

Crucial FEWSION Episode 6 – Understanding U.S. Food Supply Chains

Narrator: How much do you know about the supply chains that bring you your food? Do you know how far your food travels to reach you? And how resilient the food supply chains across the United States are in the face of the current global pandemic ... and to the longer-term issue of climate change?

Most of us think that sourcing our food locally is good – but to what extent is that true? We'll learn all the latest key findings on all those issues in this episode of *Crucial FEWSION*.

Ben Ruddell: FEWSION is a team science project, led by Northern Arizona University. I'm Ben Ruddell the principal investigator on the project. We're funded by the NSF's 'Innovations in Food Energy and Water Systems' program – to map and model supply chains across the country. For this episode we're recording outside and remotely for covid-19 safety reasons.

One of the FEWSION projects key aims is to map and visualize local food supply chains across the United States at the level of communities. Even if you live in a farm community in a warm part of the country – or where they do irrigated agriculture, most of your food is gonna come from somewhere else, and only a little bit will be sourced locally. We've been able to map and analyse food supply chains in a comprehensive way. We look at every kind of food and we look at every community in the country. So that lets us get both the big picture and the details for every food supply chain and every community.

N: In previous episodes of this podcast we've questioned how local is the food supply to a few individual communities. Since then, Northern Arizona University grad student and FEWSION project team member Darren Bingham, has completed a new detailed study. His goal was to examine what's commonly thought of as local food – and then look at what *actually is* local in terms of USDA food commodity data. With the help of FEWSION team members, he's put together accurate statistics on the states – and counties – with the most and the least local food supply chains.

But to do that, Darren and the team *first* had to decide what is 'local'.

Darren Bingham: Yeah so, we had to define what we were gonna define as local – there are so many working definitions. And so we did some reviews. I essentially found these three domains of proximity that was first researched by Stephania Erickson, geographic boundaries – political, ecological and distance boundaries. Then there was relational – which was essentially your connection with your farmer. And then 'values' – was the food organic, was it fresh, was it resilient. So, there's these three broad categories that local food is associated with. For the purpose of this paper, we really stuck with the geographic domain of physical distance and political boundaries.

N: Distance is easy and well-defined way to measure local-ness. And political boundaries – like counties and states – have data on food available at a fine spatial scale. As well as counties and states ... another politically-defined way of measuring the local-ness of food supplies are something called FAZ zones, which is how the federal government categorizes the U.S. says Darren Bingham.

DB: There's about a hundred and some FAZ in the country. it's a freight analysis shorthand essentially so the US government provided this Freight Analysis Framework so FAF. The analysis that they chose to be for cities was FAZ.

N: In the case of big agricultural regions – an entire state can be a FAZ – like Iowa. Another important thing that FEWSION researchers had to define for their study of food supply chains was ... WHAT is FOOD?!! If you think about it, the word 'food' means a lot of different things. It just doesn't

make any sense to lump it all together as if it's all the same. In this study, the researchers looked at three broad functional categories of food. The first food group was table crops, says Darren Bingham.

DB: Table crops, things that eat, that we directly eat that is not processed – so that's like your fruits and vegetables which after washing you can put straight into your mouth. So that's you know our first broad category of food in our United States supply chain. Our second grouping of food was commodity crops – so basically these go to feeding cars and animals –when I say 'cars' I mean industrial processes, biodiesel, soybean oil - those big bulk commodity crops items that you see all of Iowa's growing - all the Midwest, those big bulk commodity crops that all of Iowa growing that we eat in very small amounts. And then third we have manufactured food, broadly speaking and that's your bread, tortillas, your pre-cooked meals and frozen stuff. This kind of food has been made in factories and then distributed – these distribution points, these factories, are really important in our findings and you'll hear about it later.

N: How far *does* our food travel on average in the U.S. from the point of production to our table?

DB: 90% of all food we studied travelled less than 500 miles. Table crops travel on average 207 miles and commodity crops travelled the least at 158 miles. This is a national average – so, when you look at manufactured food it travels a bit further - 312 miles, from factory to point of consumption. Only a small amount of food – less than 10% - travels less than 10 miles. The food that's most local is the cheapest stuff, because it doesn't have the price elasticity to travel long distances – whereas manufactured food and table crops, they have a higher price and so they can actually travel those further distances.

N: Bulk food costs increase most with distance travelled... because that kind of food has the least added value and it's heavy and ... well, bulky ... it costs a lot to move – so it doesn't usually travel too far. Remember that the U.S. is a BIG country – so 200 miles might not sound local in a European country like the UK ... but the western U.S. 200 miles might actually be *pretty* local.

