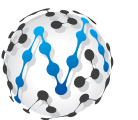


# Novel Nanotechnology in Growth and Immunity

The culmination of decades of research in nanotechnology



invati

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# 01 > Who we are

About the Co-founders

A glimpse of Invati

Our long-standing goal has been finding right solution for the farming community through our competency in invention and innovation. Poultry farming goes through continuous external challenges, and we don't pretend to have all the answers. What we do have are goals to strive for, and utilise our expertise in R&D to best possible way. Our recent foray into poultry healthcare space stems from tremendous success in agriculture and human health. We are deeply committed to work closely with poultry farmers, veterinarians, and professionals for improving farm productivity towards sustainability.

# A glimpse of Invati

At Invati, we have great land for research & development (R&D) of metals, polymers and basic elements to develop various molecules and nanotech solutions for addressing challenges in life-science verticals

## What fuels the trajectory of growth at Invati

Invention and innovation has been our greatest strength that fuels the growth trajectory at Invati. We have been granted numerous patents in the field of nanotechnology, chemical synthesis, new molecular entity, and microbial growth. In addition, our proprietary fermentation technology and certified organic products (NPOP) drives the engine of new product development.

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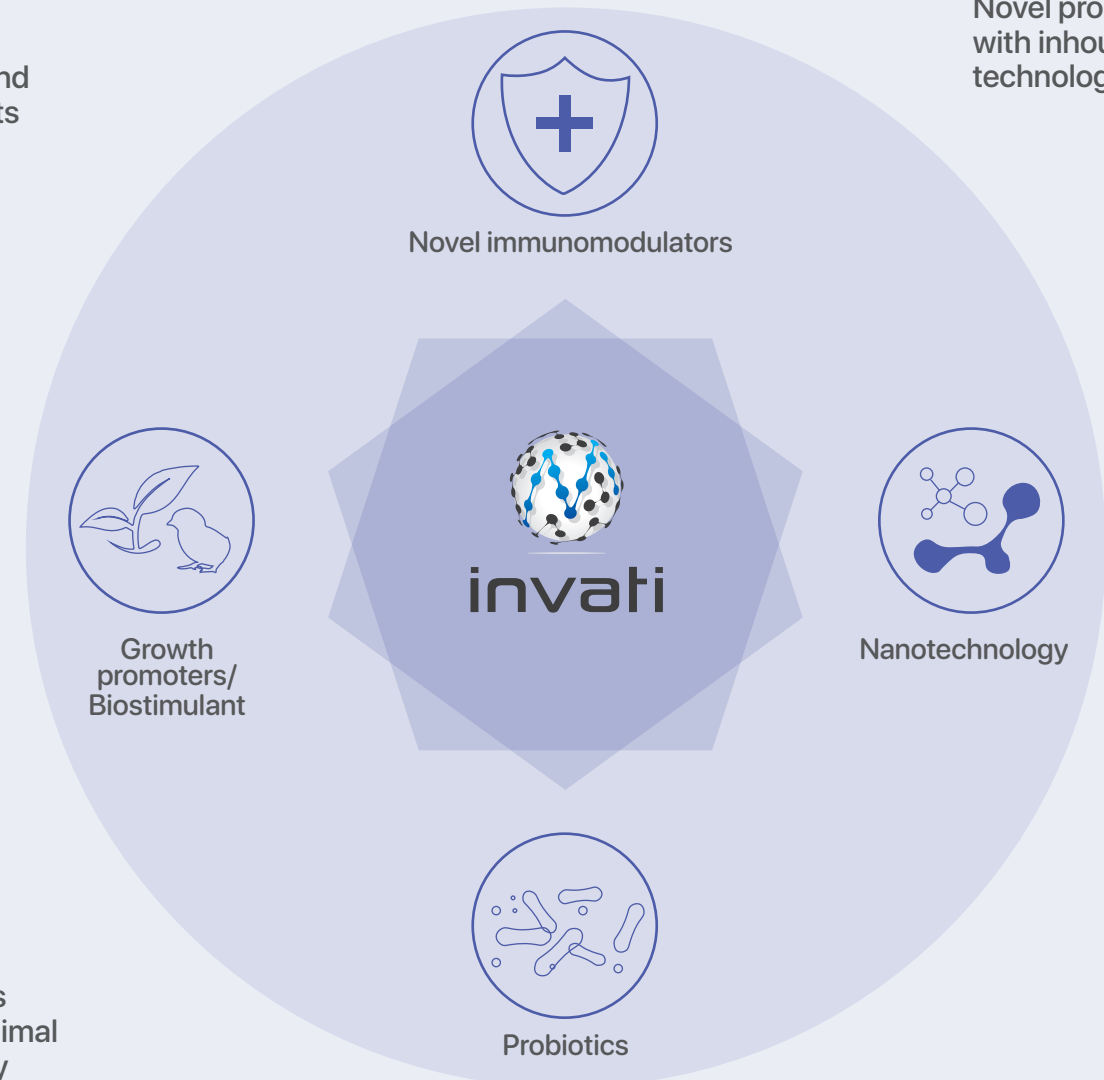
International and national patents

14

Novel pipeline for animal health, aquahealth, agriculture, and human medicine

5

Novel probiotic strains with inhouse fermentation technology



2

Novel products launched in Animal Health Industry

Improving lives through invention and innovation

# 02 > We and Nanotechnology

How it started

Changing lives

Invati and Nanotechnology is inseparable. The inception of Invati is routed through decades of research in the field of nanotechnology. In these years, we have developed proprietary (patented) process of generating stable nano-scaled metals with significantly enhanced biological activity. We have found wide range of application of these nano-scaled metals in agriculture, animal, and human health for improving lives and productivity.

