Digital Tools for Small Farms

axilab **PURDUE** UNIVERSITY.

Agricultural and Biological Engineering

Ankita Raturi Tam Bureetes, Steven Doyle, Hannah Klein Agricultural Informatics Lab www.aginformaticslab.org <u>ankita@purdue.edu</u>





When you think of <u>resilient</u> <u>food systems &</u> <u>farms</u> What do you think of?



Agricultural Informatics Lab @ PURDUE www.aginformaticslab.org



Agricultural Knowledge Work

Using historical crop rotations to plan and schedule plantings. Taking soil samples to determine heavy metals contamination. Viewing wilderness cameras to monitor conservation zones. Tracking cattle movements to calculate grazing capacity. Using social media activity to estimate product popularity. Scanning traffic maps to determine efficient delivery routes. perkinsgoodearthfarm • 2d



 $\bigcirc \bigcirc \land \blacksquare$

Iked by nightfallfarm and 34 others

perkinsgoodearthfarm Sometimes I get so food-focused, I forget to share what's going on behind the scenes!

Cue photo of our annual organic inspection meeting.

To truly do the behind-the-scenes justice, I should really have photos of Dan managing soil quality, ordering seeds, documenting all the things, etc. I'll work on that for next time......

#certifiedorganic #organicveggies #organicfarming #soilhealth

Add a comment...

 \square





Humans using

data to

learn something,

solve a problem,









DATE	WF(AT?	PLATES	NOTES	
Oct. 13th	- Anna	-		
				- 1
				284
1	Iris			28.00
6	Iris			1 FLR
5	Iris			1 Port
7	Shasta Daisies		-	
08 Ici 8	TP FEVER FEW		13" sources been the a	~ 1 W
10170	TP Gur Ba		0	1- 50
Oct. 14th	Godetla 1		+27.	place-
1	Godetia	100		beds
2	Godetia	0.00		5 100
3	Godetia /			Gill
4	Godetia			Loca
5	Snapdragons			T
5	Snapdragons			WS.
7	Smandragons		and the second sec	105 02







Unpacking the Digital Divide

So many tools,

but...

do they support small(er) farms?

For more software landscape summaries, including this, see: https://betterfoodventures.com/landscap es-overview

FARMTECH LANDSCAPE 2020





What do farmers want?!

Smith Farms Indiana

... X

Customers often ask "what do you do all winter" This winter... I have been learning how to change over to our new software.

This...is the new organized ...me . Lets just say working outside in the fields comes much more easily to me.

Check out our new look and just a few classes already scheduled. Feel free to congratulate me 😂 😂 😂



APP.BARN2DOOR.COM

Strawberry Jam Class.... Let's Jam Strawberry Jam Canning Class... Let's spend a couple hours canning our delicious strawbe...

29	3 comments 1 share
ြို Like	分 Share

Les fermiers Bio



$\bigcirc \bigcirc \land \blacksquare$

Liked by officinawalden and 407 others

terrateck The Glider 200, little brother of the Glider 500, will meet all your needs on small surfaces and in greenhouses !

Designed along the same lines, the main differences with the Glider 500 are :

2 to 4h of autonomy (8 to 16h for the Glider 500)

Maximum speed of 9.4m/min (30m/min for the Glider 500)

No remote control except a start&stop wristband

Loading capacity : 50kg added to 2 people (100kg for the Glider 500)

Soon available on our website ! 🌐



youngfarmers 🧇 🔹 13h



 \square



$\bigcirc \bigcirc \land \blacksquare$

Eiked by nightfallfarm and 189 others

youngfarmers #Youngfarmers across the U.S. are dealing with the impacts of #climatechange every day, and many face barriers to adopting #conservation practices that can play a key role in building #climate resilience, such as cost, insecure #landaccess, and lack of technical assistance.

As a result, many farmers rely on each other for mentorship and support. The American Farmland Trust found that over 50% of farmers they surveyed in New England rely on each other for conservation education.

We need policy solutions that support the resources farmers already provide each other.

@youngfarmers and @americanfarmlandtrust are excited to partner with @senatorlujan and @senjerrymoran on the bipartisan Farmer to Farmer Education Act, which would build support for farmer-led conservation education in the 2023 #FarmBill. As Congress currently decides on what will make it into the next farm bill, now is the time to support farmers' abilities to build long-term sustainability.

AgTech Mismatch with...

Regional food systems due to, e.g., lack of support for:

- Managing rich but small, squishy data
- Coordination in local supply chains
- (pre-covid) connecting direct to consumer

Environmental sustainability due to, e.g., lack of support for:

- Managing highly diverse ag systems at scale
- Decision support for adoption of new practices

Agricultural communities due to, e.g., lack of support for:

- Mobile devices
- Low/no connectivity
- Long-term analytics

What mismatches do you see?

