Mother [Nature] knows best

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The future of agriculture depends on farmers working with natural ecosystems, according US researcher Dr Dwayne Beck, who shares his model for creating profitable and sustainable cropping systems that rebuild the soil and ensure a sustainable supply of food for generations to come.

Growers meeting US no-till advocate and researcher Dwayne Beck for the first time can be a little surprised by his initial request.

"I always ask to look at the native vegetation," said Professor Beck, research manager at Dakota Lakes Research Farm and keynote speaker at SANTFA's 2019 conference. "I want to see what Mother Nature is doing with your ecosystem. Then I can compare that to what you're doing with the ecosystem."

Dwayne, who has more than 35 years' experience in his field and is recognised globally as an advocate for diverse no-till cropping systems, believes farmers can ensure a profitable and sustainable future in agriculture by replicating Mother Nature's model for local natural ecosystems. Consequently, it is critical for him to understand how native vegetation exists in harmony with the region's climate and geographic conditions, he said.

In many places including Dwayne's home State of South Dakota, where he has seen first-hand the impact of European colonisation, establishing a farming system that replicates a region's original ecosystem means reversing decades of damage and soil degradation caused by deforestation and tillage.

DWAYNE BECK HAS MANAGED RESEARCH PROGRAM FOR ALMOST 30 YEARS.

FARMING SYSTEMS ON DAKOTA LAKES RESEARCH FARM AT LEAST PARTLY MIMIC THE LOCAL ECOSYSTEM; A KEY REASON IT CONTINUES TO BE FINANCIALLY VIABLE WHILE HOSTING INNOVATIVE NO-TILL AND BIOLOGICAL RESEARCH.

South Dakota was settled in 1743 by French fur traders, who claimed the area for France and set about harvesting the native beaver population to make fur hats for export to Europe. Removing beavers from the environment was the start of a damaging sequence of events, Dwayne says.

"Before the Europeans arrived the beaver dams were held water up in a network of drainage ways across the landscape.

"When my ancestors came in they killed all the beaver then brought in settlers who immediately started to plough and over-graze the prairie.

"When the beavers were killed the dams disappeared so when it rained or the snow melted the water drained out of the landscape straight into the Missouri River, causing erosion and a lot of big floods.

"This was going on from the 1860s until about the 1930s and all of a sudden we had massive flooding. The white man's response to that was not to put the beaver back, but to build large reservoirs in the river to hold the water.

"Once they had the reservoirs farmers started to irrigate and found they had to use high-pressure irrigation to spread the water out because it wouldn't go into the soils. They had to do tillage in order to grow good irrigated crops because they didn't have the infiltration rate needed to get the water into the soil, but even with tillage the water still ran off.

"Then there was the Arab oil embargo and the price of energy went up. The price of land went down and the growers were paying lots of interest on it. This is where we [Dakota Lakes Research Farm] entered the system. The farmers got together and said 'we need to do something different'."

The research farm, in Pierre, mid-way between Minneapolis and Denver, was established in 1990 by a group of farmers to research ways to create resilient and profitable farming systems that would rebuild and protect the landscape.

Today the research enterprise is run by

South Dakota State University (SDSU), with the production side of the business managed by a farmer-led corporation that owns the facilities, most of the equipment and the 324ha of land, about a third of which is irrigated.

Dwayne has been the research manager at Dakota Lakes Research Farm, which has a 'nothing but no-till' a mission statement, since its inception and has been instrumental in devising diverse no-till cropping systems that have been widely adopted across much of central South Dakota.

Crop production results calculated during almost three decades show the financial benefits of adopting these systems.

"In 1990 when we started the east was all spring wheat and barley, all continuous cereals with tillage. In the west it was tillage-based dryland spring and winter wheat with summer fallow and irrigated corn. You didn't grow corn unless you had irrigation and it was all with tillage," he said.

"Now there's dryland corn, soy beans and wheat in the east. Dryland spring wheat, winter wheat, oil seeds and pulse crops in the west are very diverse and there's no fallow or tillage. And irrigated acreage has predominantly gone away because the guys are producing up to 12t/ha of corn without irrigation."

Comparing corn, soya bean, spring wheat, winter wheat and sunflower production in the central, north central and south central districts of South Dakota showed an increase of $1.6billion in the annual value of crop production from 1986 to 2014, he said.

"It's huge. But we didn't achieve this because we set out to improve yields or look at what fungicide to use. We set out to better manage our ecosystem.

