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Brazil: What Can Row Crop Farmers Do To Contribute To Cleaner Water

Everyday on Earth roughly 385,000 babies are born(How Many Babies Are Born Each Day?). Our planet needs reliable agricultural systems to feed our growing population. Brazil is the world's number one producer of food and they grow of a variety of different crops consisting of mainly soybeans, corn, bananas, rice and sugarcane (Britannica). Soybeans make up 50% of farmed ground in this South American country, and farmland occupies nearly one third of it's territory (Britannica). Around 50% of farmland is under a no-till practice to help with problems like erosion, nitrogen loss, and in some cases it can improve yields(Roesler and Agri-Media). The people of Brazil rely heavily on crops that they grow to feed themselves, as well as exporting their goods to other countries for profit(Britannica). There are around 4.4 million family farms in Brazil, and the average Brazilian farmer works over 1000 acres(Gross). A paid tractor driver can make $0.70 an hour working for a farmer(Soucy). This is a low wage compared to the average citizen of Brazil that makes a little under 20,000 USD a year(Soucy). Agricultural labor may not pay very well, but some can not afford to turn down the food they get to feed their families(Soucy). Brazil has a growing population of 214,000,000 people, therefore, it needs agriculture to support its citizens and economy.

Brazil's agricultural industry is great for its people and economy, but it is starting to make a negative impact on its environment and specifically its own water quality(Portal et al.). "Currently there are more than 1.2 million people without access to safe water and 20 million without access to improved sanitation"(Water.org). Many Brazilians do not have easy access to running water that is sanitary(Water.org). The combination of Brazil's agriculture based economy that relies on chemicals to grow their crops, and the lack of clean filtered drinking water results in a hazardous risk in consuming water from natural sources close to agricultural operations. Chemicals that farmers apply to maximize crop production can often run off into water sources contaminating them. These chemicals can get into rivers, lakes, wells for drinking water, and even make their way into the ocean causing problems thousands of miles away(Portal et al.). Mexico is feeling the impacts of Brazil's nitrogen and phosphorus run off coming from Brazilian farms. Mass amounts of sea grass are washing up on Caribbean beaches. The nitrogen and fertilizers cause a skyrocket in Sargassum (sea grass) growth because they over supply the nutrients the plant needs to thrive. This grass may not sound like much, but it is really impacting the tourism industry for Mexico and buisnesses that rely on the beaches for their success. Buisnesses like hotels, and restaurants are struggling in these areas because tourists want a clean beach to vacation at and enjoy. This grass problem is not the only result of agricultural chemicals contaminating the water. This is seen in the U.S. in places like the Chesapeake Bay and the Gulf Dead Zone. The chemicals from farms are washed into rivers and eventually make their way to these oceanic dead zones where nitrogen stimulated algae blooms majorly threatening sea life. Farmers that are non-organic use herbicides, pesticides and nitrogen to meet the needs and manage their crops in hopes of a successful yield. Nitrogen is a must for crops like corn or maize as it is referred to in Brazil. Without Nitrogen, the corn will turn yellow in color and its production will be significantly due to lack of optimal nutrients. Farmers also typically apply pesticides and herbicides to control insects and weeds. Without the defense of pesticides, farmers could see up to an 80% loss in production resulting in a major production loss for the farmer(Portal et al.).

There was a study released in 2020 by a team of scientists and researchers who surveyed Brazil's water quality(Portal et al.). The researchers tested multiple categories and variables in the water, but they were mainly looking for the impact that agricultural practices had on their water quality(Portal et al.). The

researchers found that the “results from our analysis of shallow wells at the Zumbi Dos Palmares settlement showed that several samples had values beyond the limits stipulated by the Brazilian legislation regulating the quality of water used for drinking water”(Portal et al.). This is a huge problem because “high concentration of nitrogen in drinking water can cause damage to human health.”(Portal et al.). Agricultural inputs like nitrogen products and herbicides are in most cases the main contaminant within the samples(Portal et al.). Today 58% of the Brazilian chemical market is made up of herbicides(Cruz et al.). Chemicals found within these samples consisted of products like ametrine, atrazine, and hexazinone(Portal et al.). Chemicals like atrizine are used by farmers to control weed pressure to ensure that their crops can get the most nutrients possible. But how do these chemicals go from the farmers field into these rivers?

