

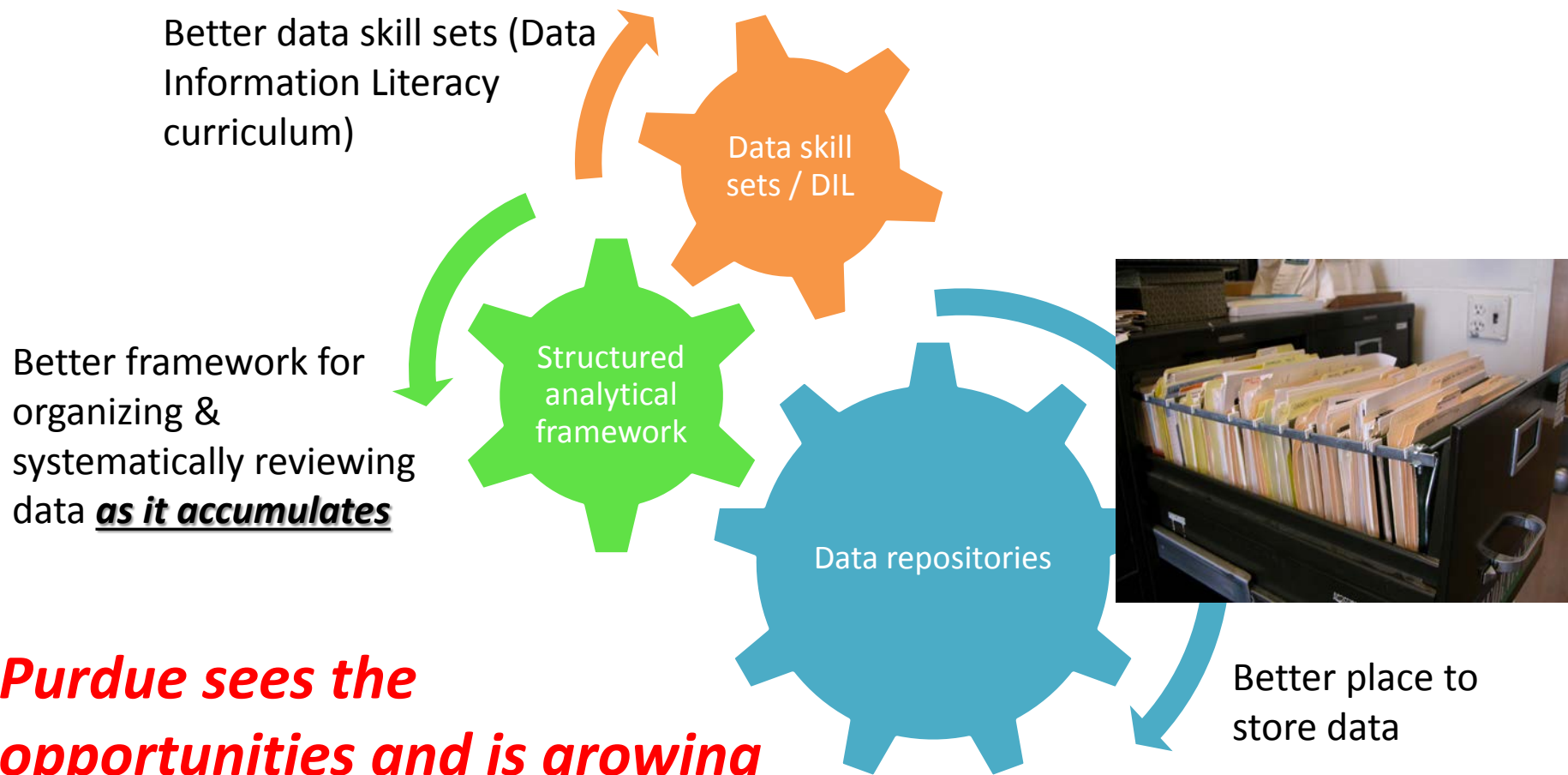
Smarter Agriculture: A pathway to evidence-based policy and management recommendations for agriculture

Sylvie M. Brouder
Agronomy Dept.
Purdue Univ.
12/4/2013

Dr. Plaut: What is the research case for Big Data?

- Turn information into insights
- Connects and empowers people
- Evidence based decision making
- Can develop integrated solutions to complex problems
- Federal mandate from the OSTP (Office of Science, Technology and Policy) that all federal agencies that award grants must make data available
- **Cost Efficiencies**

“Smarter Agriculture” ~ What do we need (to have, to be doing, etc.) to use data better in agricultural policy and management (research too)?



Purdue sees the opportunities and is growing programs in all 3 areas...

Why are data not reused?

