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Ward KEITH

Terrastar Soil Conditioner

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TerraStar

TerraManus Technologies currently owns three proprietary technologies. TerraStar® is an inflatable, molded plastic wheel (right) that represents a potentially transforming advancement in soil and water management technology which, we believe, may be the reconciling link between competing economic and environmental interests worldwide. Via a proprietary process called Hydra Forming, TerraStar uses lateral consolidation (not compaction) to create reservoirs or "weir systems" of geometrically ordered roughness in the soil to manage water flow, reduce soil erosion, and increase surface area and the water penetration rate into the soil, resulting in increased crop yields and reduced input costs to farmers.

This technology works differently than other soil modification devices, because our weir systems are created in such a way as to consolidate the soil without causing soil compaction. The walls of these weirs are formed of various curves and angles, all of which increase the soil surface area and hold and control flowing water while allowing it to penetrate into the soil. This in turn leads to enhanced yields and reduced input costs. Moreover, soil erosion and surface ponding on fields are significantly reduced because rainfall and irrigation water are held where they fall, thereby reducing runoff and increasing the rate of water penetration into the soil. TerraStar has potential applications in agriculture, bio-fuel, real estate, land reclamation, and road construction.

Our independent testing results revealed the following benefits of TerraStar usage:

* Increased crop yields and enhanced plant quality
* Reduced water and chemical costs
* Reduced soil erosion and water and chemical runoff
* Improved soil quality

According to Dr. Stephen, these results are driven by providing plants more of what they need, namely water and sunshine. The TerraStar performs three primary functions. First, the reservoirs created by TerraStar hold water in place, providing plants with the moisture they need. Dr. Stephen states that the TerraStar may improve the potential for yield in today's genetically enhanced corn hybrids, given that these reservoirs become a microbial well which creates an optimal growing environment for plants. Second, TerraStar consolidates the soil, which reduces soil erosion and (unlike other technologies which compact the soil) enhances the infiltration rates of the water. TerraStar usage reduces the soil's bulk density and increases the water-fill-pore-space of the soil by about 20%. The increased water-fill-pore-space allows for more moisture holding capacity and air movement within the soil. These enhancements are the equivalent of turning a two inch rainfall event into a four inch rainfall event in terms of available moisture for the plant. Third, TerraStar increases the surface area of the soil by approximately 30%. And as the surface area increases, the soil temperature increases and the benefits of sunshine are enhanced. This all tends to create healthier, higher yielding plants.

The **TerraSystem™** is a cropping technology that does in one pass (cultivating, planting, fertilizing and soil and water management with the TerraStar, partial prototype left) what farmers currently do in 2 to 4 passes. Multi-tasking by farmers can dramatically reduce labor and fuel costs, but the horsepower required to pull multiple implements in the field is often prohibitive. Limited field testing of simple prototypes indicates that the TerraSystem requires only about 80% of the horsepower required to pull a traditional subsoiler alone.

The **TerraSaver™** is a human-powered tractor and cropping system being developed specifically for third-world farmers. The tractor will be pedaled by two people and will be equipped with a cultivator/subsoiler, drill, broadcaster (for fertilizing) and TerraStars for wheels. It is intended to perform all of these functions, like the TerraSystem, in one pass.

This technology is being designed to address the desertification problem that exists in many third world countries and provide farmers with the tools to become self sufficient. The TerraSaver will require no power source or additional inputs other than human beings, which is a resource these countries generally have in abundance. Moreover, it will be simple to use and we estimate its retail cost at less than $1,000.00. (Above is an even simpler horse-drawn technology.) While this technology is currently in the concept stage, we intend to pursue patents on both the TerraSystem and TerraSaver technologies and we believe that the TerraSaver will effectively enable farmers in lesser-developed countries to begin reaping the benefits of "precision farming" as well the TerraStar technology.

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http://www.cleantech.com/news/4590/ag-innovation-seeks-funding
June 15, 2009

Ag Company Boosts Yields Without Chemistry

by

Lisa Sibley

Cleantech Group

TerraManus Technologies is one of 20 companies the Cleantech Group spotted in the past week looking to raise money. Find out more in the Pitch o' the week.

A new farming equipment invention from Liberty, Mo.-based TerraManus Technologies has an absorbent waffle-like effect on soil, rather than that of a pancake where the syrup runs off the sides.

Using the breakfast analogy, TerraManus CFO Gregg Whittaker told the Cleantech Group the company's new ground tilling system addresses soil erosion, water flow management and related environmental problems, while increasing crop yields and reducing input costs to farmers. And the company, which is currently pre-revenue, expects that status to change before the end of the month.

"The concept is very simple, but the science behind it is very complex," he said. "Each curve on the wheel maximizes the water flow, and consolidates rather than compacting the soil."

The company's invention, called the TerraStar, is essentially an inflatable, molded plastic wheel. It uses consolidation to create reservoirs that are walled by various curves and angles. The result helps to increase the surface area of the soil by about 35 percent as well as boosting the water penetration rate into the soil, the company claims.

Whittaker said farmers have been able to reduce water and fertilizer needs by 10 to 30 percent. And increased crop yields have been as much as 42 percent for tomatoes and 12 percent for corn, for which demand has been steadily growing in recent years (see American farmers plan to plant more corn this year).