DB: At a county level food flows are the least local. Very few counties can supply a high proportion of their food. And that's just because of the size of counties typically – they're not as big as states obviously, or these FAZ zones we've talked about. But for example – Maricopa County does best when looking at their manufactured food, because they source about 25% and that's the *most* in the state of Arizona. But they struggle in sourcing table crops and bulk commodity crops - they're sourcing less than 10% - and that makes sense because they're an urban community. However, Cochise County in Arizona which is a very rural place, does the best in the state for both table crops and bulk commodity crops. But they virtually have no (food) manufacturing – so that's just kind of an example here in Arizona – and that's very similar to how you see across the country.

At the city and state level, table and bulk commodity crops tend to be more local – and manufactured food actually seems to be less local. However, when you go to these larger scales of state and city – you often mask the details that we find at these smaller scales of analysis of county.

For example, Delaware as a state sources the least commodity crops. Delaware we know, is a very small state – but one of its counties, Kent county sources in the top five nationally for commodity crops.

N: In contrast, northern Arizona's Coconino County is one of the largest in the country. The semi-arid climate, with high desert, mountains and pine forests, mean that it's simply not feasible to grow a lot

of commodity crops or table crops locally. But cattle ranching is widespread. There are still several links in the food chain to get that locally ranched beef to the region's consumers though...

For example, the Diablo Trust – a partnership between two working ranches – the Flying M and the Bar T Bar. Collectively they span 426,000 acres of forests, ephemeral lakes, and expansive grasslands, east of Flagstaff, Arizona. The Trust has a focus on balancing cattle ranching with protecting sensitive habitats and managing the land for wildlife.

The Bar T Bar sells between 40 and 50% of the Diablo's total cattle sales – between 500 and 700 cows each year, as breeding cattle to ranches outside the region. The remaining 50 to 60% of cattle sold from the two ranches amounts to around 2 million lbs in live weight of cattle – which is about 733,000 lbs of bone-in meat a year. Around 20% of cows sold for beef are slaughtered in-state – at the nearest commercial slaughterhouse in Tucson. That meat is sold to local markets as pasture-raised 'Diablo Beef' – including to Flagstaff's Diablo Burger Restaurant, which prides itself on serving only locally-grown burgers. The other 80% of these cattle are transported to Colorado where they're finished in feedlots that provide access to pasture, along with many other requirements set by the Global Animal Partnership or GAP program. This GAP certified meat all goes to Whole Foods, which distributes that beef primarily in the states of Colorado, Arizona, as well as New Mexico, and Texas. So, animals originally raised in Arizona don't necessarily go back to there – their meat could find its way into a Whole Foods store in any of these four states.

This is just one example of the myriad complexities that the latest FEWSION food supply chain study has been investigating, says Ben Ruddell ...

BR: This study is important and ground breaking in a sense, because we wanted to document... for everybody - each community in the country - how far their food is coming from. And we wanted to study that trade-off between the sustainability and the resilience in your food supply chain.

Closer food is more locally self-sufficient, creates more local jobs, there's less greenhouse gas emissions involved in producing and transporting it. So, it's more sustainable for the environment and the economy, you might say. BUT food that's coming from further away is the key to the reliability and the resilience of the food supply chain. Because if something happens to a food business or there's drought (or something) in your own community – you want to have those adaptive options that come from bringing in food from all over the world.

N: To measure food supply diversity the FEWSION team borrowed a technique from classical ecological theory, often used to measure how diverse plant or animal species are in a defined area, says Ben Ruddell...

BR: We use what's known as the Shannon-Weaver Diversity Index for these calculations of resilience. A community that only eats food from its own backyard would have a 0% diversity – and a 0% resilience. 100% on the other hand, is a large diversity and that means that your food supply chain is spread all over the planet. If too much of your food is local, you lose your adaptive options – like your ability to respond to a local drought or a natural disaster – OR to respond to an economic disruption.

In a connected world ... of inter-connections in food energy and water systems – we want to optimize the food supply chain – we want an optimal balance between local self-sufficiency and diversity. We want sustainability and resilience – and we want that all at the lowest cost. Our food supply chains are constantly trying to balance these competing objectives.

N: Having got the methods to analyze the entire food supply data for the entire U.S. in place, the team crunched the numbers...

BR: So, what would you guess the resilience and diversity of your community's supply chain would be? Close to 0% - in the middle maybe – or approaching 100%?

