BeneTerra Subsurface Drip Irrigation for Dispersal of Produced Coalbed Water

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U.S. Patent Pending

The BeneTerra Advantage

Inside

Special points of interest:

- BeneTerra SDI provides 24x7 water dispersal 365 days of the year.
- These systems can be scaled to meet unpredictable and changing water flow from wells.
- The topsoil is left in near native condition.
- SDI provides a tremendous boost to forage crop production
- SDI can be used after the coalbed water is gone

BeneTerra has developed subsurface drip irrigation (SDI) technology to disperse produced water from coalbed natural gas wells. This system provides year-round water dispersal for energy operators while producing bountiful crops.

BeneTerra is an agricultural company with an understanding of today's environmental and social challenges. The team members are experienced in agribusiness, agronomy, accounting, wastewater treatment and business management. The combined operational knowledge and experience within BeneTerra allows the company to provide unique, comprehensive solutions for water handling.

Experience with wastewater handling has prepared the team to deal with the challenges faced by the coalbed natural gas industry.

Wastewater effluent is produced year-round and requires environmental permitting and monitoring. The water is normally sodium-rich and must be moved over great distances to be land applied.

Wastewater and produced waters require care in their application to the land. If done properly, beneficial use is a win-win solution for all concerned. The BeneTerra team is devoted to caring for the land and putting water to a higher use.

Swathing grass hay produced with coalbed water through SDI

harvesting water for beneficial use

Benefits of SDI to Energy Producers

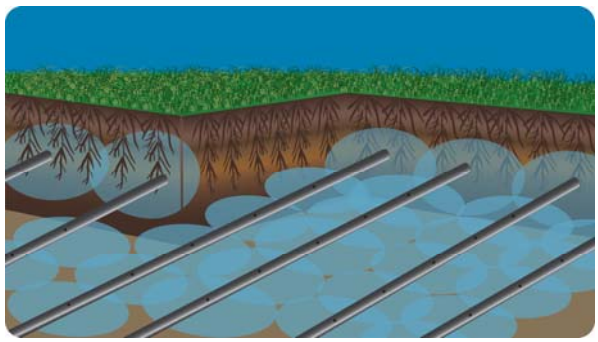
- Turnkey system designed, built and operated by BeneTerra thus allowing operators to focus on gas production
- Scaleable to meet unpredictable and changing water flow
- Year-round water dispersal
- Puts the water to beneficial use
- Diminishes need for impoundments and associated bonding and reclamation costs
- Decreases environmental risk associated with impoundments
- Diminishes need for surface soil amendments associated with surface irrigation since water is applied beneath the soil surface.
- Makes for better relations with surface landowner because of added value from increased forage production
- BeneTerra operates the system. Operator can focus upon gas production

BeneTerra SDI systems operate in winter by capturing the heat latent in the coalbed water. The systems are managed to replace subsoil moisture and move salts deeper into the soil during winter. Warmer soils give crops a head start in the spring.

How Does BeneTerra SDI Work?

Produced water is filtered, treated and pumped through a labyrinth of polyethylene tubing which spreads it uniformly across the land. The tubing has emitters attached to the inside which regulate flow from openings on the tubing.

It is placed in the soil with a chisel plow to depths ranging from 18 to 48 inches. Plants derive moisture from roots in the subsoil while the topsoil remains relatively dry. Haying operations can continue while the field is being irrigated. Heavy equipment cannot compact dry soil and weeds cannot germinate.



Who Pays for it? Who runs it?

BeneTerra contracts with energy companies to design, build and operate the SDI systems for a given period of time. Surface use and water management agreements are made between all of the parties concerned— energy operator, landowner and BeneTerra.

BeneTerra contracts with the energy operator to disperse a given volume of water over the course of a contract period. BeneTerra agrees to maintain the land in a condition that is at least as productive as it was prior to SDI operation.

Agricultural specialists on the BeneTerra team work with the landowner to optimize the system to fit his needs. That might include hay production, rotational grazing or something else. Crop species are selected jointly with the landowner. Cool-season forage grasses and legumes are preferred because of their long growing season and ability to produce high yields.

BeneTerra operates the system over the life of the contract. Once the contract expires it may be turned over to the landowner if so desired. If not, then all of the above-ground fixtures are removed.

These systems are designed to last for 10 to 15 years, if well cared for. However, there are SDI systems that have operated for more than 20 years.

Benefits of SDI to Agricultural Producers

Increased hay production along with available stock water has allowed some ranchers to maintain and even expand their herds during drought

- Forage production will be increased—there is more hay or pasture thus the carrying capacity of the land improves.
- The natural viewscape is maintained as there are very few above-ground structures visible. Fewer infiltration pits are needed by the operator.
- Native soil surface conditions are preserved because the water is placed well beneath the surface.
- SDI can be designed to fit odd-shaped fields.
- In some cases shallow aquifers can be recharged for use as stock wells in the future.
- Wildlife habitat can be enhanced.

How Much Water Will SDI Handle?

Subsurface drip irrigation is the most efficient method of delivering water to crops. Since water is applied beneath the soil surface it does not run off the soil surface. Greater amounts of water can be applied compared to surface irrigation.

Coalbed natural gas wells typically produce large amounts of water early in their development. Then the volume tapers off quickly. Operators are challenged to produce wells as their water handling capacity allows, SDI offers them some flexibility.

Crops grown with SDI will luxuriously consume water in greater quantities than are common under conventional irrigation. If managed properly, water can be applied to some soils at the rate of 90 barrels per acre-day.