The TerraStar has potential applications in agriculture, biofuel, real estate, land reclamation and road construction. It's an embodied technology, Whittaker said, meaning it works within the existing framework of farming operations, as opposed to requiring farmers to change how they farm. The company has patented its technology in the United States, and is finalizing global coverage.

TerraManus, a research and development company founded in 2005, is developing strategic partners to distribute its invention, which retails for about $90 for one wheel.

The company is seeking $500,000, most likely from angel investors, to continue its research and commercialization efforts.

The company wants to build and expand its marketing strategy with companies including Hutchinson, Minn.-based agriculture attachments manufacturer May Wes and other strategic partners. May Wes makes three universal farming attachments that work with the TerraStar, and is already selling the TerraStar.

The TerraStar can be attached to both machine and human-powered equipment, and was developed with U.S. and European high-tech industrialized farming in mind.

"We discovered very quickly that it could be used by farmers in less developed countries as well," Whittaker said.

The company's TerraSaver is a human-powered tractor and cropping system being developed for third-world farmers. Whittaker said the company is working on manufacturing and distributing its technology in Kenya.

The company's research has been conducted at Martinsville, Ill.-based Arise Research & Discovery and in Mexico, where a bean crop was tested over five years on a control plot. During one of those years, Mexico experienced a drought. But because the TerraStar increased the soil's moisture content, though the plot received little rain, it "looked like an oasis in the middle of a desert," Whittaker said.

With additional funds, Whittaker said the company wants to expand the technology's applications in twin-row planters, where crops are planted in twin rows and essentially double the amount of yield per acre compared to standard rows. But the soil currently can't support it because there aren't enough soil nutrients. TerraManus believes the TerraStar could change that.

The market potential for the company's technology is large and growing, Whittaker said. Of the $100 billion in worldwide ag equipment sales every year, $22 billion of that is in North America. Of that, $13 billion of that market worldwide and $2.5 billion in North America could benefit from TerraStar's equipment, Whittaker said.

US7478684

Soil conditioning device

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EP1912489 (A2)

Abstract -- A soil conditioning device having a series of peripheral ridge members having a leading and trailing prow shaped surface circumscribing a disc, wheel or drum and a method of use. Optionally the prow shaped peripheral ridge members are joined by sub-ridge members forming a single ridge of varying heights circumscribing the disc, wheel or drum.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to soil conservation, more specifically toward an apparatus for conditioning surface soils thereby increasing infiltration.

2. Description of the Related Art

Traditional farming comprises tasks such as plowing, disking, harrowing, seeding, fertilizing, and harvesting. During this farming process, soil is often left in a loose condition where the soil is subject to moisture evaporation and erosion. There is an increased demand to accomplish these farming tasks in a manner to conserve the soil by reducing erosion and to conserve the water by increasing the infiltration capability of the soil. Additionally, there is a demand to multitask these operations such that several tasks can be accomplished in a single pass over the land thus improving the efficiency of the farming operation and reducing costs. Due to the increasing demand for soil and water conservation as well as multitasking in farming and land management practices, it has become necessary to design machinery and supporting systems.

Traditionally, soil erosion and surface water management has been attempted with diking, imprinting and compacting systems, and reservoir tillage systems. These systems have been designed for the purpose of sealing the soil surface and/or retaining water where it falls thus reducing erosion. There are many forms of equipment available today that attempt to create irrigation pools and reservoirs in the soil surface. Examples of processes which use equipment to compact the soil into pools include furrow irrigation, diking, compacting and punching, spading and scooping, imprinting and impressing. All of these processes incorporate devices that can be mechanically driven or ground driven and can be linear or rotary in their operation. However, these traditional processes and associated devices fall short of providing a system or device which reduces erosion, reduces water runoff, increases water infiltration, and allows multitasking.

Imprinting and compacting devices compact the soil to overcome erosion by creating pools. These devices require excessive weight to be applied perpendicular to the soil surface, allowing the soil structure to be impressed in order to make their imprints. An example of an imprinting machine is the Dixon Wheel Roller.TM. which is designed to have the required weight to overcome the soils surface structure in order to make an impression. As a result of the compaction, the soil surface is sealed which causes the soil surface to become substantially impervious to water infiltration.

Compaction in soil is the direct result of weight applied to the soil surface. Compaction occurs quite frequently on farmland because of the type of equipment used, such as a moldboard plow or imprinting and compacting devices. Further compaction is caused by high traffic, tractors, carts, etc. on the soil surface. This compacted soil surface is commonly known as hard pan. When weight is applied to the soil, the soil structure is compressed. The greater the weight or load to the soil, the greater the amount of compaction. Compaction causes the surface soil to become compressed to such a level that it becomes substantially sealed and impervious to water. The top soil below the compacted surface soil is consequently substantially sealed off and has little water for infiltration. This in turn leads to a reduction in replenishing of water in the underlying aquifer which has contributed to the current water supply problems. Additionally, farmers need use equipment such as Rippers.TM., SubSoilers.TM., or Pan Busters.TM. to penetrate below the hard pan and fracture it to allow moisture to infiltrate and therefore promote root systems on the crops. This practice does little to provide a system which reduces water runoff, increase water infiltration, or allow multitasking.

More recently, imprinting type machines have been designed to require less weight to make an impression in the soil surface in an effort to overcome some of the associated problems. Even though these more recently designed machines are lighter than the Dixon Wheel.TM. and other similar devices, they are all still relatively heavy and decrease water infiltration capabilities of the soil.