The main reason for water contamination is runoff caused by rain(Portal et al.). A farmer goes out to do his field work applying chemicals like a herbicide such as atrizine. That night a big storm comes through and new newly treated farm receives a many inches of rainfall. As the rain travels on the ground into low areas like rivers it washes out the fertilizers and herbicides taking it with to the water sources. The recently applied herbicides run off into the nearby river, therefore contaminating the water and hurting the water quality. If farmers need to apply things like fertilizers, pesticides, and herbicides in order to be successful then how can we reduce the amount of product that is applied to the fields, therefore reducing the amount of runoff into lakes rivers and streams that are used for drinking water?

My family has recently been exploring more environmentally friendly farming practices. We’ve been trying to find ways to apply less chemical and fertilizer to save money and keep our local waters cleaner. By applying lower rates we believe that we can contribute to better water quality in the Ames area. Our farm has been working with Iowa State’s weed science research team the past couple years and we have looked into ways to allow our farm to apply less herbicide. Weed resistance has started to become a problem not only in the U.S. but in places like Brazil as well. “Today, there are 51 weed species reported as being resistant to herbicides in Brazil”(Cruz et al.). We are starting to notice this problem on our farm and one way that we have started to combat the weed resistance is with a special machine called a seed destroyer. The ISU research team reached out to our farm wondering if we would partner with them to run a study on this new technology. A combine separates materials of different sizes. It’s primary responsibility is to separate the grain from the plant. A seed destroyer is an attachment added to the back of a combine that mills up the unwanted plant remains along with the seeds of unwanted weeds. Normally farmers use a form of herbicide or cultivation to control weeds, but in this case they can use a more environmentally friendly practice that does not require the use of herbicide. The combine harvests its targeted crop such as corn or soybeans and during the process it mechanically distributes weed seeds back into the feild. The combine separates the desired crop from the other material and chaff, sending it out the back. Right before the excess material is ejected from the combine it runs through the Redikop seed destroyer. This machine acts as a mill and grinds all unwanted leftovers into a flour like particle size. As this process takes place the seeds on from the weeds run through the combine are also chopped up and milled so they can no longer germinate next spring. This is an efficient machine because it doesn’t require it’s own pass through the field like a sprayer or cultivator, because of it’s connection to the combine. The seed destroyer can be turned off and on and electrically controlled for convenience. The idea of this machine is that the farmer can significantly reduce the chances of volunteer weeds that come from seeds the year before and maybe even reduce the amount of herbicides they have to apply. Professor Jha, who has worked with our farm and conducted many tests with us, reports that he saw over 90% of seeds fully terminated due to the destroyer(Rowsey). He says, “I was very pleased with the ability of that seed mill to run in soybean that was heavily infested in green pigweed”(Rowsey). The hope with this machine is that the less weed pressure a farmer has in his field, the less chemical he has to apply that runs risks of contaminating water.

Another system that Iowa State's weed science team has studied is a new practice called narrow-windrow burning(Rowsey). In this process there is an attachment to the back of a combine that funnels all excess material into a dense row behind the combine instead of spreading it vastly throughout the field(Rowsey). After the combine is done working the field, farmers go back out and burn off the remaining bean stubble and stems along with weeds the combine may have chopped up and spit out the back(Rowsey). These weeds carry millions of tiny seeds that are then burnt up and killed so they can no longer germinate and grow back next year(Rowsey). Professor Norsworthy says "We had 100% kill of palmer amaranth and 100% of barnyardgrass"(Rowsey). This practice does show to be effective in eliminating this year's weeds so they can't return next year, but there are a few flaws with the system(Rowsey). One of the main dependencies of this practice is the burning step. Burning of the stubble and stems is not great for the environment and it can also be a hassle for farmers with big fields and long rows. This burning technique would probably only be worth the time spent and supervision if it was on a smaller field like a plot. Anything over a certain acre count would simply be too much to handle and burn off.