# How it started

## The course of invention, innovation, and to products

Invention of noble synthesis method of metal nanoparticles (International patent filed)

Invention of nutrient nanoparticle synthesis (Patented)

Zero valent metal nanoparticle synthesis scale up

Nutrients and metal nanoparticles size and stability standardization

HyGroNano™, first in the category, zerovalent nano-scaled minerals for poultry launched

Random field trials in poultry with nutrient and mineral nano-particle formulations

#1  
Customer satisfaction recorded by HydroNano M™ in agriculture

HydroNano M™, first in the category, plant nutrient nanoparticles launched in agriculture

2012

2014

2016

2018

2019

2021

2020

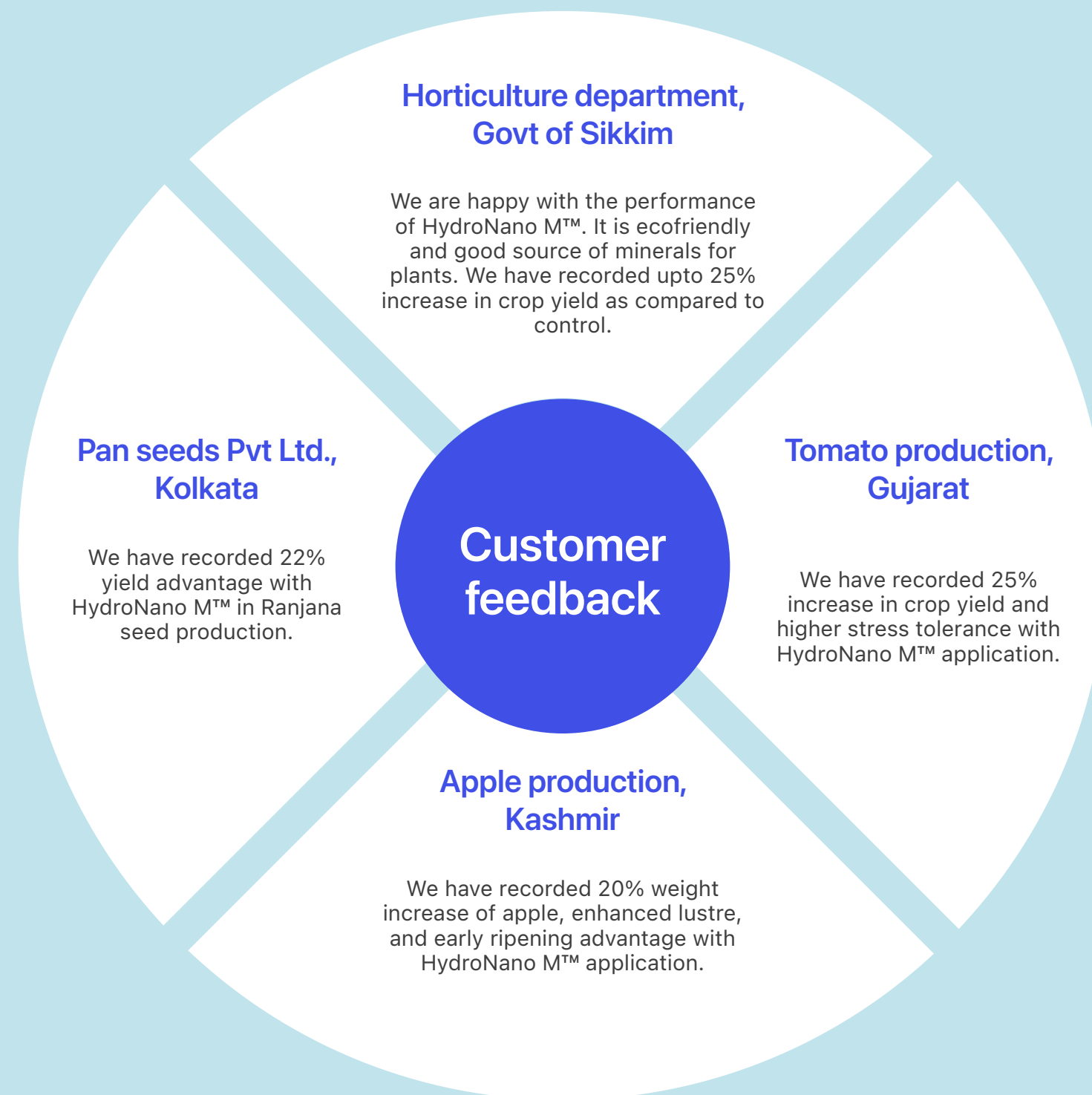
# Changing lives



The launch of HydroNano M™ in agriculture had revolutionised crop yield and productivity, since its inception in 2019. Besides productivity, the disease resistance, crop quality, foliage volume, root growth were enhanced significantly. It gives immense pleasure to have millions of happy farmers benefited by our innovation in nanotechnology

## 15 – 25%

increase in yield were recorded depending on the crop type after application of HydroNano M™







# 03 > Nanotechnology in Poultry Health

Conventional trace and macro minerals

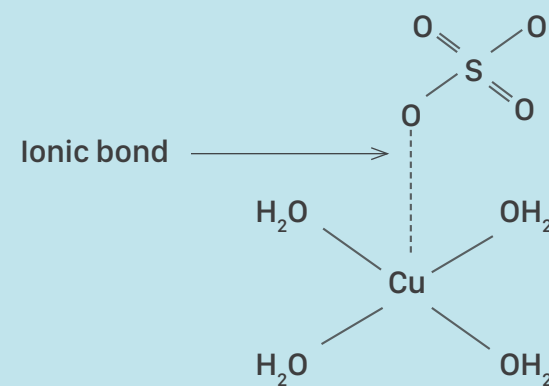
Nano-scaled minerals: Light years ahead

Nano-technology is an emerging technology with tremendous potential and diverse applications in human health, agriculture, and animal nutrition. It also offers potential advantages in supporting research in many areas of life sciences. Nano-technology has many vital biological applications as living systems depend on many nano-scale objects like proteins, DNA, and enzymes. Trace minerals are normally used in very minute quantity in animal nutrition but issues like lower bioavailability, antagonism, and higher excretion rates from body limit their efficiency.

# Conventional trace and macro minerals

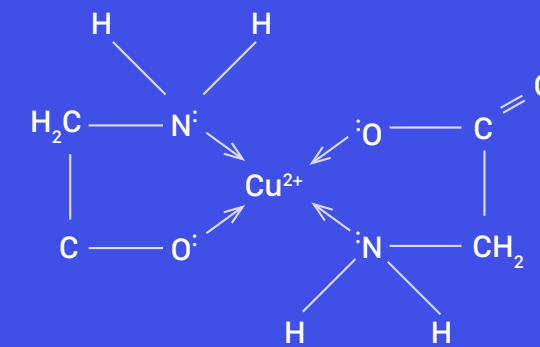
Trace minerals like Copper, Iron, Manganese, Zinc, Selenium, and Chromium are available in organic (amino acid/analogue chelate or proteinate), and inorganic (oxide or sulfates) forms with varying bioavailabilities, while chickens derive macrominerals like Calcium and Phosphorus, mostly from inorganic sources (Limestone, DCP<sup>1</sup>, MCP<sup>2</sup>, etc)