Soil diking systems and devices have been designed to overcome some of the problems associated with the imprinting and compacting systems. Diking is accomplished by scooping, digging, and/or dragging the soil which is then left in a loose condition to form pools or reservoirs. Less weight is needed for diking than imprinting or compacting devices in an attempt to leave the soil surface more pervious to water. However, when water is applied to the loose soil it impacts and dislodges the fine particles of soil and organic matter on the sides of the dikes and washes them into the bottom of the pools. These particles of soil then seal the bottom of the pools which reduces the infiltration capability of the soil and diminishes the reduction of runoff. Additionally, the loose soil is eroded from the field in both light and heavy rainfall events.

Another recent attempt to provide soil and water conservation in farming has been the practice of no-till farming. No-till farming is where the soil is left undisturbed from harvesting to planting. Planting is accomplished in a narrow seedbed or slot created by disc openers. Coulters, residue managers, seed firmers, and modified closing wheels are used on the planter to provide adequate seed to soil contact. However, there are several disadvantages associated with no-till. No-till requires the use of herbicides to eliminate competition from weeds which raises production costs. Crop residue left on the soil hinders soil warming and drying, making planting more difficult and reduces seed germination. Conventional tillage systems cannot be used to incorporate fertilizers and herbicides. The heavy residue or foliage left on the land may result in poor seed soil contact thus reducing seed germination. Also, the soil surface is not left in a highly permeable state resulting in rain water runoff and reduced infiltration to subsurface soils and the underlying aquifer.

Most recently, reservoir tillage systems such as the one taught in U.S. Pat. No. 5,628,372 ('372) have been devised to overcome the problems associated with the aforementioned farming practices. '372 teaches an agricultural instrument having a series of multifaceted peripheral ridge members having flat leading and trailing edges selectively spaced circumscribing a disc. The ridge members have a flat circumferential section spacing therebetween. The configuration of the '372 device compacts the soil to form water retaining pools in the soil from the vertical impact of the ridge member on the soil upon rotation. This compaction reduces water infiltration into the soil. Additionally, the flat trailing edge of the multifaceted peripheral ridge member pitches the soil at rotation velocities necessary for efficient farming practices. This pitching of the soil fills in the created pools with fine particles that seal the bottom of the pools which further reduces the infiltration capability of the soil. Furthermore, pitching of the soil destroys a portion of the structure of the pool leading to early failure of the remaining pool structure.

There remains a need for improving soil and water conservation as well as providing for efficient farming practices, such as multitasking, and land management practices.

SUMMARY OF THE INVENTION

The present invention is comprised of a soil conditioning device having a series of prow shaped peripheral ridge members optionally joined by sub-ridge members circumscribing a disc, wheel or drum. When the soil conditioning device is rolled across the soil surface, a series of consolidated prow shaped hollows and optional weir formations are created in the soil enhancing soil permeability and reducing water runoff. Rolling of the soil conditioning device across the soil surface may be accomplished with a mechanized, human, or animal powered apparatus. The soil conditioning device may serve as the wheels for the apparatus rolling the soil conditioning device or passively pulled with the apparatus. Preferably a transport means such as a tractor will pull a cylindrical rolling tool having a plurality of soil conditioning devices mounted thereon. The primary purpose of the soil conditioning device is enabling the soil to retain rain water where it falls and consequently reduce erosion and increase water retention and infiltration of the soil and provide for multitasking capabilities.

The soil conditioning device is a rotary device which can be attached to most any existing agricultural and horticultural machine and may also be attached to any specially designed machine for use in construction, mining or other situations which require earthworks, including home gardening. Additionally, the soil conditioning device may be fitted to an animal or human powered device such as tri-wheeled vehicle having soil conditioning devices serving as wheels. Several soil conditioning devices may be adjacently aligned to form a soil conditioning tool in the form of a cylindrical roller having a plurality of soil conditioning devices. The device or tool is driven or rolled while being in contact with the ground forming a series of prow shaped hollows and optional adjoining weirs. Additionally, the soil conditioning device or tool can be fitted with a ratchet release, break or clutch device, or can be driven mechanically from a variety of sources at speeds necessary for multitasking.

The soil conditioning device is comprised of a relatively lightweight material. Such materials may include wood, polyurethane foam, rubber, silicon rubber, synthetic rubber, Hytrel.TM., urethane, various plastics or polymeric materials, and combinations thereof. Preferably, the soil conditioning device is manufactured from plastic or polymeric materials such as high density polyethylene (HDPE), polyvinyl chloride, vinyl, or other such moldable plastic materials. HDPE has been found to be advantageous since it is a material which is light weight, strong, flexible and exhibits self cleaning capabilities when applied to the soil. Optionally, the use of UV-stabilizers such as carbon black may be added to improve its weather resistance. Combinations of various polymeric materials have also exhibited the desired properties of being relatively lightweight and a having a degree of flexibility.

The soil conditioning device is molded producing a circular outer skin having a series of prow shaped peripheral ridge members optionally joined by sub-ridge members surrounding a hollow core. This design and material of manufacture allows the shape, hardness, and weight to be adjusted at its point of use by a farmer or other user for various soil types. This adjustability enables it to work efficiently in a variety of conditions. The adjustment is accomplished by filling the hollow core through a valve in the soil conditioning device. The core may be filled with compressed air or other gases, water or other liquids, gels, solids, expanding foam, a mixture of air and water, or any combination thereof to obtain the desired shape, hardness, and/or weight.