What we found for US communities is that they mostly have a resilience and diversity in their food supply chain between 60% and 80% - in other words they're quite resilient. That resilience comes from a food supply chain that's spread out all over the region, all over the country and in some cases all over the world. BUT that diversity means that we don't have a lot of local food content on average, in our diets. That resilience comes at the cost of sustainability and local self-sufficiency. That food that comes from all over the world to the typical US community takes more greenhouses gases from more fuel and more trucks to get it here. And most of those dollars aren't going back into the local economy – so there is an economic cost as well. That far away food is more expensive and there's not as many local jobs and businesses supported.

N: What length of U.S. food supply chain does FEWSION data show is optimum to achieve a good resilient, diverse food supply?

DB: At what distance is resiliency the highest? It's highest over 200 miles but decreases drastically after 500 miles.

N: Which states are BEST ... and worst ... at producing and supplying local food. FEWSION project lead data scientist Richard Rushforth has that worked out. And some of his findings might surprise you ...

Richard Rushforth: So, in total 12 of the 50 states have the ability to provide a sufficient amount of food locally. And those states are Washington, Oregon, California, Arizona, Idaho, Wyoming, Florida, Michigan, New York, Alaska and Hawaii – with caveats for Alaska and Hawaii. These are table crops.

What's interesting about this finding – we have a small number of states that are able to provide locally these table crops – but if you think about the Mid-West and the Rocky Mountain states and Texas – these are big agricultural states ... but these are agricultural states that don't produce food that is directly for human consumption. They're producing soy beans, wheat, sorghum, corn for industrial purposes - such as inputs into livestock. They're producing any number of crops that we don't actually consume either directly or at all. So, the number of states that have a high locality – or a high self-sufficiency of bulk commodity crops – we expand the list of 12 that we already have to include 32 states that source over 80% of their bulk commodity crops.

What's notable about this is that the states that were left off this table crop food list, that are in this bulk commodity list, there are the states that we most readily associate with agriculture in the United States: Iowa, Nebraska, Kansas, Missouri, South Dakota, North Dakota, Minnesota, Wisconsin, Illinois. These are the states that - when we think about where is the bread basket of the United States – where are the fabled U.S. farmers. These states are where they're located but, paradoxically, these states are also food deserts. Because there are miles and miles and miles of crops in any direction from where you're located – these crops are either going directly into human consumption, they're either going into other food production supply chains – livestock production, pig production or poultry production – or being exported – or going into industrial chemical processes. So, there's this very interesting relationship where you could be in the middle of one of the largest agricultural producing states in the United States, and also be in the middle of a food desert. If a community or a county is more rural the more likely that that community or county is to

be growing bulk commodity crops like corn or wheat. Conversely – the more urban a county is or community is, the more likely that the type of food that that county specializes in - is in manufactured food or processed food. Big cities drive production *and* consumption of table crops and manufactured food, but don't often grow the food themselves.

N: So ... is there *anywhere* in the U. S. that produces *all* the food it needs? For manufactured food, there's only one candidate that comes close to *potential* self-sufficiency, says Richard Rushforth.

RR: ... and that's Hawaii. Hawaii has a large output of manufactured food, processed food – and that's interesting because it's very specialized into crops that we associate with the state – such as macadamia nuts, coffee, or pineapple.

N: On the mainland U.S., table crops – those foods you eat after just washing or minimal preparation – tend to come mostly from medium-sized counties...

RR: ... counties like Ada county, Idaho (where Boise is located) or Fresno county, California. These counties act like a bridge between urban and rural. They collect all of the agricultural counties and then distribute them to the urban **counties**.

N: The FEWSION team intentionally chose to do a deep dive on the domestic food chain. It is worth mentioning that there are very key choke points in that international food supply though...

RR: Santa Cruz counties where Nogales is located and Laredo, Texas are choke points for the import of table crops from Mexico. And there's a seasonality to these choke points – where Nogales is primarily responsible for the import of table crops in the winter and in the summer that shifts over to Texas.

N: Having disentangled the broad – and detailed - patterns in the major parts of the U.S. food supply chain – what can this knowledge help us with going forward? Well, in a world increasingly affected by climate change – the FEWSION team can predict the areas where, for example, table crop production will have to shift to in the coming decades.

RR: If we look out into the future and we know under scenarios of climate change that areas in the west like California, Arizona and potentially eastern Washington and eastern Oregon, these areas will get hotter and drier - and so we're going to have to look at shifting our table crop supply chains to areas that will also be suitable for agricultural production under climate changes scenarios. And these are the areas that don't currently produce a large amount of table crops. We're going to have to look at all this agricultural productive capacity in the upper Mid-West and industrial Mid-West that is not being used to its highest utilitarian purpose right now. And we need to look at how we can shift those supply chains there in the future.

