HALOPHYTES: HOW TO SOLVE THE LAND, WATER, FOOD, ENERGY & CLIMATE EMERGENCY WHILE GENERATING WEALTH

Dennis Bushnell, Chief Scientist, NASA Langley Research Centre

Webinar

Monday, 04 October, 16:00 BST

A Word From Today's Chairman

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Today's Agenda

- 16:00 – 16:05 Chairman's Introduction
- 16:05 – 16:25 Keynote Presentation – Dennis Bushnell
- 16:25 – 16:45 Question & Answer

Today's Speaker

Dennis Bushnell

Chief Scientist

NASA Langley Research Centre

National Aeronautics and Space Administration

EXPLORE

DENNIS M. BUSHNELL

Climate/Ecosystem Mitigation/Remediation: The Role of Halophytes

2-11-202

Spaceship Earth (P. Creola)

The Crew are:

- Plundering the ship’s supplies
- Tinkering with the temperature and life support controls
- Still looking for the instruction manual
- Engaging in bloody skirmishes in every corner of the vessel
- Increasing the size of the crew by 2 million per week

Conventional Green Energy Sources

- Hydro, large to small (base load)
- Surface geothermal (base load)
- Solar, PV and thermal (requires storage or a distributed grid)
- Wind, terrestrial, offshore (requires storage or a distributed grid)
- Glycophyte/freshwater biomass (base load)
- Nuclear (far too expensive, waste issues, base load)

Some Non-Traditional “Green” Energy Sources

- High altitude wind, massive capacity
- Float heat exchangers in the Gulf Stream, horizontal ocean thermal energy conversion, massive capacity
- CO_2 conversion, via solar, into CO, other fuels
- Solar hydrogen production
- **Biomass grown on wastelands using Halophytes/salt plants and seawater/saline irrigation, agriculture, also aquaculture**
- Osmotic energy

- Using halophytes (seawater irrigation), a good portion of the Sahara is capable of providing sufficient biomass to replace ALL of the fossil carbon fuels, provide petrochemical feedstock and requisite food, while returning much of the 68% of the freshwater now used for conventional agriculture, to direct human use.

- Also sequester ~ 18% of the CO_2 uptake in deep root systems

- Overall – “Solves” land, water, food, energy & climate issues

Water/Food

- Current food production based on freshwater plants
- We are “running out” of fresh water
- The ecosystem is “crashing;” the “code word” is “Sustainability”
- Engendered by population growth; ~ 50% too many of us for the ecosystem to support now, short some 50% of a planet, if/as the rest of the world attains western consumption rate will need 3 to 4 more planets
- Resulting in “PEAK EVERYTHING”
- A “solution” is to switch to Halophytes (“salt plants”), produce food on wastelands using saline/salt water
- 22 nations already working this; Solves land, water, food, energy and climate change

The immense advantages of switching to halophytes include:

- Saline-tolerant plant biomass utilizing what we have a surfeit of (and what could be our last major play regarding the ecosystem): wastelands, deserts (which make up 44% of the land area), and seawater (97% of the planet's water resources).
- Seawater contains 80% of the nutrients needed to grow plants, and researchers are developing new techniques to extract nitrogen from the air, thus requiring little fertilizer.
- Advanced technology is not required, and cultivation uses inexpensive land and water, so the economics are very favorable. The shift to Halophytes could be accomplished in relatively short order.

The immense advantages of switching to halophytes include (cont'd.):

- Halophyte cultivation for food would free up 70% or more of the total freshwater used for conventional glycophyte agriculture, and which we are now running out of for direct human use, thus solving both water and food problems.
- Cultivation of Halophyte biomass would similarly obviate the necessity of using arable land and freshwater for biofuels and provide petrochemical feedstocks for plastics and other industrial products, essentially eliminating the need for petroleum feed stocks. It is literally green energy and chemicals.

The immense advantages of switching to halophytes include (cont'd.):

- Halophytes sequester up to 18% of their carbon dioxide uptake in their deep roots (5 tons of CO_2/hectare), removing CO_2 from the atmosphere. Extensive halophyte agriculture, capable of greening EVERYTHING, REDUCES CO_2 levels.
- Seawater contains trace elements essential to healthy human physiology, which we have largely depleted from arable land due to overuse.

