Salt Mitigation in Irrigated Crops:

Reducing Negative Impacts Past, Present and Possibilities for The Future

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SALT IN SOILS

- Salt in soils is all about Sodium….

- Ask a farmer if she wants to farm SALTY Soils…
- The answer of course will be???
- Na…
- That is a chemistry joke by the way…

WE ALL KNOW THE STORY

To feed the world's anticipated nine billion people by 2050, and with little new productive land available, it's a case of all lands needed on deck," says principal author Manzoor Qadir, Assistant Director of the Water and Human Development programme at UNU-INWEH. "We can't afford not to restore the productivity of salt-affected lands."

UN Report on Salts

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HOW BAD IS IT?

- Salt is degrading one-fifth of the world's irrigated land
- Every day for the past 20 years, an average of 2,000 hectares of farmland has been impacted by salt accumulation
- This currently affects about 62 million hectares — equal to the size of France.

UN Report on Salts

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WHERE IS IT UGLIEST????

- Well known salt-degraded land areas include:
  - Aral Sea Basin, Central Asia
  - Indo-Gangetic Basin, India
  - Indus Basin, Pakistan
  - Yellow River Basin, China
  - Euphrates Basin, Syria and Iraq
  - Murray-Darling Basin, Australia, and
  - San Joaquin Valley, United States
- Even in the US's Colorado River Basin, studies show the annual economic impact of salt-induced land degradation in irrigated areas at US$750 million.

UN Report on Salt

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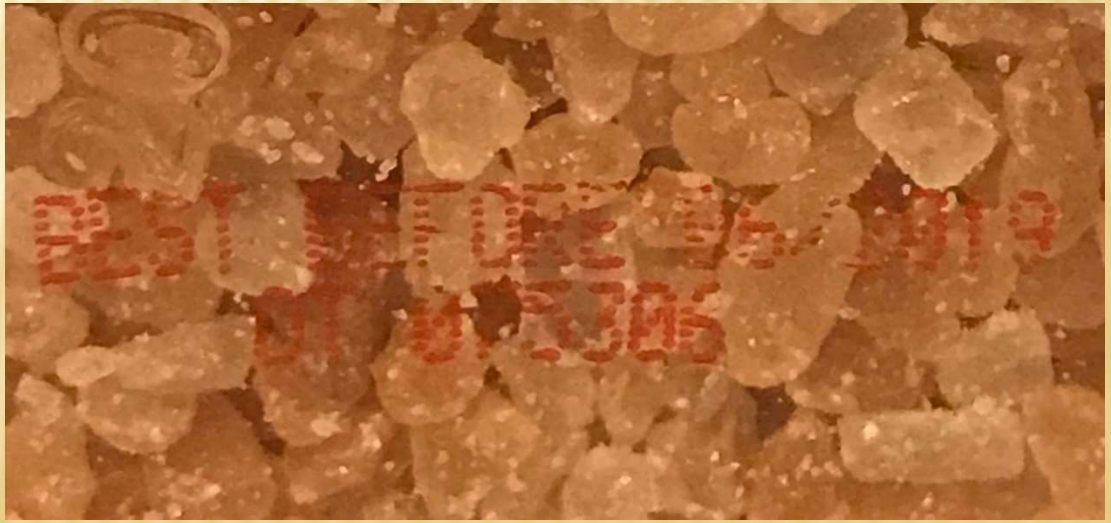
SALT PERSISTENCE

Himalayan Sea Salt---
Approx. 60 million years old

FDA says it will Expire June of 2019… this is Expired Salt



HISTORY

- For centuries, humanity and salinity have lived one aside the other. There is good evidence for Mesopotamia that early civilizations flourished and then failed due to human-induced salinization. Thus, after almost 5000 years of successful irrigated agriculture, the Sumerian civilization failed. Jacobson and Adams (1958),
- How did the Romans destroy Carthage? Salted the earth

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TEXTBOOK SALTY SOILS ARE DEFINED AS

- Salt-affected soils are subdivided into two groups:
  1. Saline soils without Natric/Solonetzic/Sodic horizon
  2. Alkaline soils with a well-developed Natric/Solonetzic/Sodic horizon, which is the diagnostic horizon of this group.

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WHAT IS A SALT AFFECTED SOIL IN ENGLISH?