One caveat I'd like to say about this data and the study is that we're analysing a past state of the U.S. food supply chain - in this case we're looking at the movement of food in 2012. The data sets that we utilize are published every 5 years so there's a big undertaking to survey food manufacturers and food distributors about where they're receiving food from and where they're shipping food to. The agricultural data we rely for this on is updated much more frequently – at the monthly, quarterly, annual time scale. But the understanding of the movement of these goods, those data sets are published for every 5-year period ending in '2' and '7'. And so, any disruptions to the production of those data sets has an impact on our ability to analyze new data sets. Things like government shut-downs push the publication of the data sets that we rely on out by months and years... so we're always going to be looking at the past, for that reason.

N: Even with these year-to-year variations, the overall pattern of food movement across the U.S. from farm to distribution center to retail outlet to table does show the same *general patterns* from year to year. One of the 'super powers' of FEWSION data analysis – is that it can identify these large-scale patterns – AND pinpoint weaknesses.

BR: Weak links in the system are ... in the fields, due drought or frost or something that could damage a whole region's crops or food production. We've known about that for a long time. That is getting worse with climate change. And a worry is that if you don't have a diverse enough agricultural supply chain that you might have climate disasters strike several parts of that system at once. Right now, we can compensate because we have a global market for agricultural products.

N: While the transportation and distribution network are strongly forged links in the U.S. food supply chain, produce picking along with food manufacturing *can* be weak links. Particularly when food processing is concentrated...

BR: ... in large food manufacturing plants where if there's only 3 or 4 or 5 food producers for that frozen lasagne, or for a pork product, or chicken, in many parts of the food supply chain you only have a few facilities that produce a product. And that is a concentration of capacity in the food manufacturing base. It's a concentration of risk and it's a lack of resilience, because you don't have many options.

What we saw this spring of 2020, during the early stages of the covid-19 epidemic, was that you had multiple food manufacturing facilities shut down simultaneously due to outbreaks. And that caused shortages of some types of meat products. This is a weakness and its due to a lack of diversity in the food manufacturing base. By contrast the global and regional diversity of the food supply chain creates a tremendous amount of resilience through its diversity. And when it comes to the distribution system for the food, what we see is a tremendous resilience in that system. There are many transporters and warehouseers. Many distributors and many retailers of food products, many, many thousands. And so, it's hard for a system that's that diverse, with that much adaptive capacity – to be disrupted.

N: We've mentioned some of the bottle necks for food supply coming INTO the U.S. from outside – but where are the choke points WITHIN the country?

BR: A lot of the more concentrated points in the food supply chain are in the western U.S. where you have a lot of people in just a few cities, and you have a lot of the agriculture and food production along the west coast and in California. Places like Maricopa county around Phoenix, Arizona, or southern California, Fresno, California, which is the center of the Central Valley of California where all that fresh food comes out of. Also - Boise, Idaho (that's Ada county Idaho) where Idaho's ag capacity is concentrated. In the eastern U.S. and there southern U.S. where most of the people are, and where a lot of the farming is, it's a much more diverse system. There's more food in that part of the country, but that capacity is spread out, so it's harder for any one disruption to take down the system.

A take away from this study is that the system we have in the United States has emerged in a way that creates a pretty good trade-off between the sustainability and the resilience of your food.

N: There's one last conclusion from this latest FEWSION study that Ben Ruddell says really provides some 'food for thought' for all of us. And that's our relationship with ... and our ideas about ... LOCAL food.

BR: People find the idea of local food compelling, right? It's this idea that has stuck with us in the media and in education for decades. I think it gets to this notion of knowing who grew your food, growing your own food, having sustainable food systems, having control over your food supply. Those are all really good things ... that is embedded in our public psyche in the United States. There's something about this social connectedness to the food. And by that standard our food in the United States is not local at all – really very little of it is.

There's reasons why we can't always have local food and why it wouldn't even be very good to have local food. We also really need a reliable, resilient, connected food supply. One that connects us to a variety of food suppliers around the world. That allows us to compensate for disasters and disruptions and food supply shocks. It also gives us access to a wider variety and quality of food than we would have otherwise. So, what we really want is a BALANCE between local and diverse global food supplies.

N: To find out more about the work being done by the FEWSION team visit <https://fewsion.us/>

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