## Inorganic minerals (e.g. sulphate)



A specific metal bound to a non-carbon containing ligand. Developed in the 1930's

## Organic minerals (e.g. amino acid chelate)



A specific metal bound to a carbon/nitrogen containing ligand. Developed in the 1970's

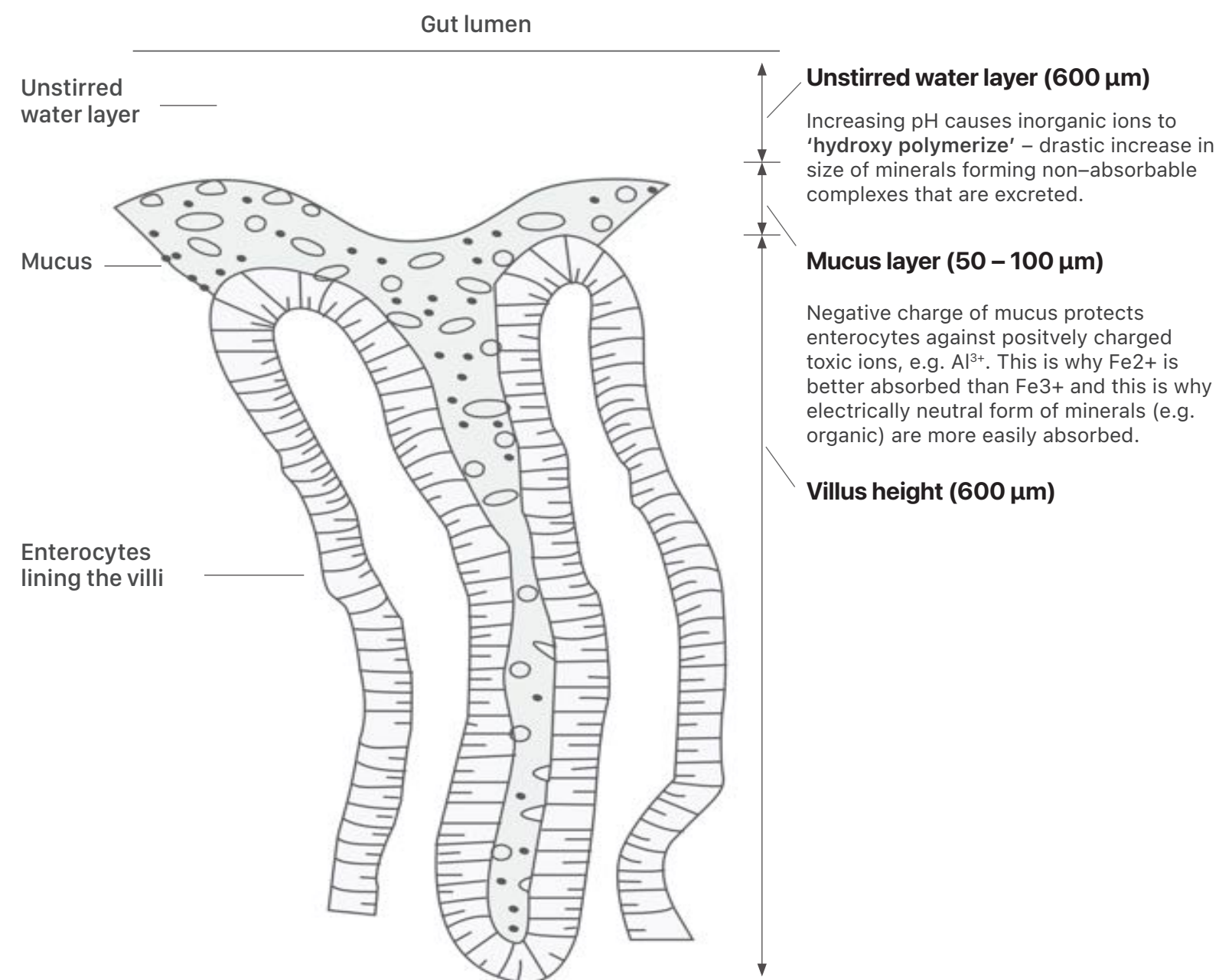
<sup>1</sup>Dicalcium phosphate  
<sup>2</sup>Monocalcium phosphate

# Conventional trace and macro minerals

In chicken gut, inorganic minerals have the risk of undergoing 'hydroxy polymerization' and trap in mucus layer leading to poor bioavailability. Besides, there are several unwanted interactions resulting in nutritional disadvantages.

## Major nutritional disadvantages of inorganic minerals:

- Interact with other minerals and excrete into the environment
- Poor bioavailability of minerals
- Complexes with phytate, and poor efficacy of phytase against phytate – mineral complexes
- Reduces efficacy of phytase and retention in poultry diet
- Degrades vitamins, lipids, and enzymes in poultry diet
- Absorption in gut requires energy expense



