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A REALITY CHECK ON RESEARCH IN AGRICULTURE

BY HOWARD G. BUFFETT

There is a serious disconnect between academic research in agriculture and the practical realities of farming that undermines how agricultural policy is developed. The consequences here in the U.S. are the threats of a highly regulated, less profitable and an environmentally unacceptable farming system; in the developing world, it keeps millions of smallholder farmers hungry. I was reminded of this by a recent academic article published in the science journal *Nature* that suggests that conservation agriculture practices, and particularly no-till, produces lower yields as compared to conventional farming. This conclusion is based on the authors' "global meta-analysis" of 610 studies across 48 crops (I did not know there were even 48 types of crops you could no-till) and 63 countries. The analysis incorporates no-till fields with no cover – that is like taking a shower without any water. It is time for a reality check from the field.

I have been farming in Nebraska, Illinois, Arizona, and South Africa for a number of years. Twenty-two years ago, I adopted conservation agriculture practices. Meanwhile, our foundation has funded a number of partners, including academics, to support research in agriculture for the past decade. Knowing both worlds, I can say with confidence that academics and farmers rarely speak the same language.

Yet academics have a megaphone when it comes to influencing decision-making around priorities for agricultural policy, particularly in the developing world. That outsized influence means recommendations may look good on paper but do not necessarily translate to progress on the farm. Let me illustrate my point using a personal example.

I recently had to have four kidney stones surgically removed. The most important thing I wanted to know was the doctor's surgical experience and success rate for kidney stone surgery. I didn't care about the doctor's test scores in medical school or how high he graduated in his class. Second, the proposed procedure mattered. One surgeon was suggesting a highly invasive procedure with risks for complications; the other recommended a much less invasive approach with high success rates. It shouldn't surprise you that I selected the surgeon with the best track record performing the least invasive approach. The surgery was a success.

Unfortunately, when it comes to big decisions that affect agriculture, policymakers seem to value academic pedigree more than farming experience. The result can be that development decisions are made in agriculture that make sense to other academics but do not necessarily work for farmers in the real world.

For example, I have made three visits to a well-established research station in Africa (not to be named so I can return). The maize yields at the research station exceeded six tons per hectare, but the average for the country's farmers remained below one ton per hectare. The researchers were thrilled with their progress but the farmers' families remained hungry. The highly controlled conditions of those maize research plots could not possibly be replicated by poor farmers.

On our own research farms in South Africa (9,200 acres), Illinois (4,400 acres), Arizona (1,500 acres), and Nebraska (1,000 acres) we divide our research into two types: standard plot-sized research run by our university partners that is designed to develop better plants and traits; and practically applied research conducted at farm-scale, which is our attempt to learn what works and what doesn't work in real-life farming. This is the antithesis of what our friends at the African research facility are doing and is counter to the desk peer review analyses performed by non-farmer academics for the benefit of other non-farmer academics.

The practical issues that farmers run into in the real world are important to understand. We regularly see conflicts between the academic research needs and the real-world decisions we must make on our farms, underscoring the gap between theory and reality. For example, we wanted to make a practical management change on a 320-acre field but found ourselves arguing with a master's student because it created problems for her thesis. Another time we found ourselves in disagreement with a professor because we needed to change the hybrid seeds we were planting, a "catastrophic" decision in his eyes. However, after four years that hybrid was no longer available, and there was better technology that farmers would choose to use in the real world. Another professor was upset with us because he wanted conditions to be "perfect."

He suggested that we use a software program that eliminates imperfections and averages the results. I wish Cargill or ADM would consider using this software when they buy my grain.

Real-world farming isn't perfect and conditions cannot be controlled. A 320-acre "plot" is big and has a range of variables that are unpredictable: it has wet spots, varying soil types, areas with compaction, different weed pressure, different varieties of bugs, etc. You cannot make 320 acres perfect, which is why most research takes place on small test plots or in greenhouses, just as it is why champion growers reach peak yields on 30 acres, not 300.

Let me give you an example from this past farming year in Nebraska. We planted our corn on a date well within the University-recommended guidance and typical for our area. We then got a late frost, which transformed our green rows of corn into limp brown plants. Then we discovered that our anhydrous applicator had not been registering properly on our monitor, meaning we put on 106 pounds of nitrogen, instead of the targeted 165 pounds. We planned on making up for it by applying additional nitrogen through the pivots and by side dressing the corners, however, continuous rain made side dressing impossible. Then one of our pivots on our corn acres got blown over so we couldn't fertilize through the pivot (we also lost several grain bins). Then a neighbor mentioned the possibility of flying on nitrogen, which I didn't even know you could do, but we were quick to call the pilot.