- **Not useful?** Question has changed... Hmmmm: Yes & No
- **Not accessible?** Poor data hygiene...
 - Diekmann interviews (J. Ag. & Food Info., 2012):

*“The researcher wanted to reanalyze data from another figure and **I couldn’t find it**. And I couldn’t; **I lost it**. It was done on an old computer system and the **technician who did [it, had] moved on** and I wasn’t able to find it.”*

*“We have had a lot of problems in the past of losing data, or **just misplacing it**. And then we have to backtrack it and that’s taken literally days or weeks to find where this data was stored. So it has been a real problem for us.”*

Why are data not reused?

- **Too much work?** Lack of data workflow tools...
 - Diekmann interviews (J. Ag. & Food Info., 2012):
*“[Another group of scientists and I] were talking about, can we get our data and pull it together? They wanted that data, [but] **it’s the annotation that’s really the hard part** [for] them [to be] able to make sense of it. I would be happy to give [out the data], but [then] **I have to explain whatever I did.**”*
- **Too expensive?** > 80% of scientists surveyed in 2010 indicated that they did not have resources to make their data open access (Science. Feb. 2011)

Question of Money, Motivation, and Mechanics...

Taking a peek at data caretaking in AGRY... K Team Fellow

(PhD student supported by Mosaic and PCS)

The screenshot shows a Windows Explorer window with the address bar displaying the path: `sbrouder > Dropbox > K_Plots_data`. The search bar contains the text `Search K_Plots_data`. The ribbon at the top includes options for `Organize`, `Include in library`, `Share with`, and `New folder`. The left sidebar shows the navigation pane with `Dropbox` selected. The main pane displays a list of folders with columns for `Name`, `Date modified`, and `Type`.

Name	Date modified	Type
2009	10/31/2013 2:27 PM	File folder
2010	10/31/2013 2:25 PM	File folder
2011	10/31/2013 2:23 PM	File folder
A&L LAB	10/31/2013 2:23 PM	File folder
K Balance	10/31/2013 2:25 PM	File folder
K removal	12/10/2013 8:53 A...	File folder
Lower depths	10/31/2013 2:25 PM	File folder
Non_linear regression	10/31/2013 2:25 PM	File folder
RonaldN	10/31/2013 2:25 PM	File folder
routine soil test	10/31/2013 2:25 PM	File folder
SAS_files	10/31/2013 2:25 PM	File folder
STB_K_Extraction	10/31/2013 2:25 PM	File folder
STK vs Time	10/31/2013 2:25 PM	File folder
Thesis_chapters	10/31/2013 2:25 PM	File folder
TPB	10/31/2013 2:25 PM	File folder

Today, I can tell you what this spreadsheet means but you can't understand all of it on your own...