- Soil salinization occurs when water-soluble salts accumulate in the soil to a level that impacts on agricultural production
- Normal productive agricultural soils have electrical conductivity values of less than 1000 µmhos/cm, whereas saline soils have a value greater than 4000 µmhos/cm which is equal to 2640 ppm total soluble salts

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THE NEWER VIEW

- Since several fruit, vegetable and ornamental crops suffer from salinity within the EC interval of 2 to 4 mSm/cm.
  - These soils are now considered salt affected if they are in region where they have been produced
- Soils in which the cation exchange sites are occupied by more than 15 percent of sodium and have a pH of 8.5 or above are called sodic (alkali) soils.
  - Although some now consider sodic soils to be over 10% on the exchange complex

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AND THIS IS A PROBLEM BECAUSE.....

- Salts are acutely toxic to crop plants
- Sodium in the soil disperses clay and similar soil particles, and prevents them from aggregating.
  - These dispersed particles become easily suspended in water and plug soil pores. This creates poor drainage for sodic soils
  - This causes them to have dry subsoil and a wet surface layer.
  - Even with adequate rainfall or irrigation, crops may fail due to these factors.
- Salt in soils also has a significant affect on the Soil Microbiome
  - Microbe activity slows, species change
- Eventually nothing lives and the soil is void of plant life

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HOW DO WE HANDLE SALT IN SOILS?

- There really are only a couple Historical solutions
- Past—Wash Them Out or
  - Keep Farming it and watch productivity diminish until you have to Abandon it
  - Try gathering the crusty soil and carrying it away
  - Grow something salt tolerant until productivity diminishes until you have to Abandon it
- Present
  - Same story, but better tillage to open soils!
- Future about the same
- Time to Get Creative!!! People want to wear linen shirts, cotton underwear and to eat!

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CURRENT AMELIORATION TECHNOLOGIES

- Amelioration is a lot of syllables to say
  - Adios
    - to Salts
- See FAO Handbook for Saline soil management
- Chapter 5 of the 144 page PDF http://www.fao.org/3/I7318EN/i7318en.pdf

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NEWER CONCEPTS

- Electromelioration is to Electrocute the salts so they die and go away
  - This is a laymen's analysis
  - Requires Power and Electrodes
    - To do larger areas requires LOTS of power
  - Most efficient is to treat (acidify) the water rather than the soil
- Precision Ag--A First World Solution
- Extensive soil testing and then make custom field maps
  - EC scanners with even more detail
- Variable rate fertilizer and acidifiers
  - NDVI triggered applicators to adjust rates Real time
- Variable Varieties based on soils
- Verified by Yield Maps
- Followed by more testing

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SOPHISTICATED CROP ROTATIONS

- More of an improvement in the 3rd World where crop rotations are a bit more feasible and grazing livestock is realistic
  - Alternative crops means different infrastructure to handle the production
  - If it is to be grazed, is stock available and economical for the areas involved?
  - What would we do with 100,000 acres of Jerusalem Artichokes in the San Joaquin Valley?
  - So it is not as simple as new seed

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BETTER LIVING THROUGH CHEMISTRY

- In “modern” times trying to find more efficient ways than naked water to move salts is The Thing

LEACHING AIDS TREATING THE SOIL

- Most of these are soil based treatments that work to solubilize the Ca, convert the Na or otherwise promote leachability
- The original product—Elemental Sulfur
- Poly acids such as Polymaleic, Polyacrylic, Polyaliphatic acid
- SACA – supra-atomic chemical agent.
- AS – adaptogenic substance Humic Acid related
- PFCA – polyfunctional chemical ameliorator
- General surfactants to loosen surface tension
  - Amway sold a zillion gallons 30 years ago

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TREATING THE WATER

- We have come across a product that is a bit more novel, and has proven effective—Paraphrased from the Manufacturer, and this is not an endorsement but an example of newer approaches…
- WaterSOLVE™ reduces pH to increase solubility. By ion exchanges, HCT has developed a means to displace bicarbonate, permanently, while converting the cations to a quazi amino acetate, and aid plant nutrition with the additional acids in nutrient uptake. The minerals in the hard water are converted to available nutrients and hence not needing to be flushed. Hard water in this case is beneficial.
- Reaction 2 of the chemistry is founded on sodium/calcium chloride. By ion exchange, the same chemistry disassociates the bonds converting calcium to the quazi amino acetate, sodium protonated inert - released, readily hydrated and flushed or passed without cell damage - chloride off-gassing.