In between, we had hail and flooding. I estimate we lost 15 acres to ponding, and more like 30 acres if you count reduced yields from standing water in addition to reduced yields overall because of the difficulty of the nitrogen applications. So in this single farming year, on one 400-acre farm, we were faced with a reduced crop and significantly increased expenses from both human error and Mother Nature.

Not one issue influencing our yields had anything to do with our no-till process. But I guess a desk peer review analysis would have concluded, "No-till doesn't work."

That is our commercial farm in Nebraska, and I could go on and on with more examples from our other farms, but I think you get the point. There is, however, one other important factor we consider in our research. Our commercial-scale research, which is focused on conservation agriculture, has little value if a farmer who farms 2,000 or 5,000 acres thinks it has no applicability to his or her farm. For example, the equipment we needed for our research, a 60-foot roller crimper to match our 24-row planter, is not available for purchase, we needed to custom-build one. First we had to convince John Deere to do something that wasn't so easy: sell us a 1770NT tool bar with only a hydraulic package and electrical package. This took a number of calls and emails, and one of the last calls I had was with the President of John Deere Agriculture and four John Deere engineers. They were trying to figure out how to run the tool bar down the automated assembly line without adding the elements we didn't need on the planter, such as the planter units, the openers, the vacuum system, the CCS tanks, etc.

John Deere, to its credit, figured out how to get us the basic frame we needed. We then hired an Amish farmer in Pennsylvania named Jake to take that frame and build what we think is the world's largest roller crimper. Jake is currently working on a 40-foot version to match our 16-row planter. The significance of these custom roller crimpers is we can demonstrate to commercial farmers how to incorporate cover crops into their farming systems using equipment that matches up with the planters they already own. Convincing equipment manufacturers there is a viable and growing market for these roller crimpers is a future step of course, but none of this research and analysis can be done at a desk or from a book, it needs to be demonstrated in the field.

This custom-built 60-foot roller crimper helps to manage cover crops on commercial scale research farms. We believe this is the largest roller crimper in the world, designed on a John Deere 1770 NT tool bar to match up with a 24-row 1770 NT planter and to fold to 12-feet wide for transportation.

The last two reality checks I want to make are about cost and yield. Table 1[1] (bottom left) illustrates a direct cost comparison of no-till and conventional farming. You can see that it means fewer dollars out of your pocket in every category. Defining the advantages of no-till to soil health is more difficult but also more important in terms of long-term value. Then there are the benefits from soil erosion control, water quality, more efficient irrigation (Table 2[2], right), and better yields in dry years. On paper, no-till's benefits appear obvious, but in reality, it's more like always eating a nutritious and balanced diet: you know you should do it, but it can be pretty inconvenient!

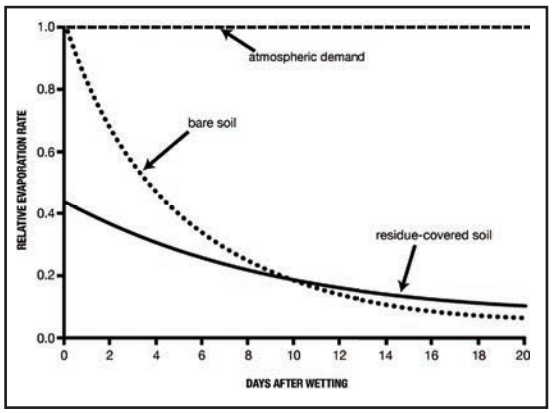
TABLE 1: COMPARING NO-TILL, STRIP-TILL, AND CONVENTIONAL FARMING

COMPARISON PER ACRE			
DESCRIPTION	**RIP**	**STRIP**	**NO-TILL**
Total cost per acre	$156.48	$129.63	$119.48
Difference from no-till	$37.00	$10.15	$0.00
Crop protection products savings	($2.66)	$0.00	$0.00
Net difference	$34.34	$10.15	$0.00
Corn yield to cover entire cost at $3.50/bu	9.8 bpa	2.9 bpa	0 bpa
Soy yield to cover entire cost at $10/bu	3.4 bpa	1.0 bpa	0 bpa
COSTS PER ACRE			
DESCRIPTION	**RIP**	**STRIP**	**NO-TILL**
Fuel	$16.97	$11.94	$10.69
Labor	$21.21	$17.57	$16.71
Repairs and maintenance	$14.48	$12.75	$12.52
Capital	$40.59	$36.06	$31.89
Depreciation	$58.23	$48.81	$42.67
Custom Hire	$5.00	$2.50	$5.00
Total	$156.48	$129.63	$119.48
LABOR AND FUEL			
DESCRIPTION	**RIP**	**STRIP**	**NO-TILL**
Tractor hours	1,642	900	797
Labor hours (in season)	4,133	3,397	3,231
Peak labor hours/day (Spring)	92	71	55
Fuel (gallons)	39,586	27,850	24,937

[1] Corn and Soybean Digest
[2] Nebraska Water Research

As a farmer who has been practicing conservation agriculture for over 20 years, I can say that doing it and doing it well can require more management and commitment to realize the clear long-term benefits over conventional practices. However, it pays off in many ways.