# Conventional trace and macro minerals

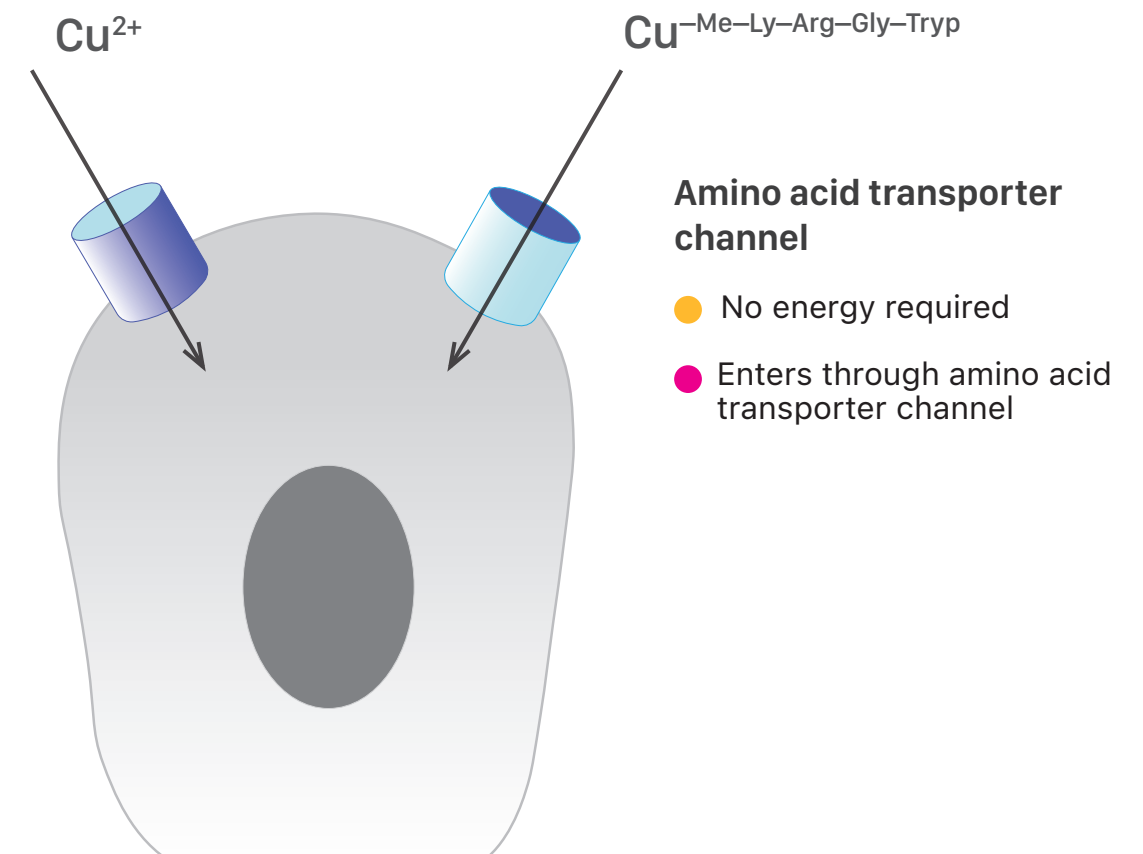
In chicken gut, organic minerals have relatively better bioavailability as compared to inorganic sources. However, there are concerns that deter consistent results.

## Concerns on consistency:

- Structural stability varies widely with the manufacturing process
- Wide variations in pH – dependent stability of various organic minerals in chicken gut
- Higher molecular size and mass depending on the ligand (e.g. proteinate)

### Voltage gated ion channel

- Requires energy (ATP) for transportation
- Requires electrochemical gradient
- Interaction with other charged mineral ions and feed ingredients



### Amino acid transporter channel

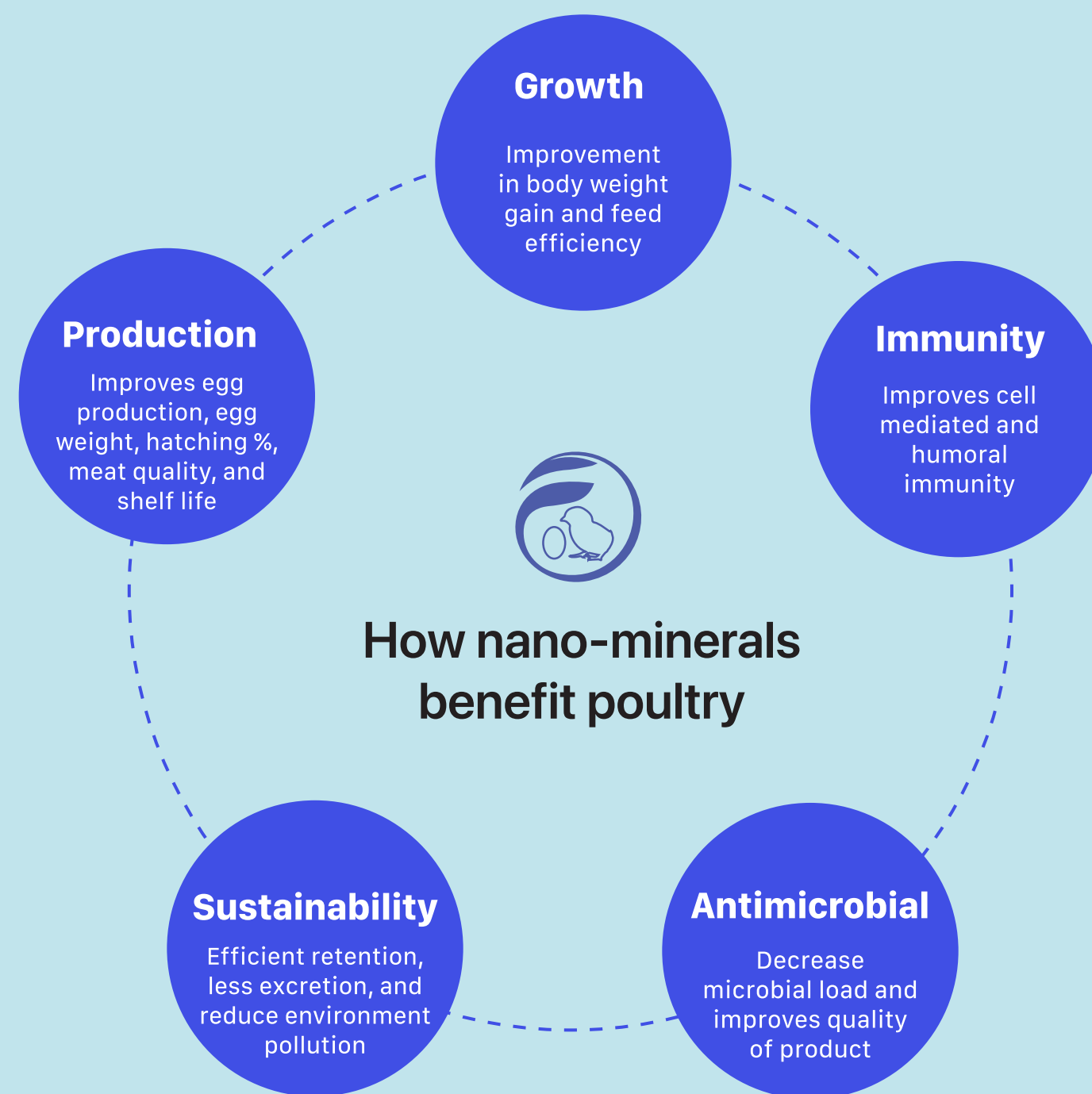
- No energy required
- Enters through amino acid transporter channel

# Nano-scaled minerals: Light years ahead

Nano-particles (NPs) possess different physico-chemical properties than other forms of minerals. It results in significantly higher biological activity.