The soil conditioning device molds or consolidates the soil upon which it is rolled or driven upon by applying light pressure to the soil surface in a substantially horizontal direction so as to lightly consolidate or bind the outermost surface of the soil together. Consolidating the soil surface lightly sticks the outermost surface soil particles together leaving a porous permeable soil surface for greater infiltration capabilities. As the device travels through the soil, the soil flows over and around the various component surfaces of the device restructuring the soil to a desired form. While the soil flows over and around the various surfaces, the soil is caused to lift and flow in a bow wave fashion behind the device or tool having a plurality of devices. While the soil is in the flowing state, the device is rotating within the soil flow and forming, ushering, and gently kneading the soil while ushering it into place producing a series of consolidated hollows and optional weirs, therefore leaving the soil surface in a "Geometric Ordered Roughness (GOR), necessary for the control of erosion caused by water and wind, in a process known as "Hydroforming". This process of consolidating the soil requires little or no additional pressure or force perpendicular to the soil surface thus providing little or no compaction to the surface soil. The consolidation is accomplished in a substantially lateral direction and shapes a structure in the soil consisting of various curves and angles forming prow shaped hollows and optional adjoining weirs which increases the soil surface area. The increase in permeability and surface area of the soil surface both contribute to the increase in soil infiltration and consequent reduction in erosion. Additionally, the prow shape of the ridge allows for the device to be operated at speeds necessary for efficient farm practices.

The soil conditioning device of the present invention consolidates the soil surface into a series of permeability or porous prow shaped hollows and optional adjoining weirs controlling water flow and increasing the surface area of the soil contacting rain water thus increasing the effective infiltration rate of the soil. These prow shaped hollows and optional adjoining weirs are designed to slow and/or stop flowing water while allowing it to infiltrate the soil. These structures are consolidated evenly over their entire surface of the soil increasing the surface area of the soil and increasing the infiltration rate of the soil. Additionally, increase surface area increases soil warming from the sun allowing for improved seed germination. Below this molded or consolidated surface, the soil structure remains loose thus allowing water to percolate throughout the soil. These prow shaped hollows and optional adjoining weirs increased porosity, infiltration rate, and water absorbing capability of the soil directly reducing erosion of the soil by substantially eliminating and/or slowing water runoff. Additionally, surface ponding on fields is reduced since rainfall or irrigation water is more easily absorbed by the soil having a higher porosity and surface area in contact with the water.

The soil conditioning device has many applications and benefits. It is capable of working on most all soil types and agricultural applications, such as planting, surface water control, soil warming, reducing wind erosion, cultivating and plowing, or common construction applications, such as scraping, building berms, reclaiming land, or even creating meridians between interstate highways.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the soil conditioning device of the present invention showing the prow shaped ridge members and subridge members circumscribing a wheel.

FIG. 1

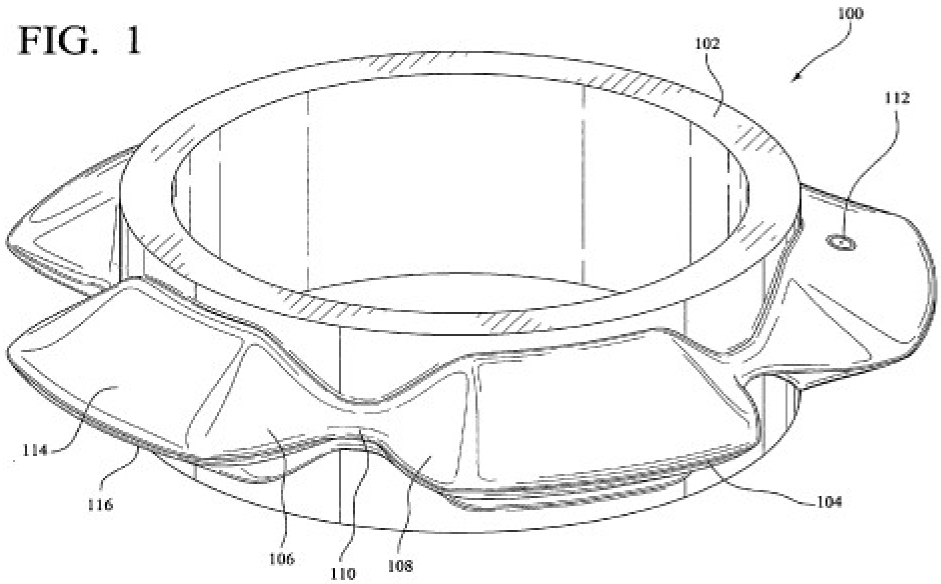

FIG. 2 is a perspective view of an embodiment of the soil conditioning device of the present invention showing a plurality of spaced prow shaped ridge members circumscribing a wheel.