"How do we capture the water and the sunlight and turn it into products we can sell? We looked at the natural grassland ecosystem because that had to be our model.

"We call this transformational change or a holistic approach. The light bulb did not result from incrementally making candles better.

"Almost all agricultural research is incremental. We need incremental research to do a better job of understanding wheat but we also need to take a look at the big picture."

For Dwayne, the 'big picture' is about understanding the four key processes of the ecosystem: water cycle, energy flow, mineral cycle and community dynamics.

Water cycle

When it comes to the water cycle, Dwayne asks: "Does the rain feed plants and deep percolate to recharge groundwater or does it run off and cause erosion and water quality degradation?"

He believes no-till techniques are critical to improving water use efficiency. "Simply from being no-till we can now put on 50mm of water in nine minutes with no run-off. When people visit us we walk them behind the irrigator when we're putting on 50mm of water and they don't get muddy shoes because the water goes in the soil like it's supposed to."

Residue, or what Dwayne calls 'soil armour', together with 'macro pores' – large holes in the soil created by termites, earthworms and crop roots – increase water infiltration. "The water goes in the big holes and it gets away from the surface into the soil where it's not prone to evaporation. I leave a lot of pens in the field because I stick them in the macro pores to show people and then I get all excited and leave them in the field."

His motto for water cycling is: take the E out of ET (evapotranspiration), which is a combination of evaporation and transpiration. With evaporation, water moves from the land into the atmosphere. Transpiration is the process of water

DAKOTA LAKES RESEARCH FARM STILL HAS LAND UNDER IRRIGATION BUT MANY LONG-TERM NO-TILL SOUTH DAKOTA GROWERS HAVE MOVED AWAY BECAUSE THEIR IMPROVED RAINFALL INFILTRATION MEANS THEY NO LONGER NEEED TO IRRIGATE.

movement within a plant and eventually from the leaves as vapour.

"Water goes out of your soil either by transpiration or evaporation. You make no money if it evaporates.

"Taking the E out of ET should be your focus here in Australia where it's dry.

"Maximise water holding capacity. As you add organic matter you increase the water holding capacity of the soil and this is where you can use some cover crops at times.

"The most dramatic difference you'll see in time, if you do this right, is all of a sudden you'll hold way more water and if you're using the mycorrhizae, you can extract more water and produce crops where it wouldn't be possible with conventional techniques."

Energy flow

Dwayne's message on energy flow is to harness the power of the sun, once again replicating the natural ecosystem.

"Focus on being the best sunlight harvester; not the best wheat grower but the best sunlight harvester that you can be," he said. "Ecosystems harvest sunlight energy to drive all of their processes."

For Dwayne, sunlight meets the ley criteria for an effective energy source: it's constant, benign and internal.

"Sunlight is constant, the sun is going to come up tomorrow, whereas fossil energy is finite; we can't count on it always being there. Sunlight can be damaging from a cancer standpoint but other than that it's pretty benign, whereas fossil fuels are not so benign. Sunlight energy is internal – it's coming from biological processes driven by sunlight – rather than external where you have to purchase it."

He is also quick to point out that farmers need to maintain the soil's energy by ensuring the microorganisms living underground have the food they need to thrive. "When we take off grain plus straw or hay in the same season there's no energy out there for the microbes to eat. Everybody says, 'I want to increase my microbes.' Well you can't starve them, you have to feed them. It's like any other livestock you have."

Mineral cycle

Removing residue from a paddock also impacts the mineral cycle because it depletes the system of energy and nutrients.

COVER CROPPING A TOOL, NOT A FAD

Cover cropping might be considered the latest agricultural fad by some farmers, but US researcher Dr Dwayne Beck says covers are a tool he has used for the past 40 years.

"It seems like all of a sudden cover crops are the big thing everybody has to do now to be successful," said Dwayne, keynote speaker at SANTFA's 2019 conference and research manager at US-based Dakota Lakes Research Farm.

"Cover and forage crops are a way to improve rotational diversity and intensity while providing competition for weeds but they are a tool, not an end. You don't use them all the time. They should be used to fine-tune or tweak crop rotations.

"We seldom use cover crops in our dryland situation unless I'm planning to do something with forage, but if I have a wet harvest and my soil's nearly full of water it doesn't make any sense to let that go to waste."

Covers are also a way of building carbon in the soil, he said. "In sub-humid, semi-arid and arid environments, cover crops can be used to increase organic matter and biological activity."

Despite his long experience with cover crops in the US, Dwayne says getting them right is largely guesswork. "Managing cover crops is really more of an art. It's more guesswork and instinct than science at this point."