However, biofuels from Halophytes, with their some 3%ish production from solar efficiency cannot compete with cleaner and far more efficient (25% now, heading to 70%) other renewables.

What is Needed/Missing for Serious Halophyte Adoption

- Continued degradation/shortages of food, water, climate/ecosystem writ large, when/as things become bad enough halophytes will happen, is the only nearer term, very affordable to profitable no new technology solution space with the requisite scale and ready availability for land, water, food, minerals and climate
- A “Burpee Seed Catalog” for Halophytes and readily available training for the differences, such as some 33% additional irrigation levels, with regard to saline agriculture
- Adult education to explain the opportunities, change the “I’ve never heard of Halophytes” responses

Aquaculture/“Algae”

- Open water cultivation is most economical; the Gulf of Mexico could use the continent sized nutrient stream from the Mississippi River efflux
- Renewable energy technologies/electrics will be/are less costly than algae as a biofuel, and transportation is going electric as storage costs reduce by 15% per year, therefore major algae products will probably be protein and “oils” vice biofuels.

An Example of the Power/Importance of Halophytes - “Water”

- Planet water resources are some 97.5% saline and 2.5% “fresh”- 68.5% of the fresh water tied up in glaciers, 30% in ground water, most of the rest in permafrost and the great lakes, Lake Baikal, .007% of the total water is “available” fresh water
- Usual approaches to the increasing water shortages are to improve utilization of the .007%. This is often expensive and far from curative given the increasing water requirements.

“Water scarcity is now the single greatest threat to human health, the environment and the global food supply”

Irrigation Influences Upon Rainfall

- Irrigation can represent an enormous perturbation of the regional atmospheric water and heat balance
- Cool, wet surfaces increase low level atmospheric instabilities, incite “storms”
- Various studies indicate:
  - 18%-25% precipitation increase (from only .4 acre-meter irrigation)
  - Irrigation increased rainfall by 91%
  - Irrigation and vegetation changes are clear dominating factors with direct influence upon atmospheric water content

Characteristics of Desert/Wasteland Halophyte Agriculture (AG)

- No observable salt buildup thus far; if it occurs, it can be “mined” for valuable minerals
- Produces a cooler/moist surface which induces freshwater rain downwind; on the Sahara, puts rainfall into the middle east, stops desertification of the sub Sahara
- Utilizes what we have a plethora of: wastelands and seawater to SOLVE serious societal problems NOW and affordably

Halophyte (Salt-Plant) Utilization (Per Yensen)

- Patents issued for Halophyte crop(s)
- 10,000+ “natural” Halophyte plants; 250 are potential “staple” crops
- Huge areas worldwide are already salt-affected (1B hectares) and another billion hectares overlie saline aquifers
- Over 100 halophyte plants now in “trials” for “commercial” applications
- ~ 25% of irrigated land salinated,% increasing

Halophyte Characteristics

- Can have yields equal to glycophytes
- Cover the product spectrum, seeds, fruits, roots, tubers, grains, foliage, “wood,” oils, berries, gums, resins, pulp
- Rich in energy, protein, and fats
- “Salt penalty” for Halophytes is an additional 35% water requirement to handle excess salts