FIG. 2

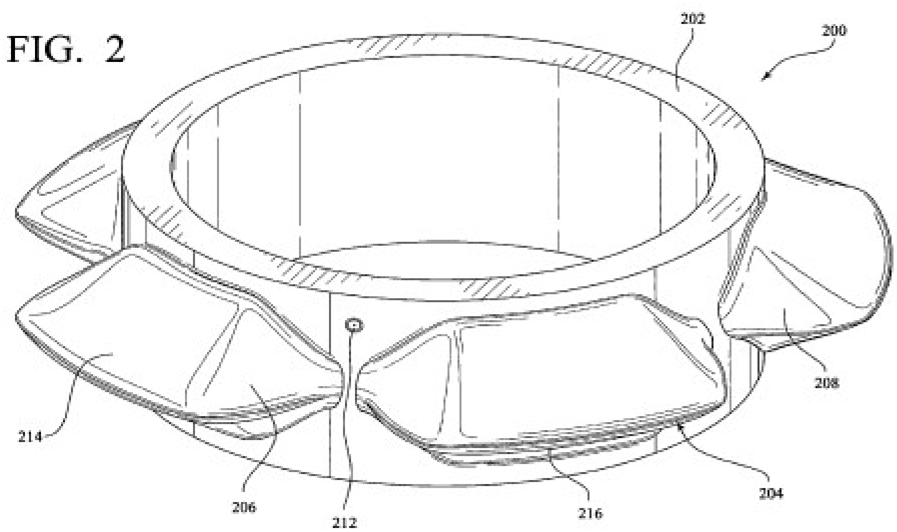

FIG. 3 is a side view of the soil conditioning device of FIG. 1 showing the relative size of the prow shaped ridge members and subridge members circumscribing a wheel.

FIG. 3

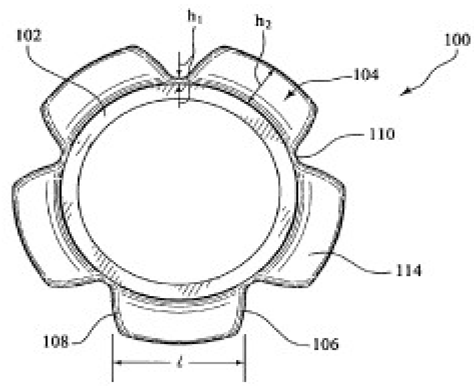

FIG. 4 is a front view of the soil conditioning device of FIG. 1 showing the angle between opposing sides of the prow shaped ridge members circumscribing a wheel.

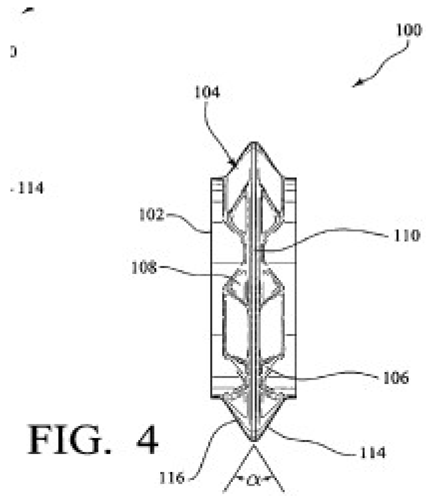

FIG. 4

FIG. 5 is a front view of a soil conditioning tool incorporating a plurality of the soil conditioning devices of FIG. 1.

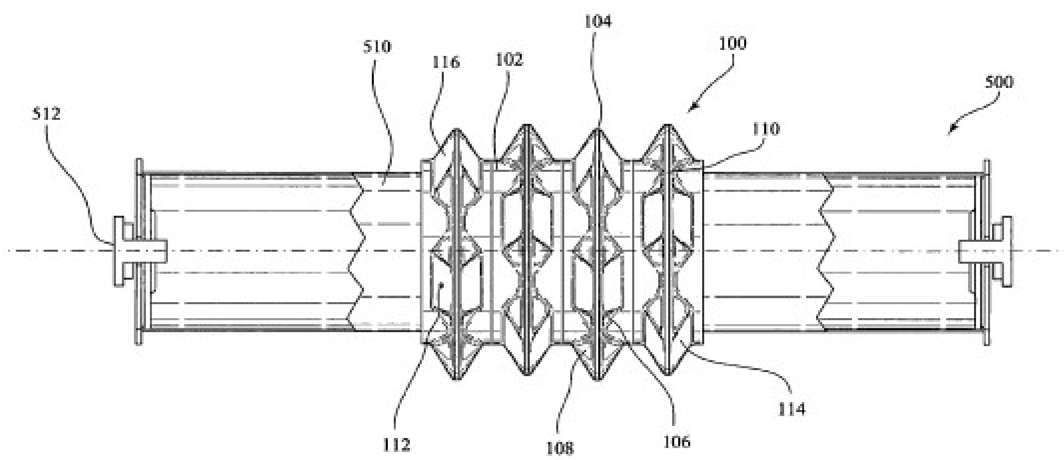

FIG. 5

FIG. 6 is a top view of a soil conditioning tool incorporating a plurality of the soil conditioning devices of FIG. 1 for use after planting.