## World of advantages:

- Enhanced surface area of NPs results in significantly higher bioavailability
- Significantly lesser unwanted interactions
- Minerals are important component of metabolism and exoskeleton. Higher biological activity of NPs result in significantly better performance indices of chickens (broilers and layers).
- NPs have been proven to modulate gut health of chickens towards beneficial microflora.
- NPs like Cu, Zn, and Ag have excellent antimicrobial activities against key poultry pathogens (e.g. Salmonella, E. coli and Campylobacter)





# 04 > HyGroNano™

[Salient features](#)[Field trials](#)[Usage guidelines](#)

Grand success of HydroNano M™ in agriculture inspired us to formulate for animal health. In 2020, we began with poultry where series of random trials were undertaken for evaluation of different nano-scaled mineral formulations. We are happy to determine the right formulation by 2021. The formulation is launched as 'HyGroNano™' and comes with huge benefits for poultry farmers.

## Salient features



We have deeply understood the problems of variation of mineral bioavailabilities in chickens affecting nutrition significantly, especially, during the challenging times.

**HyGroNano™ is the fusion of two different technologies, Zero-valency and Nanoscaling of minerals, taking a giant leap ahead of nanotechnology, and creating revolution in mineral nutrition of chicken**



### Salient features:

- Iron, Zinc, Magnesium, Calcium, and Boron in nano-form < 100 nm.
- Near zero  $\zeta$ -potential<sup>1</sup> (zero-valent) of nanoparticles maximising cellular uptake and eliminating probability of unwanted interactions.
- Dramatic increase in surface area (2000 – 3000X) of nano-scale minerals ensure significant increase in biological activity as compared to the native forms.
- Novel carrier – water soluble carbon with particle size ranging from 100–1000 nm.
- Proven safe in series of clinical trials<sup>2</sup>.



# Field Trials

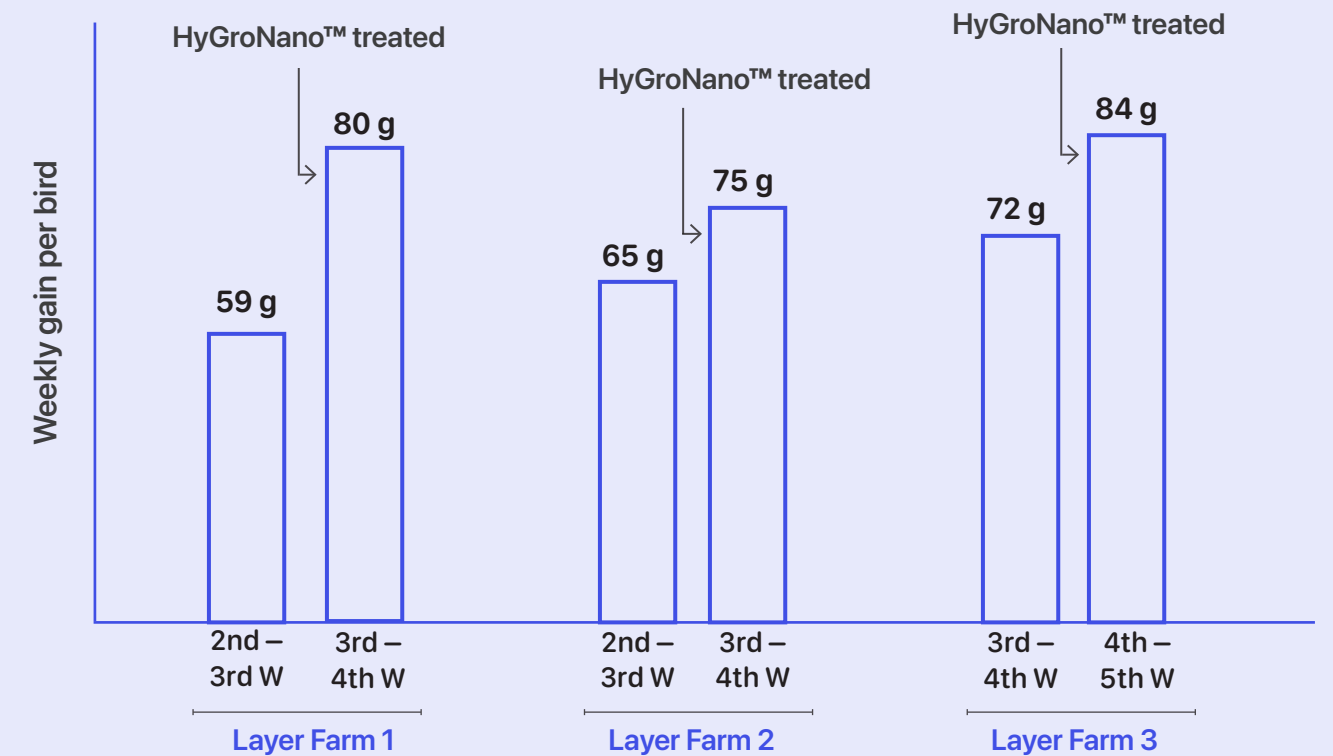
## Field trial of HyGroNano™ in broiler chickens

Study type	Controlled field trial in integration (commercial broiler farm)	
House	1 – open type; two partitions	
Design	HyGroNano™	Control
Birds/partition	750	750
Duration	35 days	35 days
Usage	Day 1 – 5; 1 ml per kg BW <sup>1</sup> Day 10 – 13; 1 ml per kg BW	—
Results (BWT)	1st W – 180 g 2nd W – 360 g 3rd W – 789 g 4th W – 1170 g 5th W – 1785 g	1st W – 160 g 2nd W – 330 g 3rd W – 735 g 4th W – 1095 g 5th W – 1706 g

<sup>1</sup>Body weight

HyGroNano™ significantly improves the growth performance indices, plausibly due to its direct effect on biological activity in chickens, and indirectly, mediated by the positive effect on the chicken immune system.

## Field trial of HyGroNano™ in commercial layers



In 3 commercial layer farms, chicks were treated with HyGroNano™ as indicated above at 1 ml per kg BWT in drinking water for 7 days (3rd W – 4th W and 4th – 5th W in farm 1/2, and farm 3, respectively). The weekly gain in BWT per bird were compared with previous week in all the farms. Breeds in trial: Farm 1 (BV300), Farm 2 (Bovans W), and Farm 3 (Lohman)

HyGroNano™ significantly improves body weight gain in layer chicks.