The amount applied is limited by soil permeability and/or underlying groundwater quality. These systems typically require an "Underground Injection Control" permit which is mandated by the USEPA.

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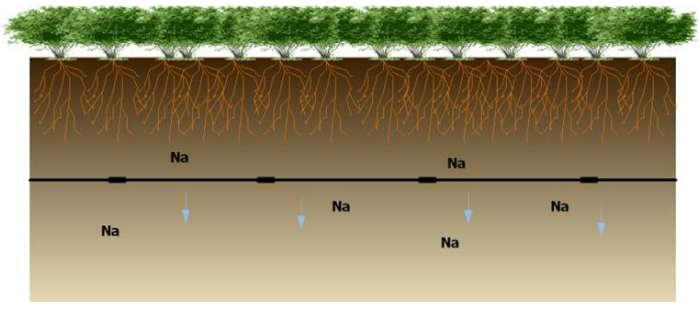
What About The Salts?

Coalbed water is typically about 99.8 pure water. The primary mineral is sodium bicarbonate also known as baking soda. Most refer to sodium chloride as salt but technically sodium bicarbonate is a salt as are calcium sulfate (gypsum), magnesium sulfate (Epsom salts) and calcium carbonate (lime).

The subsoils of arid regions naturally contain many tons of salt which are commonly salts of calcium and magnesium. Most of the native calcium and magnesium in semi-arid soils are found beneath the topsoil layer and can extend downward to great depths.

BeneTerra SDI systems are designed to utilize the native calcium and magnesium already present in the soil to offset the effects of sodium. Then the salts are pushed to a lower depth in the soil where they will reside with other salts that have existed there for thousands of years.



Contact us at

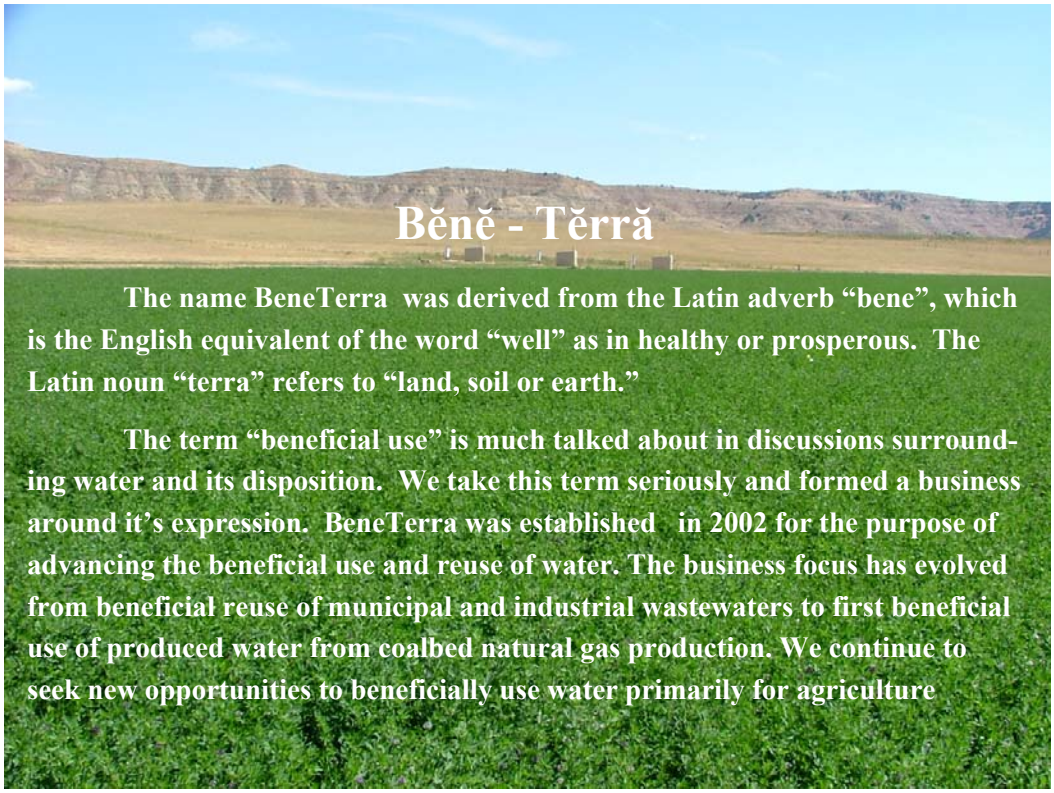
BeneTerra LLC
1415 N. Main St.
Sheridan, WY 82801

Phone: 307-673-0607
Fax: 307-673-1080
E-mail:info@beneterra.com

We are on the web!
Check us out at
www.beneterra.com

harvesting water for beneficial use

Corporate office:
420 S. Jackson St.
Pratt, KS 67124



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The name BeneTerra was derived from the Latin adverb "bene", which is the English equivalent of the word "well" as in healthy or prosperous. The Latin noun "terra" refers to "land, soil or earth."

The term "beneficial use" is much talked about in discussions surrounding water and its disposition. We take this term seriously and formed a business around it's expression. BeneTerra was established in 2002 for the purpose of advancing the beneficial use and reuse of water. The business focus has evolved from beneficial reuse of municipal and industrial wastewaters to first beneficial use of produced water from coalbed natural gas production. We continue to seek new opportunities to beneficially use water primarily for agriculture

BeneTerra LLC
1415 N. Main St.
Sheridan, WY 82801
USA

place
stamp
here

harvesting water for beneficial use