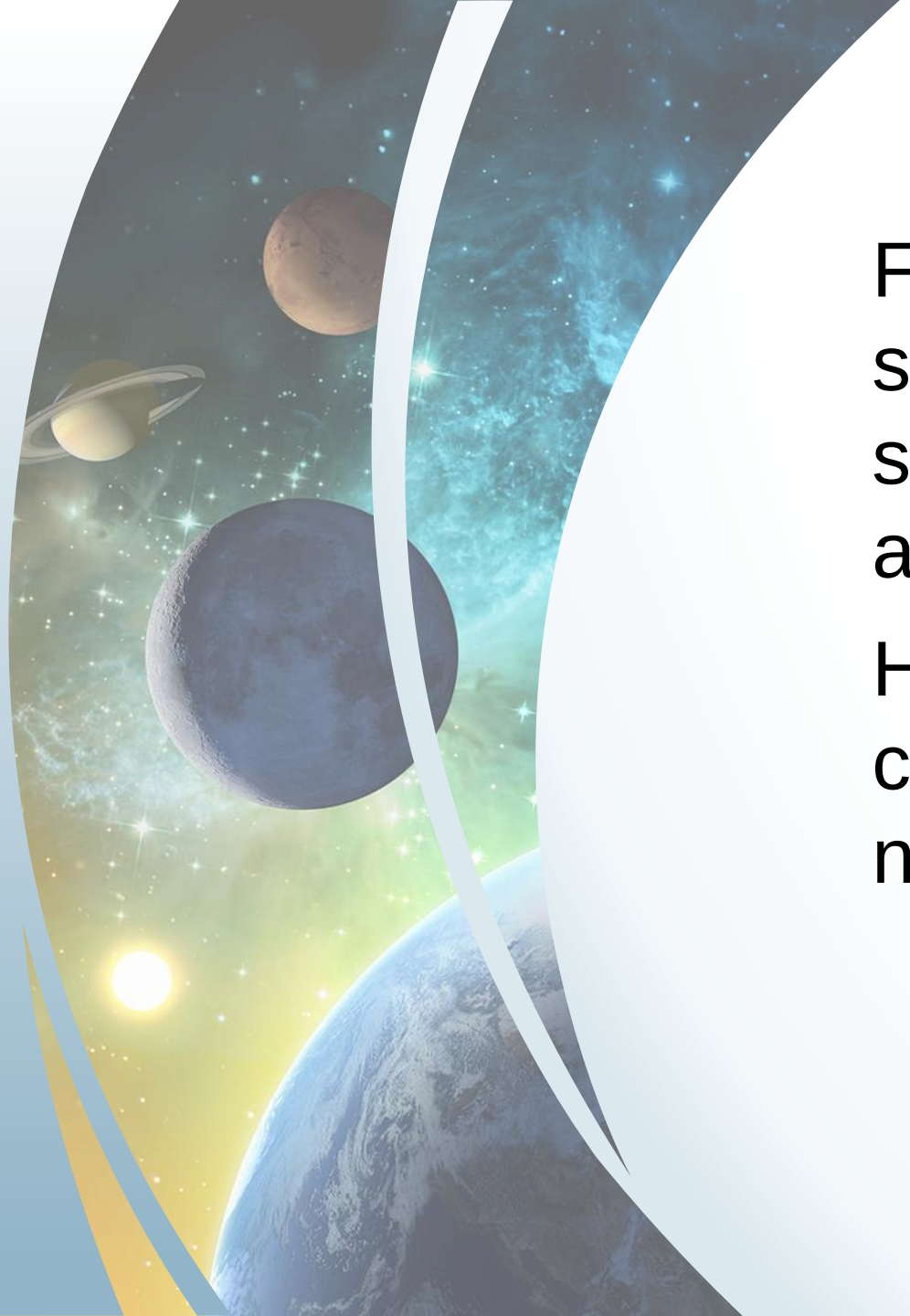
Halophyte Utilization

- Food
- Fodder
- Biomass/energy
- Petrochemical feed stock
- Wood
- Landscaping, ornamental
- CO_2 sequestration
- Land desalinization
- Wildlife habitat

Example Countries with Saline AG Projects

- China
- Mexico
- Eritrea
- India
- Pakistan
- Israel
- Libya
- Jordan
- Tunisia
- Sudan
- Egypt
- Iran
- Morocco
- U.S.
- Saudi Arabia
- Syria
- UAE
- Kuwait
- Australia
- Venezuela

- Current status: prototype farms/experiments for food/fodder



For centuries, on the Indian subcontinent, there has been a very successful saline/brackish water agriculture for food and fodder.