# Usage guidelines

In general, HyGroNano™ should be used at 0.5 – 1 ml per kg BW<sup>1</sup> as indicated in the table.

Class	Age	Application
Broiler/Layer & Breeder chicks	Day 1 – 5	1 ml per kg BW <sup>1</sup> in drinking water
	Day 9 – 12	1 ml per kg BW in drinking water
	Day 16 – 18	0.5 ml per kg BW in drinking water
	Day 22 – 24	0.5 ml per kg BW in drinking water
Grower/Layer /Breeder	5 – 7 days per month	0.5 ml per kg BW in drinking water

HyGroNano™ can be used in flocks to counteract stress, recovery from viral infection, poor productivity, improve flock uniformity at 0.5 – 1 ml per kg BW

<sup>1</sup>Body weight

# 05 > HyGroNano™ : Microanalysis Report

Mineral size distribution

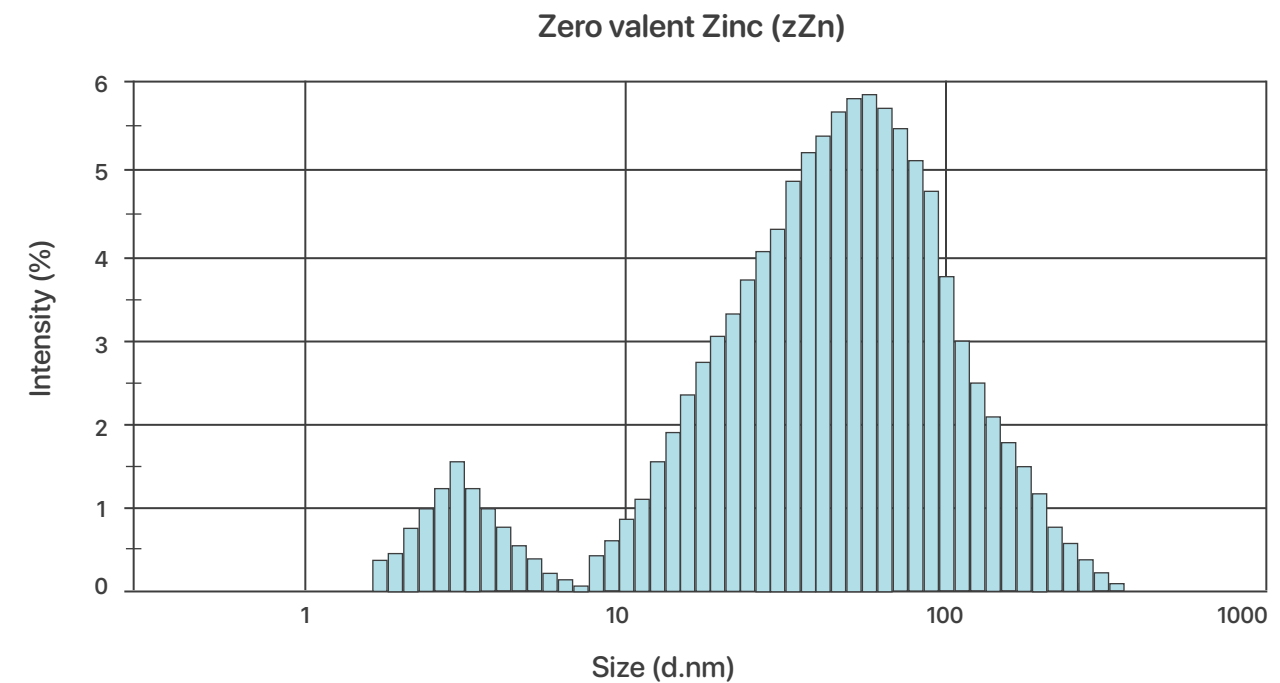
Electron Microscopy

Individual minerals in HyGroNano™ is synthesised separately, transforming them to zerovalent nanoparticles and formulated in water soluble carbon base. The particle size, distribution, and stability of the minerals are periodically tested by dynamic light scattering and Electron microscopy.

# Mineral size distribution

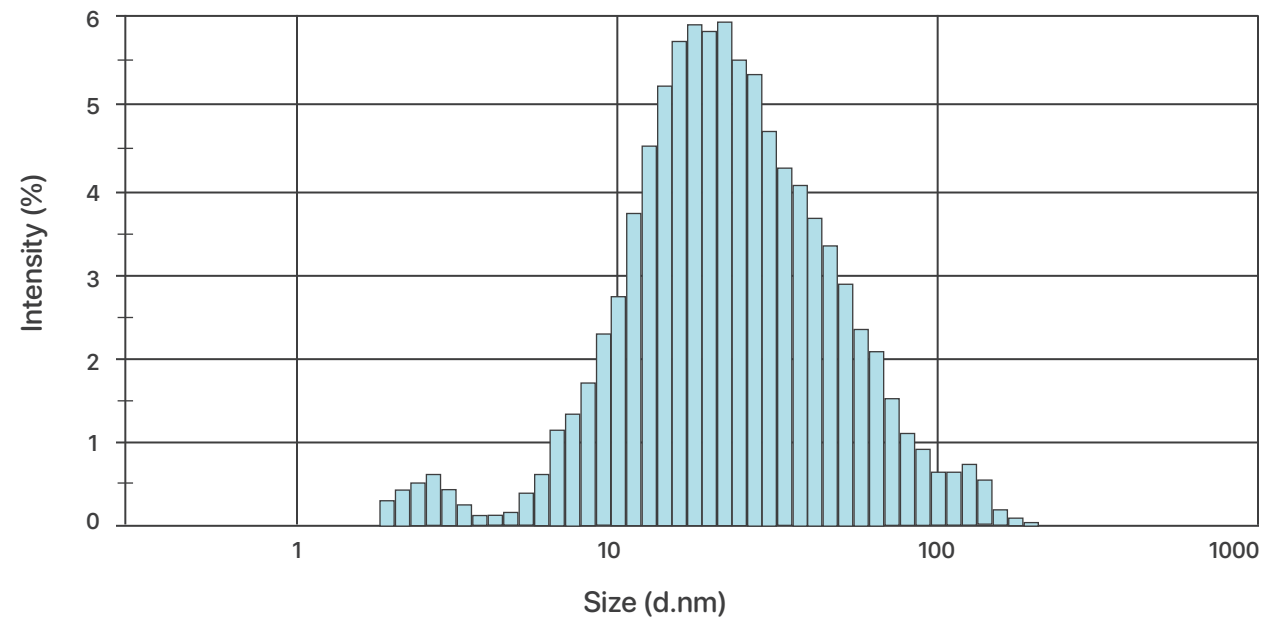
**HyGroNano™ is a result of proprietary (patented) synthesis transforming minerals to nanoparticles (NPs) and zerovalency state. The NPs in the formulation are periodically evaluated for stability by dynamic light scattering (DLS).**

Zero-valent Iron, Magnesium, Zinc, Calcium, and Boron are present in particle size < 100 nm as detected by dynamic light scattering (DLS). This results in unmatched efficacy of HyGroNano™ in comparison to the commercially available products.