There is another version of this practice called chaff lining(Rowsey). Most of these processes are similar but instead of burning the windrows, the farmer lets the rows of chaff rot(Rowsey). The mulch effect is counted on to keep the weed seed germination levels down and unable to grow because of all the remaining bio material in the same windrowed pile(Rowsey). "We saw a lot of water hemp emerging along those lines. However, at the time of post-application in corn and soybean, the concentration of the chaff material worked for us"(Rowsey). The growing environment within and along the chaff lines was not as reliable as the main field(Rowsey). The weeds in the chaff line were 2-3 inches tall compared to weeds outside the chaff line that were 6-8 inches tall(Rowsey). "This allowed our post emerge applications to be more effective" Jha states. The windrow effect keeps the weed seeds in more of a controlled row that makes up about 5% of the field instead of spreading out all stubble and seeds(Rowsey).

A few more solutions I have researched involve split application of fertilizer, cover crops, and field buffers. Field buffers can be a great way to slow down the travel of nitrates that would have potentially entered a river, but were absorbed by grasses, and trees on the way(EPA). This buffer provides protection for the river or water source that the fertilizer could contaminate(EPA). Farmers could make a small effort to grow small trees or grass along the low sides of their fields where the water naturally flows(EPA). Cover crops are also another great way to absorb the nitrogen before it enters the rivers(EPA). They can even lead to better production for the farmer because they hold in the nutrients that their crops need like phosphorus, potassium, and nitrogen(EPA). When a field is bare without any crops it is more likely to be eroded and water ways will cave in(EPA). The root systems of the cover crops along with other grass buffers planted help to keep the soil together and maintain its nutrient levels.(EPA)

Split application is a way of putting down nutrients like nitrogen for corn at 2 seperate times in the growing season. Some farmers only make one round and put all of their eggs in one basket with the application of nitrogen towards the beginning of the growing season. This leaves room for washouts that contribute to runoff. Running a split application operation helps to preserve the fertilizer you put down so the crop can use it at the beginning of the season and later when the corn is more developed the farmer can apply more fertilizer as needed. Split application may even save farmers money in cases where there are droughts and the crop is not healthy enough to benefit from the additional input. On subsequent application passes the farmer can choose not to apply on wet areas that wouldn't yield due to overly wet conditions. Farmers can even choose later in the season how much they want to change their rates based off the year they are having. For instance, if there is a very dry year where the crops are not doing as well the farmer can dial down the rates because he knows he will not get as much yield out of the crop. On the other hand if the crops are looking great, then the farmer can decide to turn up the rates allowing for more growth and potentially more yield. This control can save the farmer money on a bad year and also make them money on a good year when they can take advantage of the promising crop. These practices can be

quite beneficial to the farmer and at times end up saving them money, but it may take some time before they see the differences and changes.

Personally, my favorite solution out of these few is the Redikop seed destroyer. I think that it is an impressive machine with proven results. What I really like about this solution is that it is added onto an existing and necessary process. Every soybean farmer needs a combine to harvest their crop. By adding this device it can render the weed seeds unable to germinate instead of distributing them into the field. The main aspect of this machine is that allows it to be so successful is how it kills of the weeds and seeds on its own not requiring a herbicide or cultivation practice. For countries like Brazil, lakes, rivers, streams and especially natural wells need to be sanitary enough for drinking. With 80% of Brazils population living in a rural area it is important that their natural water sources are not contaminated by agricultural chemicals. Many Brazilian citizens depend on natural flowing water in their area for drinking and sanitary purposes. This means that any local use of chemicals runs the risk of contaminating a person's local drinking water. The seed destroyer does not completely rule out the need for herbicides, but in most cases it can reduce the amount of herbicide that needs to be applied for a farmer to maintain his fields. A farming practice like this can benefit the people of Brazil and the water they drink because of the reduced amount herbicides used. I see this practice turning into a more common use by farmers to not only reduce weed pressure, but help keep their local water cleaner. If this machine were to go to Brazil it would definitely be a challenge to incorporate into Brazil's practices. When our farm started this practice a couple years ago, there were only 3 of these machines in the U.S. Farmers will have to have a big enough combine to run the seed terminator, but most farmers that are looking to run an attachment like this already have pretty big equipment. If this machine were to be mass produced and then exported to Brazil, I think the people of Brazil, would benefit greatly from it. Reducing the amount of herbicides needed to maintain a field will help keep our water cleaner and less contaminated. We have seen some weed improvements with the use of this machine on our farm and I think it would do just as well in South America.