Barriers to flourishing local food systems include: knowledge, quality of life, finances, social supports, & infrastructure on top of global crises.

Barriers for aspiring and early beginning farmers (0-5 years)

- · Access to land, capital, and other resources
- Knowledge of how to farm
- Access to community
- Finding sales outlets and buyers
- Determining a niche

Barriers faced after the initial momentum of launching their farms (5-10 years):

- Access to diverse markets and managing market pressures
- Managing burnout and mental health
- Access to capital resources and financial and business tools to support growth
- Access to professional development as they move beyond the "101" level
- Risk management
- · Labor recruitment and retention for appropriate scaling (if desired)
- Reaching and maintaining the desired scale
- Adjusting production and market outlets as farmers hone their skills and build connections to buyers

Barriers to sustaining an advanced farmer community (10+ years):

- Farm viability, that is, making farm finances work longer term
- Access to professional development for advanced farmers
- Managing burnout and mental health
- Building longer term communities in a dynamic social context
- Work/life balance
- Labor recruitment and retention
- Climate change and other existential threats

So, how do we **collectively** engage in the **responsible design** of **information systems** to foster **resilience** in **sustainable, regional food systems**?

Our Approach: Participatory + Open Source



NORTHEAST **Cover Crop Decision Support Tools** COVER CROPS December 13, 2021 .COUNCIL. COVER CROP EXPLORER SPECIES SELECTOR TOOL FILTER PLANT HARDINESS ZONE ^ Zone 4 Zone 5 Zone 7 GRASS GRASS BRASSICA BROADLEAF GRASS Barley, Winter Cereal Rye, Spring **Barley, Spring** Brassica, Forage **Buckwheat** Hordeum vulgare Hordeum vulgare Brassica oleracea Fagopyrum esculentum Secale cereale Cover Crop Name View Crop Details Search by cover crop name ADD TO LIST COVER CROP TYPE ~ ENVIRONMENTAL TOLERANCES V SEEDS V SEEDING METHODS ~ GROWTH × LEGUME LEGUME LEGUME LEGUME GRASS Cereal Rye, Winter Clover, Balansa Clover, Berseem Clover, Crimson Clover, Red ROOTS V Secale cereale Trifolium michelianum Trifolium alexandrinum Trifolium incarnatum Trifolium pratense TERMINATION METHODS View Crop Details V WEEDS ~ ADD TO LIST THE REAL PROPERTY AND ADDRESS OF

ABOUT

HELP

FEEDBACK

© Cover Crop Councils, designed by the Agricultural Informatics Lab & implemented via the Precision Sustainable Agriculture initiative. Available at: www.covercrop.tools.

Gathering for Open Ag Tech; Join our Herd

- Foster community via online and inperson events
- Coordinate new and existing tech development
- Learn from each other!
- Align tech with user communities
- Foster a culture of maintenance, responsibility, and care
- Strategy and resources on agri-food tech development
- Connection to global, funded collaborative projects e.g., <u>https://openteam.community/</u>

Learn: <u>https://goatech.org/</u> Chat: <u>https://forum.goatech.org/</u>





Farm-Data Challenges

Record Keeping Pressures Certifications **US Policy & Regulation** • Food Quality Protection Act of 1996 USDA CERTIFIED HUMANE Food, Ag, Conservation & Trade Act of 1990 ORGANIC Irrigated Lands Regulatory Program RAISED & HANDLEI • Global Warming Solutions Act 2006 Environmental Quality Incentives Program FAIR TRADE CERTIFIED

Observations and Task Tracking

"We work with a lot of data, but data comes in different forms. So, lots of being in and walking the fields. Lots of, lots of tracking weather. And looking at the moisture content of the soil, sort of like, my dad has a better sense of- it's still a little mystical to me when we have to water! [... A] lot of what we do is very old fashioned in term of: we just spend a lot of time in the fields. Walking, driving, by virtue of living here, we do a lot of visual observation of what's happening."

Daughter Farmer @ Organic Orchard, 2015

"Where does attitude go in the database?"