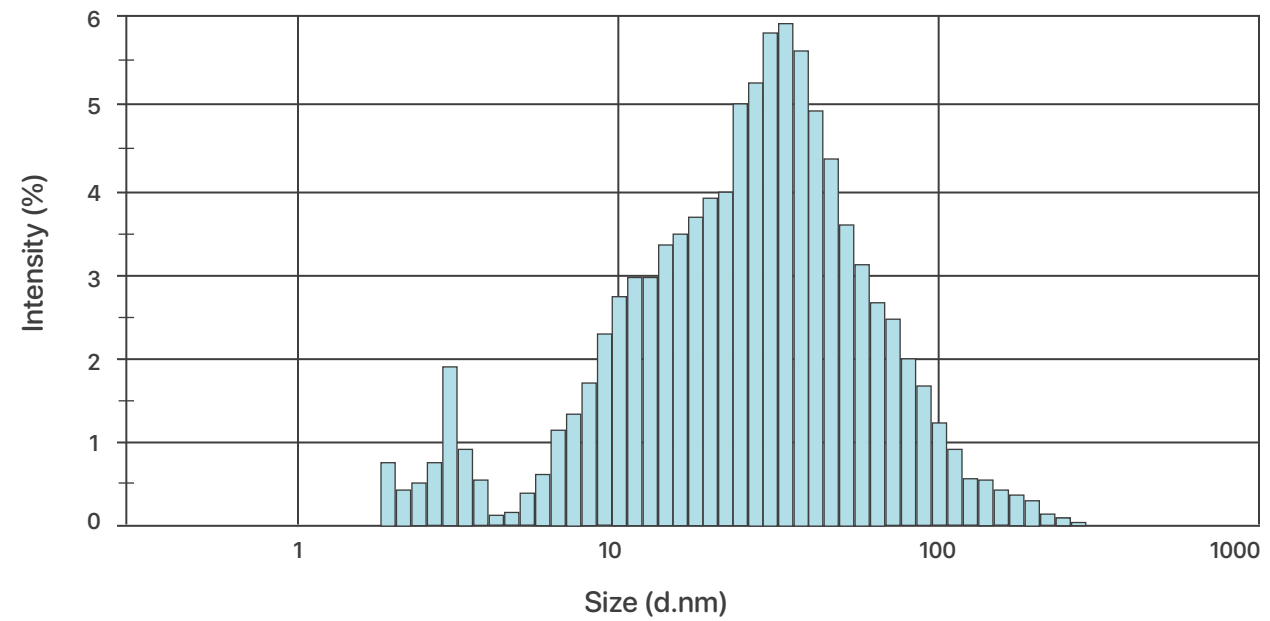


# Mineral size distribution

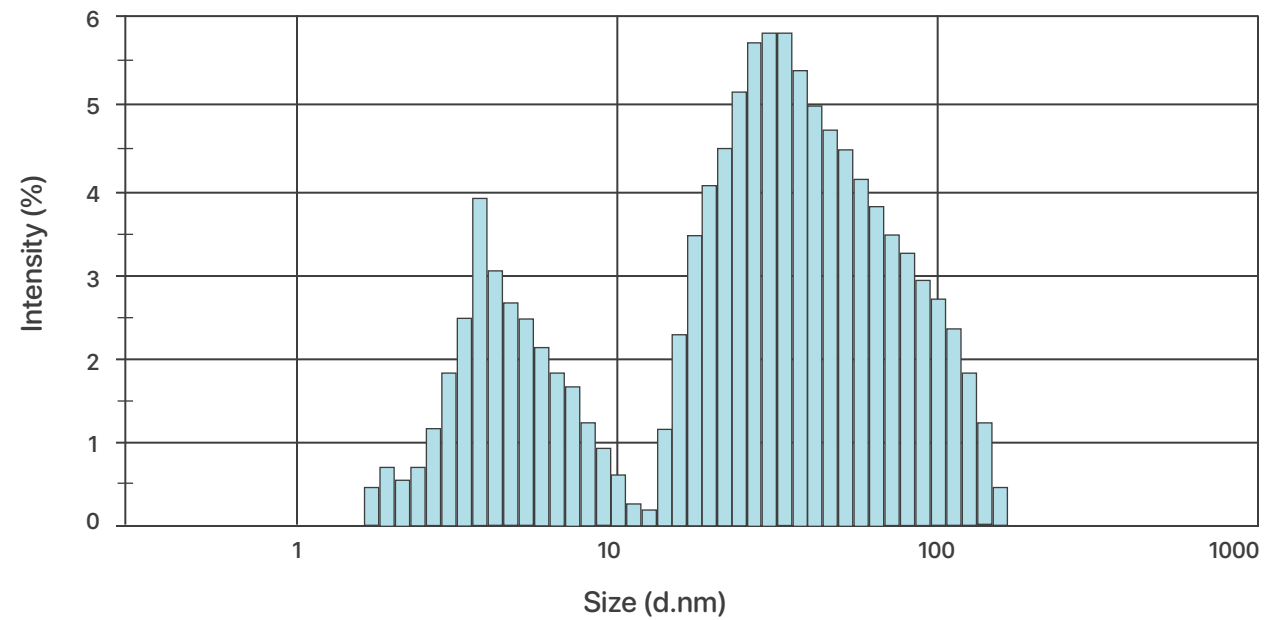
Zero valent Iron (zFe)