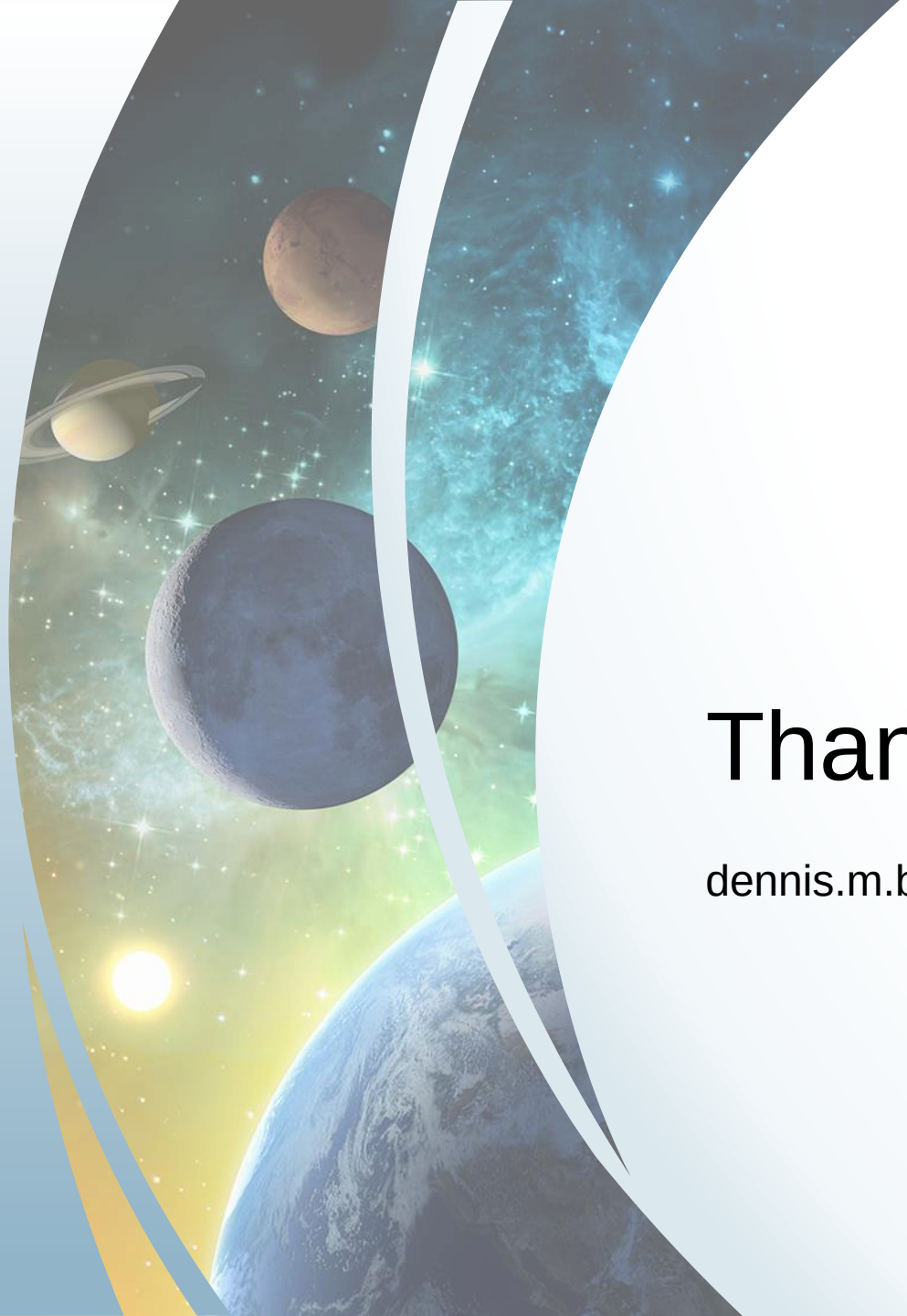
Halophyte farming has been conducted for many years without noticeable salt buildup.

Example Major “Wastelands” Especially Suitable for Halophyte Biomass Production

- Western Australia
- Around the Arabian Sea/Persian Gulf
- Middle East
- The Sahara
- Southwest U.S. including West Texas
- Atacama in South America
- “Others” worldwide

The Desert + Halophyte + Seawater = **Opportunity**

- Utilize wastelands, deserts (inexpensive land)
- Utilize seawater (plentiful, inexpensive water)
- Utilize Halophytes, salt plants
- Grow truly massive amounts of food and biomass for petrochemical feed stocks and green fuels, while sequestering a lot of CO_2, returning 70% of the fresh water back to direct human use
- Affordably, with existing technology, NOW - A 15 to 20 year profitable “fix” to land, water, food, energy and climate challenges



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Comments, Questions & Answers

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Thank You For Listening

Forthcoming Events

- Wed, 06 Oct (15:00-15:45) Climate Change & The Financial Sector: Supporting The Net-Zero Transition
- Mon, 11 Oct (15:00-15:45) Innovative Tax Techniques For Employee Share Schemes
- Thu, 14 Oct (15:00-15:45) Asynchronicity & The Future Of The Workplace
- Wed, 20 Oct (09:00-10:00) Launch Of Global Green Finance Index 8

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