The implementation of a seed destroyer in Brazil would open many doors for farmers, especially those who grow organic soybeans. Organic soybeans are graded into two groups that both have significantly higher prices simply because of demand(Martens). One class of soybeans goes to animal feed for what some consumers may consider a more premium style of meat and the other portion goes into a speacalized food category(USDA). Brazil is expecting to see a growth in the amount of non GMO soybeans grown in the 2022-2023 season(ProTerra). Growing organic is not easy and it can be quite hard to manage pests, diseases and weeds(USDA). When I asked Bobby Martens, a proffesor at Iowa State University and small organic farmer, "What is the biggest impact on your yields?" He quickly answered "weed pressure"(Martens). Proffesor Martens later mentioned that many organic farmers who have large enough operations are able to grow a soybean crop with up to 75% of the yield of a conventional farmer if the conditions are fit(Martens). He also mentioned that organic soybeans sell for around 2.5x more than conventional soybeans(Martens). This means that there is money to be made for those who are willing to micro manage their organic crop. This is where the seed destroyer comes in to play for organic farmers that need newer technology to help manage weeds. Instead of needing a fundraising organization or a government institution to help start up the implementation of the seed destroyer in South America, farmers could purchase these machines independently for the use of their farm. An organic farmer is always looking for ways to keep control of their weed pressure and the seed terminator is a great way to help minimize next years weed presssure. If a farmer makes a purchase on an $80,000 seed terminator they will be able to pay it off over time because as the amount of weed pressure lowers, theoretically the yeilds will increase becasue the given crop will be able to take in more nutrients. If farmers are able to increase their yields by limiting the weed pressure then they will eventually be able to pay off the machine and start to make more money from crops with higher potential.

A big question for this interesting solution is how will we educate the organic Brazilian farmers that there is money in organic farming and that there are great solutions and technologies such as a Redikop seed destroyer to help them be profitable while contributing to cleaner water. A simple starting point would be to educate the Brazilan farmers on these opportunities and promote organic practices. First off I would like to start educating farmers on organic practices. Iowa State Extensions offers loads of information free to everyone that is easy to access and can be quite helpful for those who want to better understand how organic soybean farming and how it works. I would find a way to publish an article or advertisement teaching farmers how organic farming works and also how it is easy to get into that would be similar to a research document made by I.SU. The article would offer information about what organic soybeans are used for, the best practices, techniques, where and how to sell organic soybeans and solutions to common problems such as weed pressure. I would also make sure to include that there is lots of value in organic farming. Organic soybeans are worth 2.5x more than conventional and a good organic farmer can grow beans with 75% of the yield of conventionally grown soybeans. I would make sure that this resource has all a farmer needs to know about organic farming and what takes to be successful in the business, then I would look into having it published by multiple companies and organizations that have relations to Brazil's agricultural industry. One website I would like to have this article published on is "Brazil's Ministry of Agriculture" which is similar to America's "USDA" Further research is required to identify other networks to connect with Brazilian farmers. I would make sure that the article is published in Portuguese so Brazilians can understand the information given. Another outlet for this information would be through companies whose target markets are organic farms. If Brazilian farmers understood the value and the process of growing organic I believe that more farmers would consider adopting this practice and making better choices for clean water and the planet.