His 10 top tips for covers are:

1. Decide on your goal before trying to choose your cover crop or cover crop mixture.
2. Think of the cover crop as just another component of your crop rotation.
3. Use a mixture of species to meet several goals simultaneously. Mixed stands add more diversity, compete better with weeds and optimise nutrient cycling.
4. Create conditions beneficial to the next crop. This should be one of the primary goals of a cover crop. If you're not getting equal or better yields after the cover crop, you're doing something wrong.
5. Consider water and nutrient management. Water used by a cover crop between cash crops can be regained during the growing season because of better infiltration, reduced run-off and improved water relations, provided cover is maintained.
6. Understand local rainfall patterns and the water-holding characteristics of your soils to fully benefit from cover and forage crop programs.
7. Cover crop seed must be cheap in terms of cost/hectare. Small seeds mean less volume/hectare, which reduces the number of stops to refill the seed box.
8. Small seeds grow better on the surface than larger seeds while large seeds usually emerge better through a mat of residue.
9. Using harrows to improve germination of surface broadcast seed also improves the stand of weeds, but having weeds in a cover isn't necessarily a problem as long as they don't go to seed.
10. Think of soil organisms as tiny cows or sheep and use cover crops to balance their diet. In paddocks with high-carbon (low protein) residue like wheat and corn stubble, sow high-protein cover crops like peas. Where residue levels are low or it is high in protein (nitrogen), sow high-residue, high-carbon cover species to increase the level of cover and provide carbon for the soil microbes.

"Nutrients are lost by burning straw but cutting hay or straw takes everything off," he said. "With a 5t/ha hectare wheat crop, if you burn the straw you lose 82% of the nitrogen present, a bit of phosphorous, 40% of the potassium and 80% of the carbon. Everybody says, 'Burning is really bad, we don't do that any more', but if I take the stubble off and sell it as hay I don't lose percentages, I lose the whole thing; all the nutrients are gone."

Nutrients can also be lost through leaching or erosion, which is where cover crops come into consideration, he said. Cover crops can be used to catch nutrients and re-release them slowly into the system rather than having them leach into the sub-soil and seep out of the side of hills.

"Ecosystems that leak nutrients turn into deserts. When you come into a native system and start extracting the nutrients you waste the carbon, the organic matter goes down and that's the start of desertification."

Community dynamics

Dwayne sees weeds and diseases as efforts by the natural ecosystem to add more species to monocultures and single-species crops.

"How many species have a fairly stable population in your paddocks? Not very many, so Mother Nature tries to help you.

"Weeds and diseases are nature's way of adding diversity to your system. So when you start running into weed and disease or insect problems, don't go looking for something to kill them. First, look to understand that species.

"If you start putting chemicals on you're going to knock out beneficials and get resistance.

"If your consultant says 'let's go out and put a herbicide on your wheat and we'll throw a little insecticide or fungicide in at the same time because it's only a dollar', what have they just done? They've ensured there are no predators there."

Dakota Lakes Research Farm has not applied broad-scale insecticides for more than 16 years, instead ensuring there are good populations of predators like ladybird beetles and pirate bugs to keep pest populations low.

PEAK OIL? GROW YOUR OWN

"Never in the history of all of mankind have we knowingly faced the kind of issue we have now with climate change and population," Dakota Lakes Research Farm research manager Dr Dwayne Beck told the 2019 SANTFA conference.

"We're using oil that's getting more expensive to produce food that's getting less expensive and we're degrading the soils in the process. It makes no sense if you start looking long term."

In the past 100 years agriculture has become largely reliant on fossil fuels to power its operations, he said, with 80% of the total input costs in modern agriculture able to be traced directly to fossil fuels.

"Fossil fuel input in agriculture 120 years ago was zero and fossil fuel input in agriculture will have to be zero again in another 120 years."

Dakota Lakes Research Farm, which operates a cropping and livestock operation on 324ha, will be fossil fuel neutral by 2026. "We're going to produce as much oil as we use," said Dwayne. "We press our own oil seeds and use that oil. We sometimes sell the oil, but the income offset the cost of oils we buy in.

"Doing the right thing environmentally is almost always the correct economic approach in the long run.

"We don't need to change our habits to save nature or the planet; nature and the planet will go on without us. We need to do these things so our descendants have a planet suited to them."

MIXED COVER CROPS FOR SUSTAINABLE FARMING

Australian Government | National Landcare Programme

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