Father Farmer @ Organic Orchard, 2015

Raturi, A. (2017). Modeling Sustainable Agriculture. UC Irvine. https://escholarship.org/uc/item/64n882qb

Farm Productivity & Management

		ck of the materials (fertilizers, pest control materials	erials, soil amendmen cel/block and maintair	ts, adjuvants, etc.) n in your records to
that you al update as	oply to your finecessary.	VINE 44.20	_ Crop Year:	2015-16
arm Name	Parcel ID	Material Applied (Brand Name, Manufacturer,	Purpose	Rate/ Amount
5/2 - \$15		Formulation)	FEATURERL SOIL BUILDING	1 × P52 12 ×
the last		REANDT UME SULFER	FUNCICIDE	1-67 TO 50 GAU
5/18		ACMICULTWRAL SULFCL 902	FUNC. CINZ	1.5 L63 TO SOC
s li ⁹		REPEAT SULFER THEATHE	u .	1 1 Mars
6/19		AT SAME ROPE	THE REAL PROPERTY	I CUP PER

Organic Vineyard, Organic Input Form

SPRAY LOG ROAD 59 2015 SEASON

DATE	MATERIALS	RATE	ROWS	NOTES
2/11 and 2/12	Compost Tea Seaweed	1#/ 100 gal	1-6, 12-52	Used 3 full spray tanks to finish orchard Balanced fungal and bacterial tea w/ molassas a few trees pushing flowers Sprayed in afternoon.
17-Feb	Compost Tea Regalia Seaweed	1gal/acre 1/2#/ 100gal	1 to 11	covered block I skipped origanially Higher Fungal tea recipe, no molassas Just starting to all push flowers PM Spray
20-Feb	Compost Tea Regalia Trigger Kelp Actinivate Nufilm	250 gal 2.5 gal 1 gal 5# 14 oz/ acre 16oz	15 to 30	Drove in B3, pretty good coverage PM Spray
21-Feb	Botector Kelp Nufilm	2.5# 5# 16oz	3 to 11	Drove in B1, very very good coverage. Sprayed in the am.
25-Feb	Botector Kelp Nufilm	2.5# 5# 16oz	21 to 28	B1, very good coverage. Sprayed at night

Fruit & Veg Organic Farm, Spray Logs

Raturi, A. (2017). Modeling Sustainable Agriculture. UC Irvine. https://escholarship.org/uc/item/64n882qb

Environmental Sustainability



Organic Vineyard



Organic Microgreens Garden

Raturi, A. (2017). Modeling Sustainable Agriculture. UC Irvine. https://escholarship.org/uc/item/64n882qb



Solutions for Small-Scale Farms

Fact Sheets

These small farm solutions fact sheets offer a general understanding of NRCS technical servi or management concepts. The factsheets are introductory in nature and should not be used to management concepts without technical support.

Farmers, ranchers and forest landowners are encouraged to seek <u>NRCS technical assistance</u> management needs of their operations.

- <u>Abandoned Well Plugging:</u> a plugged well is no longer dangerous as an open hole to peo
- <u>Ag Chemical Handling Facility</u>: A farm chemical mixing or handling area is a place where that any spills do not soak into the ground.
- Alley Cropping: Plant crops between tree rows to generate annual income and diversify
- <u>Animal Mortality Disposal</u>: An animal mortality disposal facility is a safe method to dispo composting, incineration, rendering, and burial.
- Balancing Animals with Forage: Increase pasture longevity by understanding your forage
- Biological Pest Management: Better control insects and disease with natural alternatives
- <u>Composting Manure</u>: Composting is well suited for manure that contains a lot of bedding or spilled hay.
- Cover Crops: Utilize planting grasses and legumes to combat crusting soils, soil erosion,
- Farmstead Windbreaks: Reduce heating cost and provide a natural barrier for weather evaluation of the second second
- <u>Fencing</u>: Better manage and protect your resources by strategically limiting access from
- Forage Planting: Provide weed management, increase livestock feed, poor yields and lac
- <u>Forest Farming</u>: Diversify your land and make your land more profitable.
- <u>Fuel and Fire Breaks</u>: Increase protection of your property and resources from the hazard
- <u>Grade Stabilization</u>: Grade stabilization is installed to stop a gully at the edge of a field. It brings water to the structure.
- <u>Heavy Use Area Protection</u>: A heavy use area is protected by first removing all the mud a will last for a long time such as gravel or clam shells.
- Irrigation Water Management: Irrigation water management is a plan to help you know w water in an efficient manner.
- . Low-Cost Irrigation System: A low-cost irrigation system can be as simple as a series of t
- <u>Managing Manure Nutrients Central</u>: Managing nutrients in manure means taking advantage of the second seco

Local & Regional Market Connections



Diversified Direct-to-Consumer Farm

Raturi et al. 2021. Resilient Foods Project. Publication forthcoming. www.resilientfood.org

What is the typical digital footprint of a Midwestern farm?