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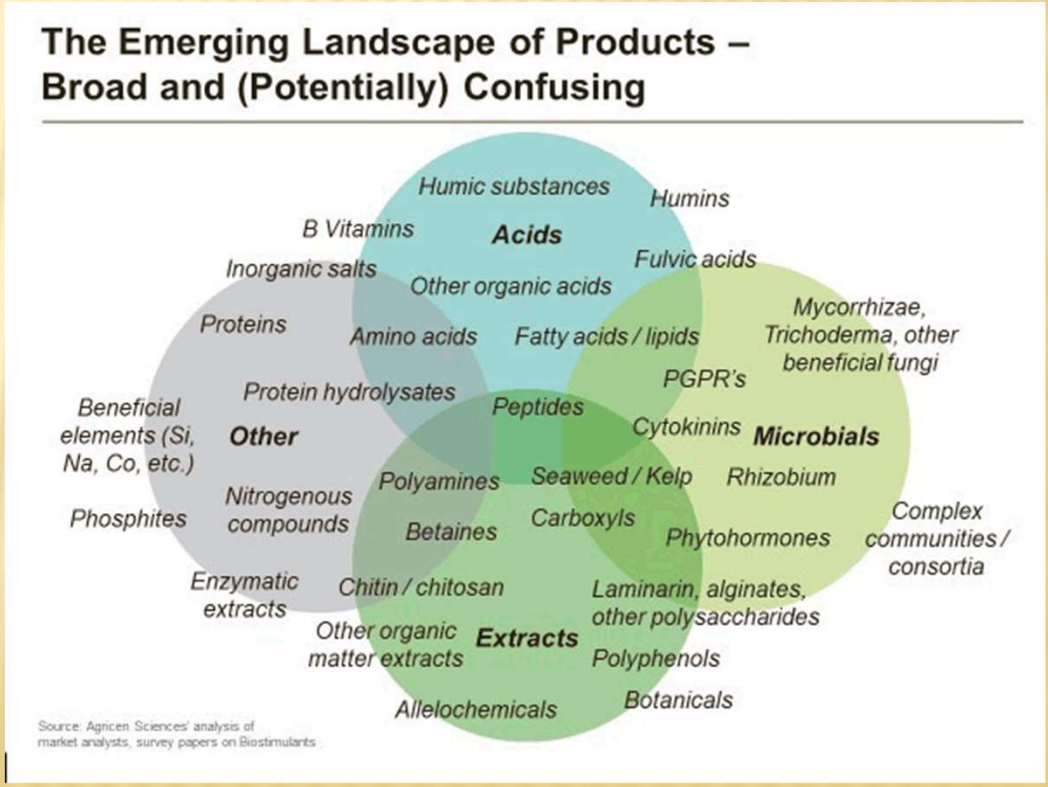
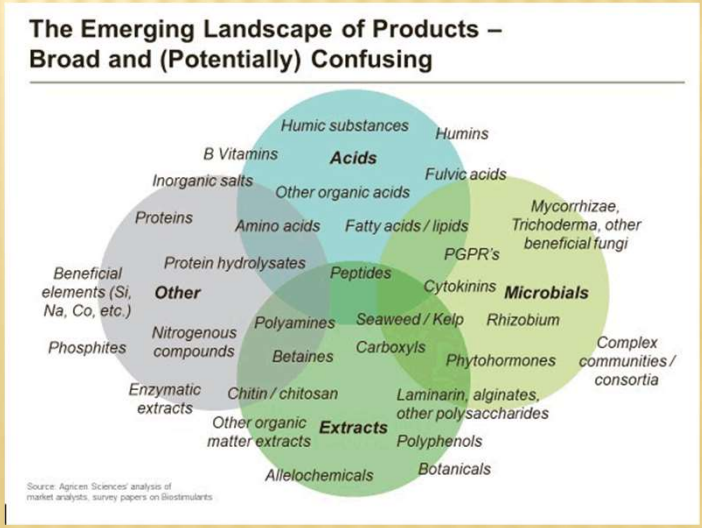
THE FUTURE IS NOW

- Biologicals are the next big thing
- Biostimulants
  - Humic/ Fulvic Acids
  - Protein Hydrolysates
  - Seaweed/Botanicals
  - Chitosan/Biopolymers
  - Inorganic Compounds
  - Beneficial fungi
  - Beneficial bacteria
  - Lots of OTHER



BIOSTIMULANTS

- We understand near zero
- We are very actively testing products for Abiotic Stress mitigation
  - Imagery-Canopy Cover, Counts
  - IR Radiometery
    - Canopy Temperature
    - Crop Water Stess Index
  - Ultrasonic Transducers & Lidar
  - NDVI, NDWI and the whole alphabet soup of Hyperspectral measurements



MORE BIO BASED SOLUITONS

- Halophytes
  - Some work being done now to use them as a food or fodder
- Consuming Microbes
  - We have worked with a salt eating microbe
  - The thought is mesmerizing…

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LET'S NOT FORGET

- Plant Breeding
  - Genome mapping
  - Crisper
  - Transgenics
- Both to
  - Change plant physiology to live in salty ground
  - Adapt plants or microbes to work together

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TO THE FUTURE!