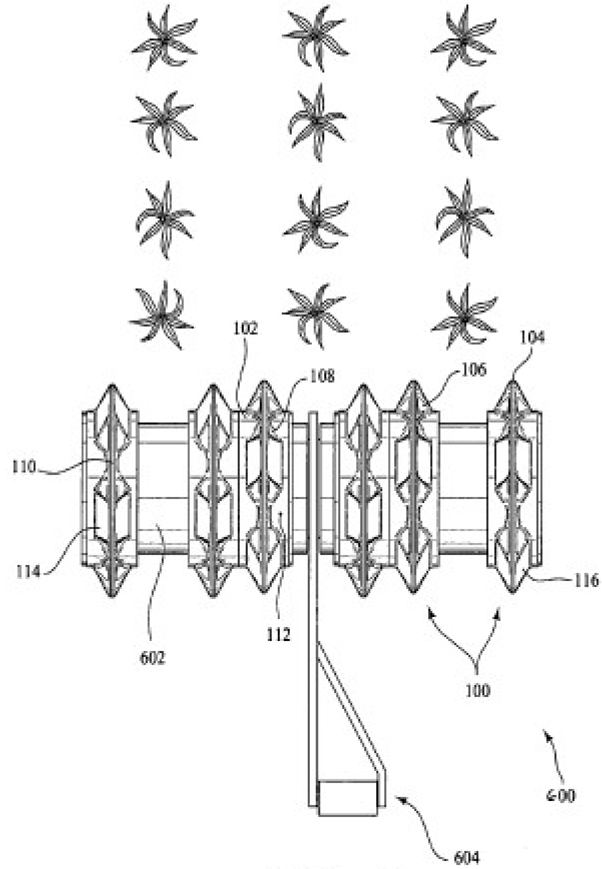

FIG. 6

FIG. 7 is a top view of a soil imprint formed by the tool of FIG. 5.

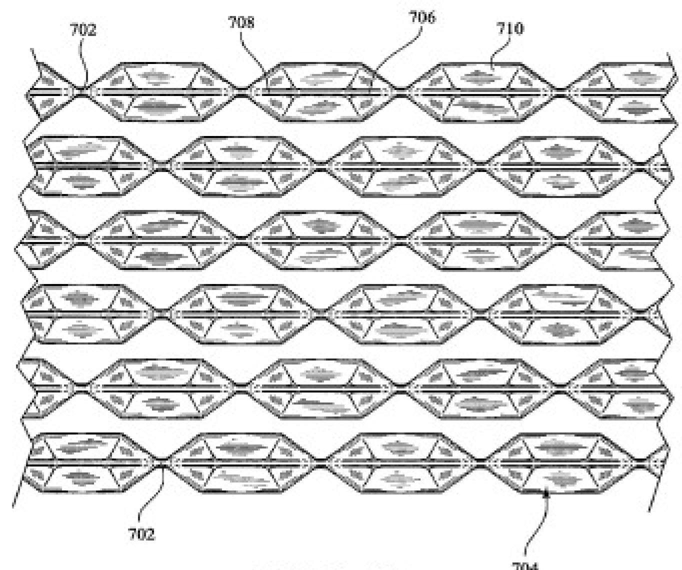

FIG. 7

FIG. 8 is cross-sectional view of soil being consolidated by the device of FIG. 1.

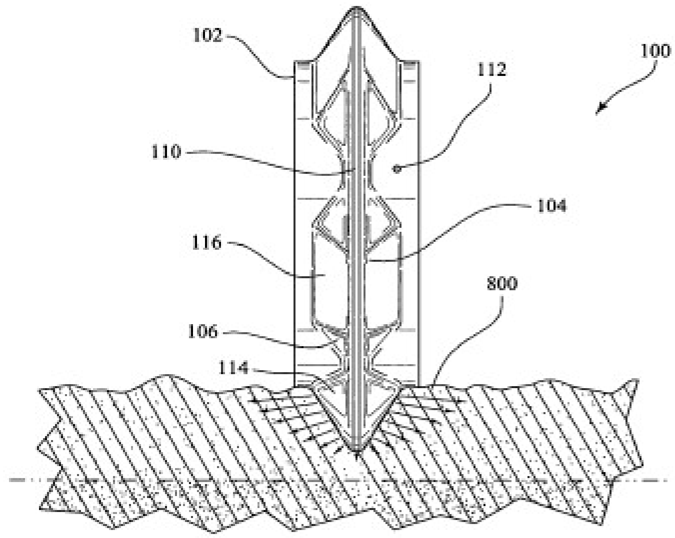

FIG. 8

FIG. 8a is a top view of the soil having been consolidated by the device of FIG. 2.

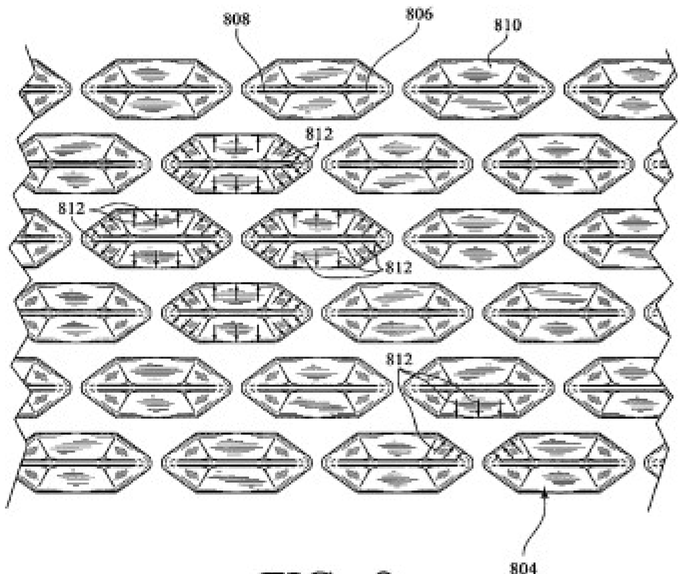

FIG. 8a

FIG. 9 is a cross-sectional view of a soil conditioning tool in an expanded state.