Between the world's growing population and its need for water quality I feel like the seed destroyer, as well as the list of agricultural practices I listed above would be very beneficial to not only farmers but the lakes, rivers and streams next to their fields. These solutions are not perfect, but they do reduce the amount of herbicides, fertilizers, and nitrogen that have chances of running off and contaminating drinking water. I feel like we are taking steps in the right direction toward better water quality as well as global conservation in general. These practices are only the begginning of what is to come for conservation and what products and solutions will be released in the future. If farmers put in the effort to make a difference we will see much higher water quality, with lower nitrate and herbicide levels resulting in cleaner drinking water. Farmers and researchers are always looking for the next step to a cleaner, healthier and more sanitary environment for the world we live in now and the generations to come.

Works Cited

"Agriculture of Brazil." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., https://www.britannica.com/place/Brazil/Agriculture.

"Brazil's Water Crisis - Water in Brazil 2021." *Water.org*, https://water.org/our-impact/where-we-work/brazil/.

Clark, Andy. "Cover Crops Improve Soil Conditions And Prevent Pollution." *SARE*, 30 Sept. 2021, https://www.sare.org/publications/cover-crops/ecosystem-services/cover-crops-improve-soil-conditions-and-prevent-pollution/.

Cruz, Ricardo Alcántara-de la, et al. "Chapter: Herbicide Resistance in Brazil: Status, Impacts, and Future Challenges." *IntechOpen*, IntechOpen, 19 Feb. 2020, https://www.intechopen.com/chapters/71135.

EPA. "The Sources and Solutions: Agriculture." *EPA*, Environmental Protection Agency, 4 Nov. 2021, https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture.

Gross, Anna. "As Brazilian Agribusiness Booms, Family Farms Feed the Nation." *Mongabay Environmental News*, 17 Jan. 2019, https://news.mongabay.com/2019/01/as-brazilian-agribusiness-booms-family-farms-feed-the-nation/.

"Growth in the Brazilian Non-GMO Soybean Production." *ProTerra Foundation*, 30 June 2022, https://www.proterrafoundation.org/news/growth-in-the-brazilian-non-gmo-soybean-production-2/.

"How Many Babies Are Born Each Day?" *The World Counts*, https://www.theworldcounts.com/stories/how-many-babies-are-born-each-day.

Martens, Bobby. "Farming Organic Soybeans." 5 Sept. 2022.

"Nutrient Stuartship." *Nutrient Stewardship*, https://nutrientstewardship.org/implementation/split-fertilizer-application-helps-optimize-nutrient-management/.

Portal, Thayana Paranhos, et al. "An Integrated Assessment of Water Quality in a Land Reform Settlement in Northern Rio De Janeiro State, Brazil." *Science Direct*, Elsevier, 7 Mar. 2019, https://www.sciencedirect.com/science/article/pii/S2405844018355609.

Roesler, Sue, and Lee Agri-Media. "Till and Cover Crops Thrive in Brazil." *No-Till and Cover Crops Thrive in Brazil*, No-Till Farmer, 26 Aug. 2019, https://www.no-tillfarmer.com/articles/1126-no-till-and-cover-crops-thrive-in-brazil.

Rowsey, Ginger T. "Novel Approaches to Managing Weed Seeds in Crops." *Farm Progress*, 5 Oct. 2021, https://www.farmprogress.com/weeds/novel-approaches-managing-weed-seeds-crops.

Soucy, Lauren. "The Average Salary in Brazil (2022)." *The Average Salary in Brazil*, 10 Jan. 2022, https://biz30.timedoctor.com/average-salary-in-brazil/.

Statista Research Department. “Topic: Agriculture in Brazil.” *Statista*, 14 Jan. 2022, https://www.statista.com/topics/5838/agriculture-in-brazil/.

University of Minnsota. *Timing Matters: How to Limit Spring Nitrogen Loss for Corn*, 5 Apr. 2021, https://blog-crop-news.extension.umn.edu/2021/04/timing-matters-how-to-limit-spring.html.

USDA. *USDA Coexistence Factsheets - Soybeans*. Feb. 2015, https://www.usda.gov/sites/default/files/documents/coexistence-soybeans-factsheet.pdf.