- Biologicals are the HUGE wildcard
- Chemistry will improve and be more understood
- The first world precision will assist dealing with heterogenic fields
  - But 50% of global population lives on $3 or less
  - 1/3 of humans are subsistence farmers
  - Median Age in much of Africa is under 20
- When All is said and done–

ALL of these technologies will be used
Together for Success

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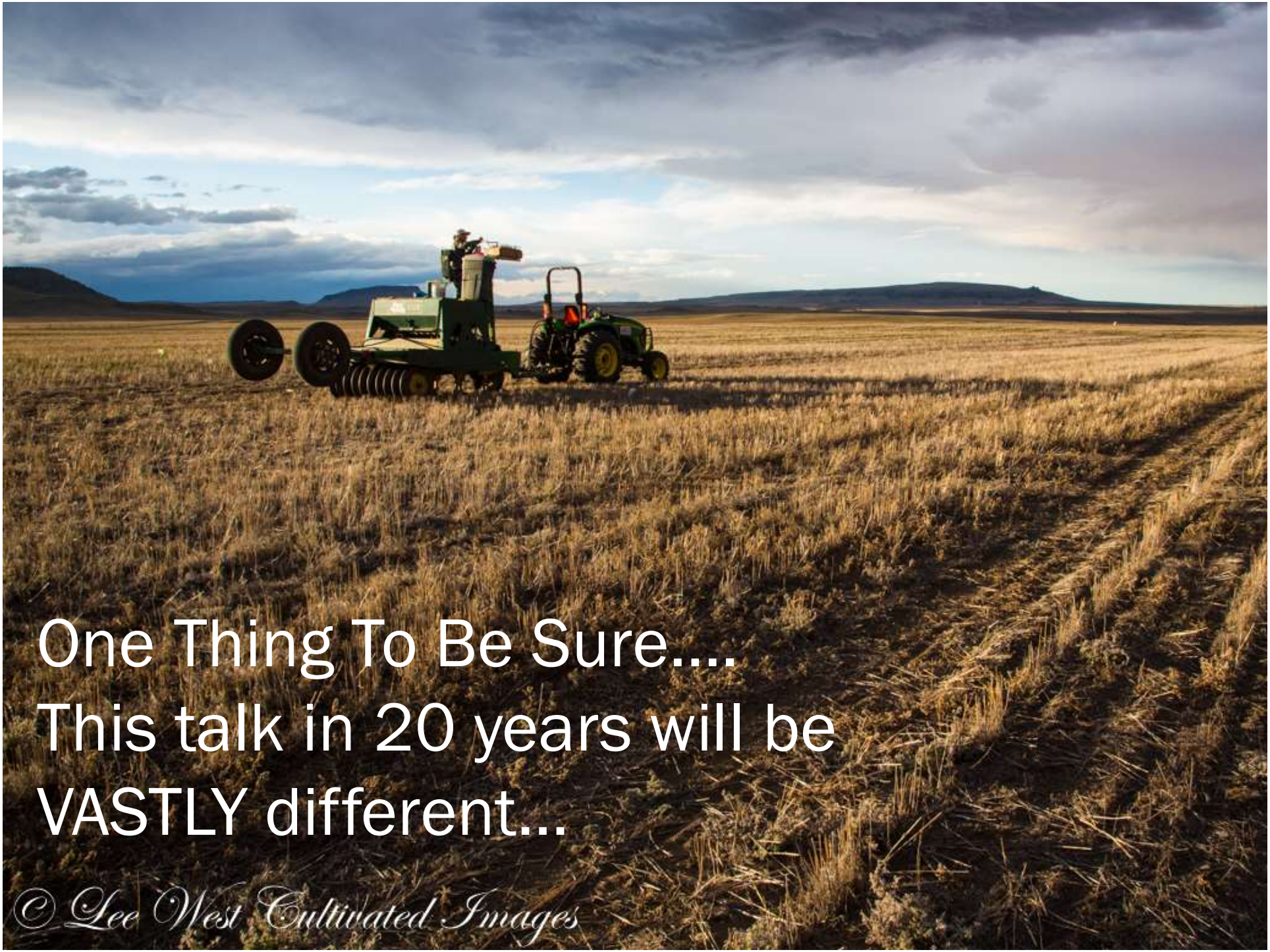
One Thing To Be Sure....
This talk in 20 years will be
VASTLY different...
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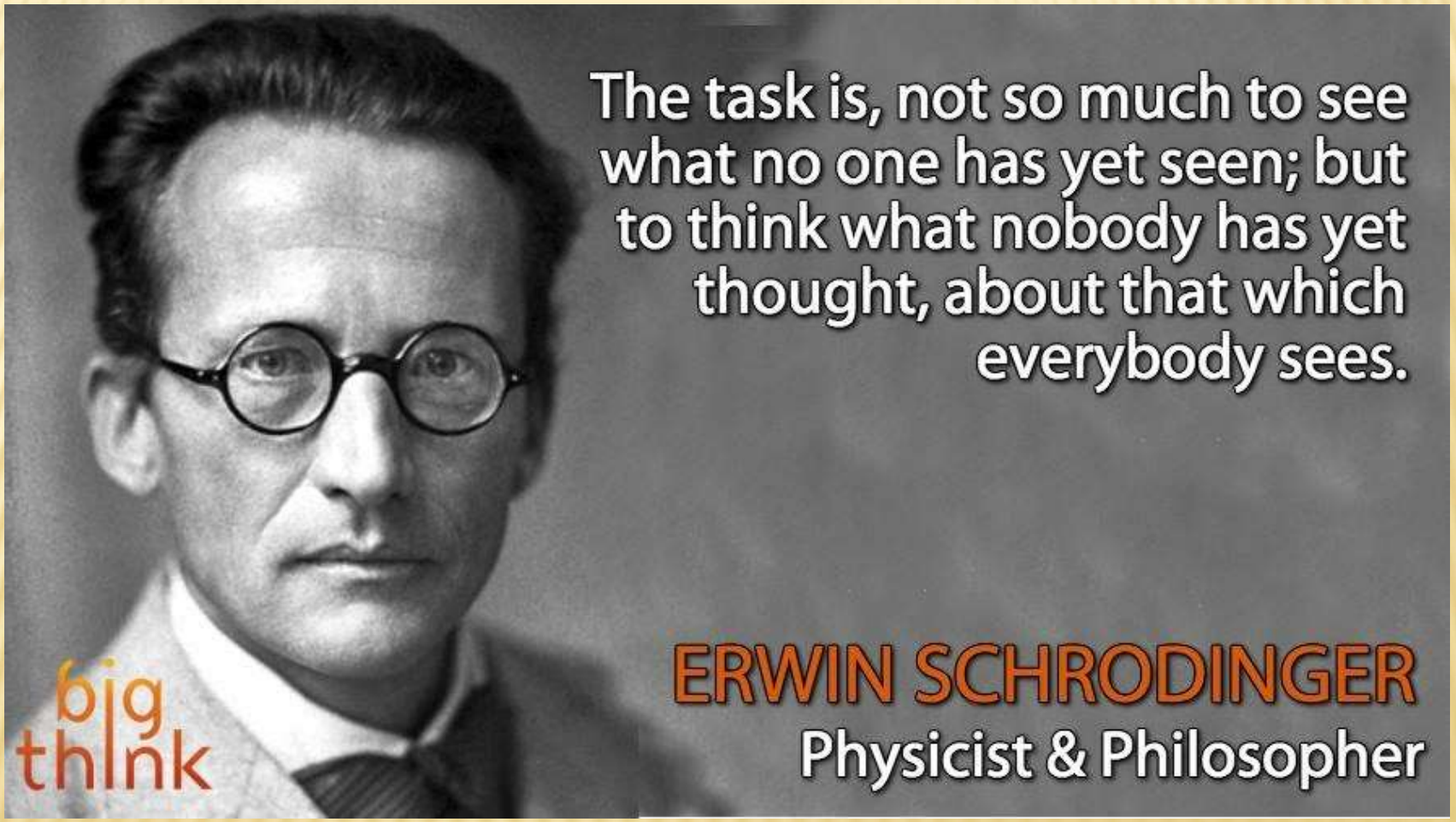
QUESTIONS??


The task is, not so much to see what no one has yet seen; but to think what nobody has yet thought, about that which everybody sees.
ERWIN SCHRODINGER
Physicist & Philosopher
big think