We interviewed **29 farmers** across rural, peri-urban and urban spaces, and **12 local food distributors** who coordinate between farmers, small businesses, markets, and other institutions.

Direct Sales Livestock

• ⊕ x, x' | <u>A</u> • <u>ℓ</u> • <u>A</u> • = = = = | ⊡ • | ○ • ⊞ •

Ŧ

Farm

^ ⊟ ५ ৺ ৺ 🛱

Spring/Summer Daily Chores:

Inside Barn:

- Horses Small bale of hay if needed and a small (coffee can) of feed.
- Ram Small bale of hay if needed, a small (coffee can) of feed, and water.

Aa8bCcDdEe AaBbCcDdEe

Normal No Specing

- Calves 2
- Check hay and water, Give 2 red scoops of feed



OFF AutoSave	∖ନେଟେ∿ଏ କ		D C	2020 (Calf Re	port ~	
ome Insert Draw Pa	ge Layout Formulas	Dat	a Rev	riew	View	♀ Tell me	Ľ
Paste S I U v	• 14 • A* ⊞ • <u>⊘</u> • <u>A</u> •	A A	lignment	% Numl	ber	Cells	Editing
7 🔹 X √ $f_{\rm X}$ Ma	irch						
A	В	C	D		E	F	
		2020	CAL	F LC	G		
Cow (Herd #1)	Birthdate	Tattoo	Tag #	Bull or	r Heife	r Notes	
(N) Cherry #22 (2018)	8/3/20	1.000				Sire: Whisper Royal Chief 10H (5)
(N) Lady (2018)	Open	P. 1				· · · · · · -	
(N) Luana #46 (2016)	5/19/20	E l	#0			Sire: Old Timey	
(N) Princess (2015)	Open	E i					
#18 Augus (Old)	5/26/20		#0			Sire: Old Timey / Butcher Cow Ja	n. 2021
#18's Daughter (2018)	5/14/20	Fi i	#0.~~		\boxtimes	Sire: Old Timey / Butcher Cow De	c. 2021
Bossy (2017)	3/25/20	E :			\boxtimes	Sire: Old Timey / Calf Name: Fern	
Taya (2017)	8/14/20	li i			\boxtimes	Sire: Old Timey	
Winnie (2018)	Open	B 9					
		Fi i				с ь	
Daisy (2017)		D. 1		\boxtimes		Sire: Old Timey - Daisy is not takin	g care o
Mary Rose (2014)	10/4/20	E i	ŚŚ	\boxtimes		Sire: Old Timey	
Petunia (2018)	Open	1					
*(N) Cloud Nine	Rented Bull						





Hoosier

Harvest

Website







What **decision support** do we hear people ask for?





Digging into the Software Landscape

SOFTWARE CATEGORIES

	Farm Planning Includes all high-level planning for future seasons and the farm in general. Also includes recordkeeping for both finances and field logs.		Resource Management Includes management of workers, machinery, and materials. Purchasing of farming inputs like fertilizers and feed also falls into this category.		Livestock Production Includes all activities related to livestock production, from breeding to sale or slaughter. Livestock health and grazing plans also falls into this category.		Crop Production Includes all activities related to production of row crops, fruits, vegetables, or other plant-based products from seed to harvest. Weed, pest, and disease management also falls into this category.		
	Examples		Examples		Examples		Examples	fortilizer	
	Production strategy and scheduling, budgeting, land management planning.		Machinery purchasing and maintenance, inventorying, labor scheduling and payment.		Grazing plans, breeding, health monitoring, feed formulation and scheduling.		application, irrigation, harvesting, pest and disease scouting, herbicide application.		
	· · • Farm-Gate • · · · • Farm-G			ate • • • Farm-Gate • • •			• • • Farm-Gate • • •		
Environmental Monitoring & Certification		s & Reporting Marketing & Com		mmunity Distribution L		ogistics Product S		es	
Includes all activities related to weather, soil, ecology, and other environmental matters. Crop or livestock-related activities that touch on these subjects, like tilling and renting bees for pollination, also fall into this category.		Includes all activit complying with pro regulations, and co includes both volu certifications, such organic, as well as like the food safet	ivities related to production standards, certifications. This pluntary standards and uch as certified as mandatory ones, fety modernization act.		intended to with rs, rs and other Includes all activiti shipment of agricul from producers to or the next link in chain.		es related to the Includes all Itural products the sale of p either consumers consumers c the production production c		rities surrounding ucts to either e next link in the
Examples Tilling, determining planting date, drift monitoring, raising/lowering high tunnel flaps, greenhouse controls. Examples Pesticide storage and disposal, reporting of production practices for organic certification, training for pesticide application permits.		and disposal, action practices cation, training cation permits.	Examples Sending newsletters, advertising content, showcasing product availability, storytelling, solicitation of grower contracts, customer management.		Examples Storage of products before shipment, calculating route efficiency, procuring shipping services, some harvest logistics.		Examples Product inventory management, sales tracking, invoicing, setting up booths at farmers markets, negotiating production contracts.		
· · · · rann-Gat		Gate	FUR V	www.aginfor	rmaticslab.org	· · · Gate-Fo	ork • •	Gate	-FOIK ···