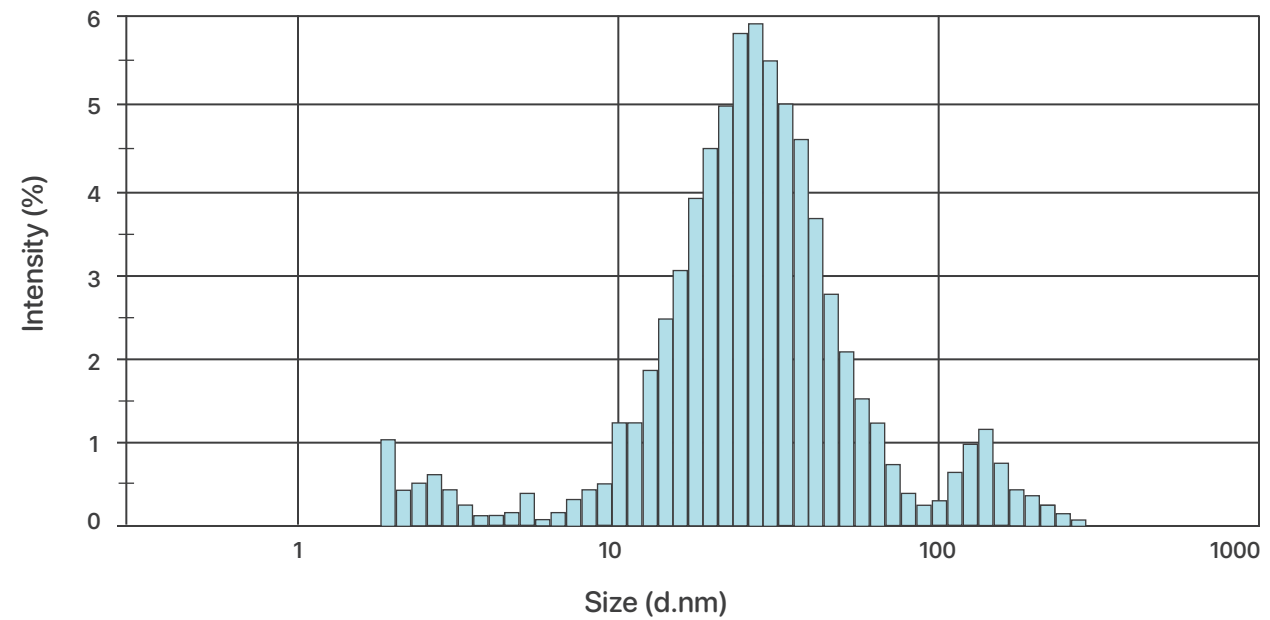
Zero valent Calcium (zCa)



Zero valent Boron (zB)



Zero valent Magnesium (zMg)

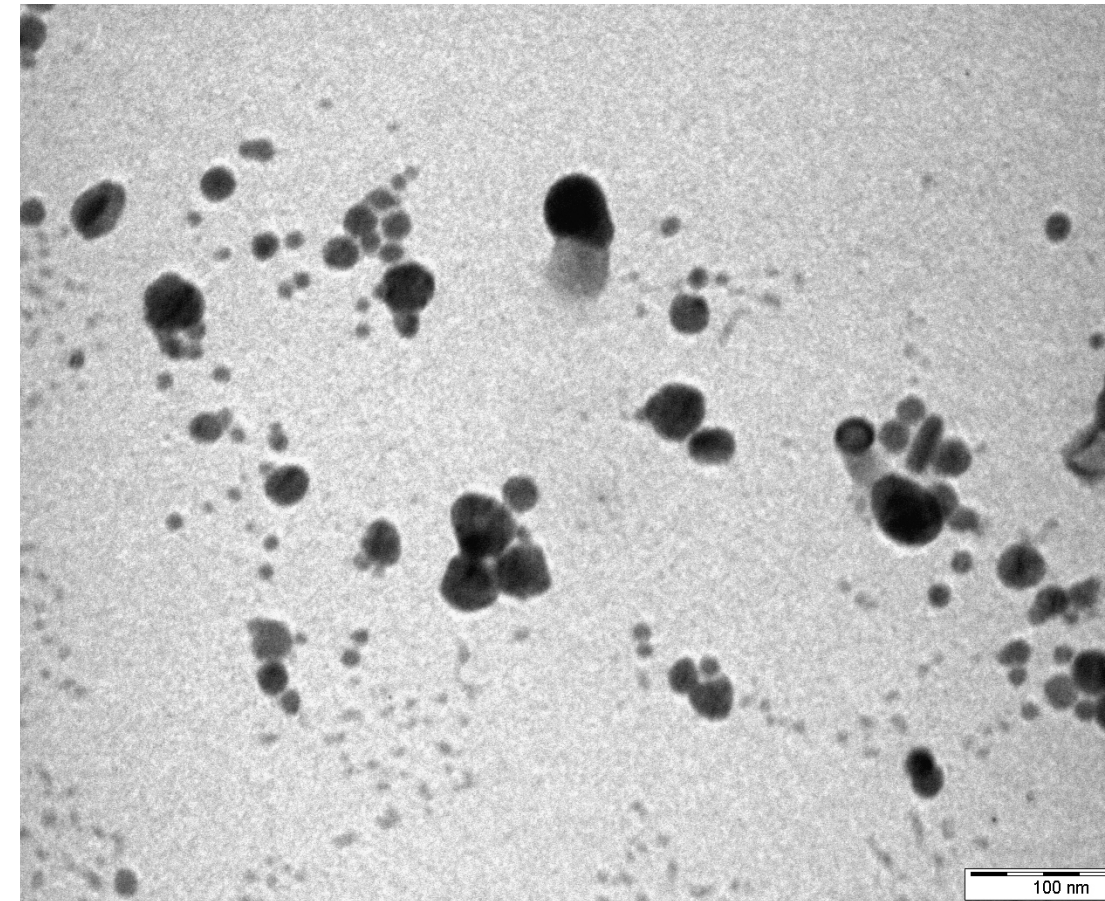


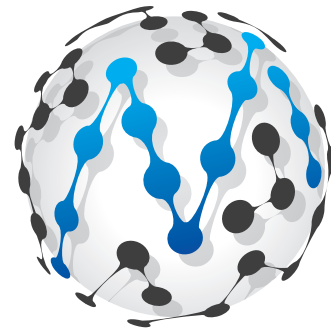
# Electron Microscopy

**For shelf life evaluation of HyGroNano™, production batches are periodically tested by Transmission Electron Microscopy (TEM).**

## Notes:

- The mineral nanoparticle size varies 10 –100 nm.
- There are few nanostructures with more than one mineral combination.
- The shape of mineral nanoparticles are nearly spherical.
- The nano scaling of the minerals are visible in the electron micrograph





**invati**

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**Improving lives through invention and innovation**

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