurements for:

- Soil analysis
- Leaf sap monitoring
- Irrigation water assessment
- Salinity management
- Root-zone evaluation

HOW LAQUAtwin SUPPORTS CEREAL AGRONOMY

Monitoring Area	Key Parameters	Agronomic Objective
Soil Monitoring	pH, EC, NO ₃ ⁻ , K ⁺ , Ca ²⁺	Root-zone and fertility management
Plant / Sap Monitoring	NO ₃ ⁻ , K ⁺ , Ca ²⁺	Nutrient uptake and stress evaluation
Irrigation Monitoring	EC, pH, Na ⁺	Water quality and salinity control

Model name	Part number
LAQUAtwin PH-11	3999960122
LAQUAtwin PH-22	3999960123
LAQUAtwin PH-33	3999960124
LAQUAtwin-4EC-11	3201077522
LAQUAtwin-4EC-22	3201077523
LAQUAtwin-4EC-33	3201077524
LAQUAtwin ORP-11	3200965260
LAQUAtwin-4ECSalt-11	3201077528
LAQUAtwin Salt-22	3200689158
LAQUAtwin Na-11	3200689159
LAQUAtwin K-11	3200689160
LAQUAtwin Ca-11	3200689161
LAQUAtwin F-11	3200934412
LAQUAtwin NO3-11	3200689162
LAQUAtwin-NO3-11C	3200689163
LAQUAtwin-NO3-11S	3200689164
4M LAQUAtwin kit	1300083234



Disclaimer: The nutrient ranges, salinity values, and agronomic interpretations presented in this brochure are indicative guidelines only. Actual optimal values may vary depending on cereal species, cultivar, growth stage, soil type, climate conditions, irrigation water quality, fertilisation strategy, and local agronomic practices. Soil, sap, and irrigation water measurements should be used as decision-support tools rather than standalone diagnostic methods. For accurate nutrient management decisions, field measurements should always be interpreted together with visual crop assessment, environmental conditions, irrigation analysis, soil analysis, and, when necessary, periodic laboratory tissue testing.

HORIBA UK Limited
Kyoto Close, Moulton Park,
Northampton NN3 6FL, UK
Phone: +44 1604 542600
waterquality@horiba.com
www.horiba-water.com

HORIBA Instruments Pte. Ltd.
163 Kallang Way, #08-14 Mapletree Hi-Tech Park
@Kallang Way, Singapore 349256
Phone: +65 6745 8300
laqua@horiba.com
www.horiba-laqua.com

HORIBA Instruments Incorporated
9755 Research Drive, Irvine, California 92618
USA
Phone: +1 949 250 4811
labinfo@horiba.com
www.horiba.com/us/en