Thinking in "USE CASES"

	EXAMPLES
A	sa farmer,
	I want to use my historical sales data ,
	so that I can create my crop plan
<u>More</u> - As an ex	tension educator, I want to use social media so that I can teach people about soil health.
As an ur	ban farmer, I want to use sensing systems so that I can monitor lead contamination.
As a mai	ket manager, I want to use an online marketplace… …so that I can reach under-served communities.
979-0479-0479-0479-0479-0479	www.aginformaticslab.org

Please Fill out as many cards as you'd like.

Consider...

- Current practices that work
- Problematic datadriven activities
- Opportunities for codesign

Resilient Food & Tech Library Preview

	Image: Non-State Image: State Image: State									by supply chain stage
		Resource	ce Name	Small Farms Activi	ty Catego	ries ~	Function	nalities Available \lor	Brief Descript	
	× "	Farm	STAGE Count 23						U	
	1	Ag Scol	uter	Crop Production	Farm Plan	ning	Scoutin	Soil Fertility	Mobile scouti	
							Farm N	http://bit.lv	y/resilier	ntfood-
Can be sorted a	ind ²	Agritect	ture Designer	Farm Planning			Farm N	tools		
filtered by softwo	are							~80 toole a	o for	
category and	3	AgSqua	ared	Farm Planning Cr	op Produc	tion	Farm N		o iai	
functionalities				Resource Manager	ment		Accou	Small farm	is focus	
		Bugwoo	od Apps family	Crop Production			Pest Ic	North Amo	rico focu	
				Environmental Mo	nitoring &	Managem	Invasiv	NOITH AITE		- III-1325245
	5	Bushel		Farm Planning			Farm N	lanagement	Suite of grain	
	6 Cash Cow			Marketing & Community Engagement		agement	Website Builder		operators.	
			Livestock Production			Livestock Management Beef/dairy cov and recordkee		Beef/dairy cov and recordkee		
	83 record	ls								
	r Airtable							× ^م Vi	ew larger version	

Grouped

AgTech quality sniff-test

Utility: how practical is it for users (farmers, managers, workers)?

Usability: how easy is it to use? does it bring you joy?

Interoperability: can we seamlessly move data across systems?

Trust: do users trust tech/developers with their data & livelihoods?

Resilience: is the tech robust, reliable, and adaptable?

Digital Tool Demonstrations

- 1. **farmOS** recordkeeping and farm management
- 2. Litefarm sustainability-focused farm management



Building Your Toolbox



Contribute to the Tool Library

Would you like to share any:

- Software(s) that you like to use?
- Spreadsheets tools?
- Workbooks, infographics, and other data artifacts?



Co-designing Digital Tools



Imagine you're at your favorite place, maybe a farm, a wetland, or on a rooftop garden. You're in the field, it's a great day, but a someone has a hard problem that they've called out here for.

As you're talking, you get to the point where you whip out your phone and do what?

Do you calculate something?

Look for information about what you see?

Draw something?

What is it you want this digital portal to provide?

Draw out a storyboard and share it with us!

With gratitude to our community partners

Farmers Interviewed in California, Cover Crop Councils, Farmers Interviewed in the U.S. Midwest, Food Coordinators Interviewed across the U.S., Purdue Extension, Univ. California Ag & Natural Resources Extension, FarmOS, Open Food Network USA, Renewing the Countryside, Purdue Open Ag Tech Systems Center, Partners in Food & Farming, and members of the Gathering for Open Ag Tech (GOAT).

With thanks to our funding partners

U.S. Department of Agriculture (USDA) National Institute for Food & Ag, USDA Natural Resources Conservation Service, USDA Agricultural Research Service, Foundation for Food & Ag Research, Midwestern Cover Crop Council, Open Technology Ecosystem for Adaptive Management via Wolfe's Neck Center for Research & Education, Social Science Research Council, OurSci LLC, and Purdue University

axilab

Agricultural and Biological Engineering

Thank you!

Ankita Raturi, Tam Bureetes, Steven Doyle, Hannah Klein

ankita@purdue.edu

www.aginformaticslab.org