TABLE 2: IRRIGATED MOISTURE RETENTION FOR BARE VS. COVERED SOIL



Finally, let me address the assertion that conservation agriculture reduces yields. Using the past three years of winning corn yields in the U.S. as certified by the National Corn Growers Association, in all three years, the top no-till/strip-till irrigated winner out-yielded the conventional irrigated winner (Table 3, below). I know this might not pass the peer review test that the academic world requires, but it is consistent with my last 20 years' of experience farming in the real world.

TABLE 3: NCGA NATIONAL WINNERS: 2011-2013 CORN YIELD TEST

IRRIGATED CATEGORY (bushels per acre)	2011	2012	2013
TOP CONVENTIONAL	370.3836	372.3357	418.3376
TOP NO-TILL/STRIP-TILL	429.0216	384.3609	454.9837

Side dressing with a John Deere 2510H Nutrient Applicator toolbar allows for minimal soil disturbance in this no-till field. It also splits nutrient applications to reduce leaching and improve nitrogen use by corn plants.

Water savings, higher yields, environmental benefits, and reduced costs are real world facts when it comes to no-till. It doesn't mean everyone gets the same results and it doesn't mean everyone manages no-till well enough to achieve all of the benefits. It does, however, mean that no-till is an important solution to soil health, resource management and some of the other challenges farmers face, particularly in the developing world where alternatives are limited. To say otherwise undermines an important solution to improving production and food security for farmers.

There is no silver bullet just as there is no one size fits all for farmers. Farming is difficult, unpredictable, and sometimes frustrating. You only find solutions by trying them in the field. I cannot tell you how many times I have had a farmer say to me, "I tried no-till for one year and it didn't work." There is no control in real world farming. There is no new practice of significance that can be tested in a single farming year because there is no such thing as a typical farming year.

I understand the barriers that farmers face when it comes to implementing new management practices on the farm. Whether it is equipment, a lack of information and training, a need for better support, or a concern about the risk of a big change, there are very real reasons farmers do not make the change to no-till. But when no-till is done well, it improves everything we care about as farmers, conservationists and consumers.

After no-tilling thousands of acres for over 20 years, operating no-till farms on two continents, visiting hundreds of no-till and minimum-till projects in dozens of countries in Latin America and Africa, I know the facts in the field. I cannot compete with a desk review researcher who knows how to use a computer and run a regression analysis, but who has never set up a planter or unslugged a combine; or a farmer who wants to turn a field black because his family has always farmed this way, or because he can, or because he simply likes to "recreational till." I appreciate how difficult it is to change behavior.

Howard G. Buffett on his farm in Illinois. Buffett uses no-till coulters and trash cleaners on this planter to no-till corn into soybean stubble. Preliminary indications from Channel representatives show that for on-farm production in 2014, no-till soybeans on HGBF ground yielded the highest in the area.

A few years ago I had to work a field that had not been tilled for 18 years so I could replant corn. It happened because of a reduced stand of corn from frost and rootworms and I was concerned about controlling volunteer corn from too many years of using glyphosate back to back. My son and I drove by the field and the corn was up about six inches. Nice green rows against the dark Illinois earth. My son said to me, "Dad, it is good you started me on no-till, because this field looks really nice."

We must get beyond what looks nice. We must realize that trying anything new is difficult, but the results justify the effort. We should treat no-till more like our marriage: don't just do it for a year and give up but make a serious commitment to success. And we must listen to more farmers when talking about what works or doesn't work in the field. This is our approach with our *Harvesting the Potential* campaign. U.S. farmers will face increasing pressures from activists, regulators, consumers and companies to improve on our farming system.

Conservation agriculture is part of the answer to this challenge. Unfortunately, the disconnect between theory and reality has caused policy makers to treat conservation agriculture as an afterthought. In fact, no-till reduces soil erosion, maintains water quality, increases resiliency, sequesters carbon, enhances the diversity of our farming systems, and increases crop yields. Achieving these gains will depend on listening to farmers who understand real world farming and scientists who provide support that translates into workable and scalable applications in the field.

THE HOWARD G. BUFFETT FOUNDATION

Howard G. Buffett is a farmer and Chairman and CEO of the Howard G. Buffett Foundation. He has farmed for over thirty-five years and the foundation has invested over $100 million in research to improve agriculture and invested more than $250 million in agriculture-related programs. Visit www.HarvestingthePotential.org and www.BrownRevolution.org to learn more about the foundation's efforts to improve farming techniques in the United States and around the world.