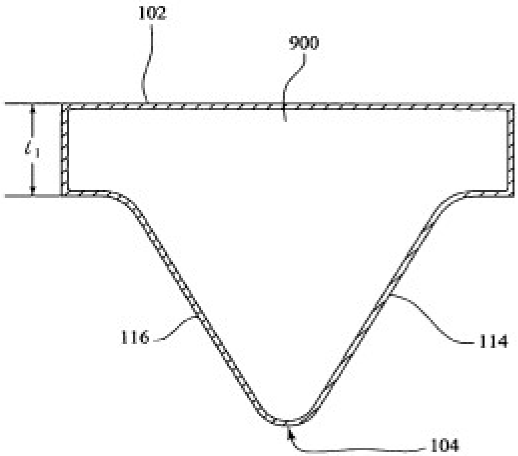

FIG. 9

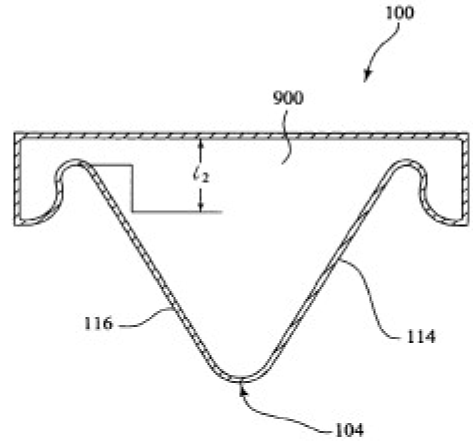

FIG. 9a

FIG. 9a is a cross-sectional view of a soil conditioning tool in a retracted state.

DETAILED DESCRIPTION

FIG. 1 shows soil conditioning device 100 having a series of prow shaped peripheral ridge members 104 joined by sub-ridge members 110 circumscribing wheel or disc 102. Each of the plurality of ridge members 104 has a leading prow shaped surface 106 and a trailing prow shaped surface 108. Spanning between each leading surface 106 and trailing surface 108 is a subridge member 110. This embodiment of the soil conditioning device may also be described as a wheel member 102 having a central continuous outer peripheral ridge of varying heights about wheel member's 102 circumference. The peripheral ridge is formed by prow shaped peripheral ridge members 104 having leading prow shaped surface 106 and trailing prow shaped surface 108. Ridge members 104 are joined or interposed by sub-ridge members 110 and have a rounded top surface and side walls 114 and 116 sloping toward wheel member 102.

Soil conditioning device 100 is shown circumscribing wheel 102 and being of a unitary material having a hollow interior. Preferably, soil conditioning device 100 is formed with a polymeric material. More preferably, the polymeric material forming the soil conditioning device of the present invention is high density polyethylene. Optionally, a UV-stabilizer such as carbon black may be added to the polymeric material to improve its weather resistance.

Valve 112 is shown is shown in a sloping sidewall 114 of ridge member 104 and provides injection access to the inner core of device 100. Compressed air or other gases, liquids, gels, solids, or any combination thereof may be injected into the inner core through valve 112 to obtain a desired shape, hardness, and/or weight of device 100.

Rolling or driving soil conditioning device 100 upon the soil surface creates a permeable soil surface having a series of weirs and an increased surface area improving infiltration and controlling water flow thereupon. The soil surface is consolidated improving resistance to movement of soil particles by moving water while increasing permeability thus increasing infiltration capability of the soil. The weirs slow and direct the flow of water upon the soil surface, resulting in a cascading effect. This cascading effect reduces the inertia of the flowing water minimizing the soil's erosion. These soil structures increase the soil surface area and decrease water run-off.

FIG. 2 shows soil conditioning device 200 having a plurality of prow shaped peripheral ridge members 204 selectively spaced about a peripheral surface of disc or wheel or disc 202. Each of the plurality of ridge members 204 has a leading prow shaped surface 206 and a trailing prow shaped surface 208. Soil conditioning device 200 may also be described as wheel member 202 having a series of central disjointed outer peripheral ridge members 204 wherein each peripheral ridge member 204 has a prow shaped leading end 206, a prow shaped trailing end 208, and two opposing sloping sidewalls 214 and 216 sloping toward wheel 202.

Soil conditioning device 200 is shown circumscribing wheel 202 and being of a unitary material having a hollow interior. Optional valve 212 is shown in wheel 202 providing material access to the core of device 200. Rolling soil conditioning device 200 upon the soil surface consolidates the surface soil laterally into a series of preselectively spaced prow shaped hollows.

FIG. 3 shows soil conditioning device 100 of FIG. 1 having prow shaped ridge members or sections 104 interposed with subridge members or sections 110 circumscribing wheel or disc 102. Interposed ridge members 104 and subridge members 110 form a central continuous outer peripheral ridge of varying heights circumscribing wheel 102. Ridge sections 104 are of a primary height h.sub.2 and subridge sections 110 are of a secondary height h.sub.1. Primary height h.sub.2 is greater than secondary height h.sub.1. Preferably, h.sub.2 exceeds h.sub.1 in a range of approximately 1.5 inches to 5 inches. Also in this embodiment, each ridge section 104 has a primary height h.sub.2 extending continuously about the circumference of wheel 102 (l) in a range of about 5 inches to 10 inches.

FIG. 4 shows a front view of soil conditioning device 100 with prow shaped ridge members 104 and subridge members 110 circumscribing wheel 102. Shown here are opposing side walls 114 and 116 of ridge member or section 104 having an angle .alpha. therebetween. Preferably angle .alpha. is in a range of approximately 40.degree. to 80.degree., and more preferably is approximately 60.degree..

FIG. 5 shows soil conditioning tool 500 incorporating a plurality of the soil conditioning devices 100. Soil conditioning devices 100 are axially aligned and retained forming cylindrical rolling tool 500. In the embodiment shown, soil conditioning devices 100 are adjacent one another in a staggered ridge member 104 alignment. However, soil conditioning devices 100 may be in a spaced configuration on cylindrical roller 510 and may as well be in a configuration having ridge members 104 aligned radially about cylindrical roller 510. Attaching hubs 512 extend axially from each end of cylindrical roller 510 for rotatingly attaching to a transport means such as a tractor or as the last device in a multitasking train of farming tools, or optionally placed in various positions within the train of farming tools, providing for an efficient method of soil and water conservation easily incorporated into current farming practices.

FIG. 6 shows a top view of soil conditioning tool 600 incorporating a plurality of the soil conditioning devices 100 of FIG. 1 for use after planting. Soil conditioning devices 100 are axially aligned, spaced, and retained forming cylindrical rolling tool 600. A plurality of pairs of soil conditioning devices 100 are adjacent one another in a staggered ridge member 104 alignment on cylindrical roller 602. However, soil conditioning devices 100 may be spaced having three, four or even more soil conditioning devices 100 adjacently aligned and the spacing between adjacent devices 100 may vary depending upon the size of the plants. Cylindrical roller 602 may be in a configuration having ridge members 104 aligned radially about cylindrical roller 602. Attaching arm 604 extends radially from a center portion of cylindrical roller 602 for rotatingly attaching to a transport means such as a tractor or as the last device in a multitasking train of farming tools.

FIG. 7 shows a top view of soil imprint 700 formed by soil conditioning tool 500 of FIG. 5 or other device having at least one soil conditioning device incorporated therein. Having soil conditioning tool 500 driven (i.e. used as a powered wheel) or rolled (i.e. passively pulled or pushed) by mechanical, animal, or human power upon the surface soil while being in contact with the ground consolidates the soil into a series of prow shaped hollows 704 and adjoining weirs 702. Leading end 708, mid-section 710, and trailing end 706 make up hollow 704 and are formed by sections or walls 106, 114, 116, and 108 of device 100 respectively.

FIG. 8 shows a cross-sectional view of soil being conditioned by soil conditioning device 100 of FIG. 1. Shown here are force vectors 800 primarily in a lateral direction consolidating the soil surface. As device 100 rolls upon the land, leading prow shaped surface 106 makes contact with the soil and as device 100 continues to roll, leading prow surface 106 and ridge member 104 laterally consolidates the soil as shown by force vectors 700. Having prow shaped leading edge 106 first contacting the soil allows the soil to be consolidated with less than about fifty pounds force per ridge member 104. Additionally, having trailing surface 108 in a prow shape allows device 100 to move about the soil surface at speeds of up to about 14 mph without throwing or pitching the soil.

FIG. 8a shows a plan view of the soil having been conditioned by soil conditioning device 200 of FIG. 2. Shown here are force vectors 812 indicating the lateral direction of consolidation and primarily showing the forward and rearward direction of consolidation achieved by the prow shaped ridge members 204 forming a series of prow shaped hollows 804. Prow shaped hollows 804 have leading end 808, mid-section 810, and trailing end 806 and are formed by sections or walls 206, 214, 216, and 208 of device 200 respectively.

FIGS. 9 and 9a show a cross-sectional view of soil conditioning device 100 in an expanded state and a retracted state respectively. Having soil conditioning tool 100 comprised of a flexible material such as a polymeric material and formed having a hollow center or cavity allows ridge member 104 to retract when device 100 encounters a radial force as is likely when device 100 encounters a rock or other hard material within the surface soil. The force required to retract ridge member 104 within device 100 may be adjusted by filling core 900 of device 100 with compressed air or other gases, liquids, gels, solids, or any combination thereof to obtain a desired hardness. This retractability of ridge member 104 provides that a substantially consistent horizontal force within the surface soil is provided, hence uniform consolidation is achieved. A retraction of l.sub.1 less l.sub.2is possible without substantially altering the configuration of ridge members 104.

The present invention is a soil conditioning device having a series of prow shaped peripheral ridge members optionally joined by sub-ridge members circumscribing a disc, wheel or drum and a method for creating a permeable soil surface. The prow shape peripheral ridge members consolidate the soil in varying degrees from the top of the impression to the bottom of the impression which increases water infiltration and reduces soil erosion. At the top of the impression the soil is at a greater risk of erosion by surface water run-off, therefore the soil is consolidated to a greater degree. At the bottom of the impression the risk of erosion is considerable reduced and as a maximum infiltration rate is required to absorb the accumulating water, the soil is consolidated to the minimum to enable the soil to stay in place, allowing maximum percolation of the accumulating water by interstitial flow. When the soil conditioning device is moved on the land the prow shaped ridge member enters the soil sweeping the soil sideways so as to consolidate the soil laterally. This is in contrast to compacting the soil as is the case in more traditional devices. Furthermore, as the device leaves the soil, this sideways sweeping action consolidates the soil laterally at the front of the impression leaving the impression in a stable condition structurally and allowing for the maximum water infiltration and percolation. This is in contrast with the more traditional systems where the soil is left loose and highly erodeable as the devices exit the soil.