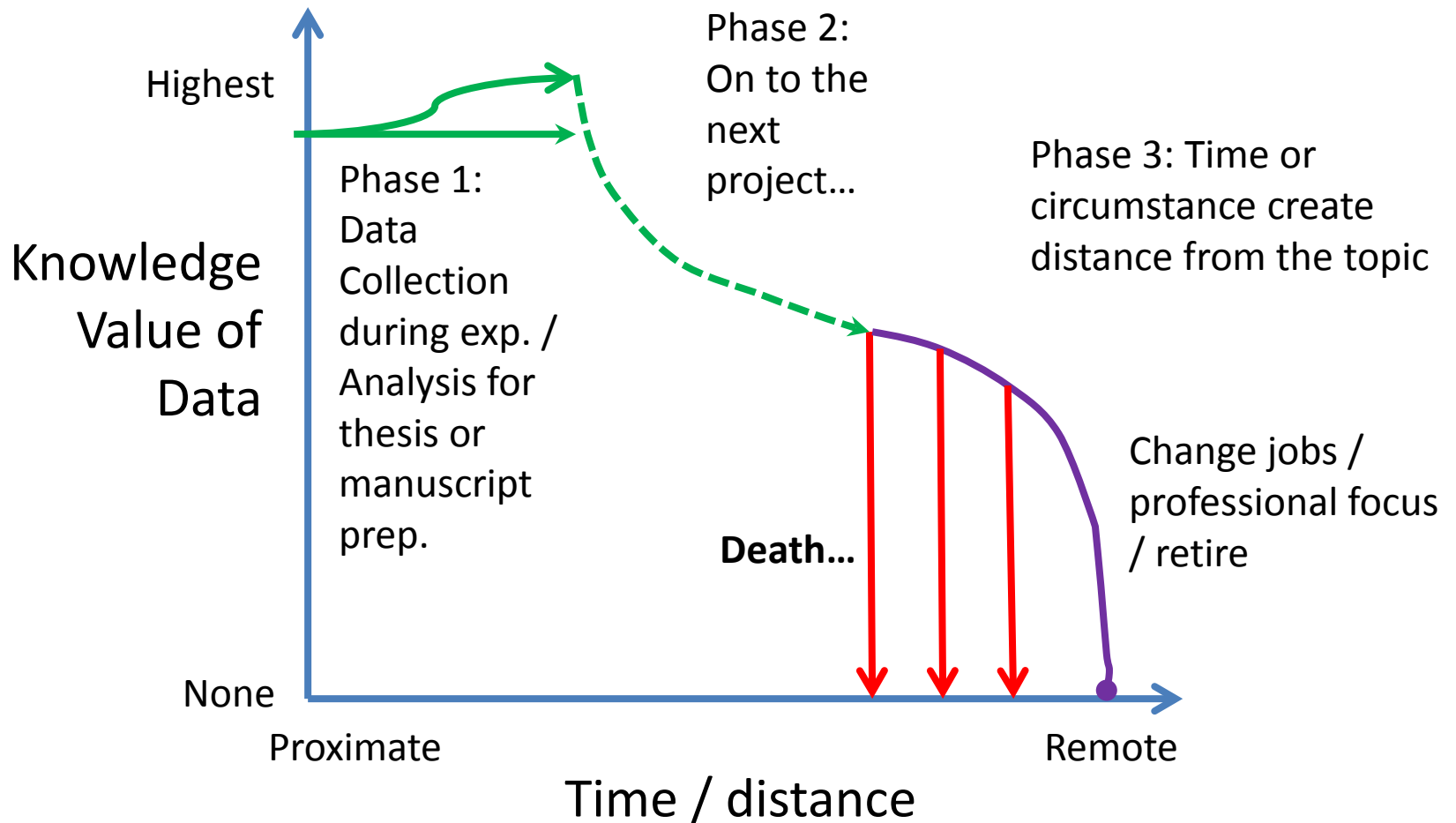
The screenshot shows a Microsoft Excel spreadsheet titled "AllFarms_STK_2011_F - Microsoft Excel non-commercial use". The spreadsheet contains data for K analysis of corn samples. The data is organized into two main tables, one for fall/spring samples and another for samples 111-132 and 141-352. The tables include columns for Plot, treatment (trt), application (app), depth, soil weight (g), solution volume (ml), dilution, and K concentration (ppm) measured as readout, solution, corrected, and soil. A red circle highlights the "soil wt (g)" and "Solution (ml)" columns in the first table. Another red circle highlights a note in the second table: "note: 111-132 were sampled during the fall 141-352 were sampled in the spring". A blue arrow points from the bottom of the spreadsheet towards the note.

K (ppm)											K (ppm)											
Plot	trt	app	depth	soil wt (g)	Solution (ml)	Dilution	readout	solution	corrected	soil	Plot	trt	app	depth	soil wt (g)	Solution (ml)	Dilution	readout	solution	corrected	soil	
152	k1	a	1	2.01	20	1	7.4	7.3	7.3	73	For 111-152											
152	k1	a	2	2.01	20	1	7.2	7.1	7.1	71	Turmail				2.03	20	1	4.9	4.8	4.8	48	
152	k1	a	3	2.01	20	3	3.4	3.3	3.3	99	Clermont				2.06	20	1	9.3	9.2	9.2	89	
152	k1	a	4	2.01	20	3	4.5	4.4	4.4	132	S-2				2.04	20	1	8.8	8.7	8.7	85	
152	k1	a	5	2.07	20	3	4.7	4.6	4.6	134	Blank					20	1	0	-0.05			
152	k1	a	6	2.02	20	1	10.2	10.1	10.1	100												
252	k1	a	1	2.05	20	1	7.2	7.1	7.1	69	For 211-252											
252	k1	a	2	2.03	20	1	5.5	5.4	5.4	53	Turmail				2.08	20	1	5.2	5.1	5.1	49	
252	k1	a	3	2.08	20	3	2.6	2.5	2.5	71	Clermont				2.01	20	3	3.4	3.3	3.3	97	
252	k1	a	4	2.06	20	3	3.4	3.3	3.3	95	S-2				2	20	1	8.7	8.6	8.5	85	
252	k1	a	5	2.03	20	1	7.9	7.8	7.7	76	Blank					20	1	0.1	0.1	0.0		
252	k1	a	6	2.06	20	1	7.6	7.5	7.5	72												
351	k1	a	1	2.02	20	3	3.2	3.1	3.1	93	For 311-352											
351	k1	a	2	2.01	20	1	6.9	6.8	6.8	66	Turmail				2.08	20	1	5	4.9	4.9	47	
351	k1	a	3	2.04	20	3	3.4	3.3	3.3	98	Clermont				2.04	20	1	9.7	9.6	9.6	94	
351	k1	a	4	2.07	20	3	3.7	3.6	3.6	105	S-2				2.05	20	1	8.7	8.6	8.6	84	
351	k1	a	5	2.04	20	3	3.6	3.5	3.5	103	Blank					20	1	0	-0.05			
351	k1	a	6	2.03	20	1	7.1	7.0	7.0	69												

What is this???

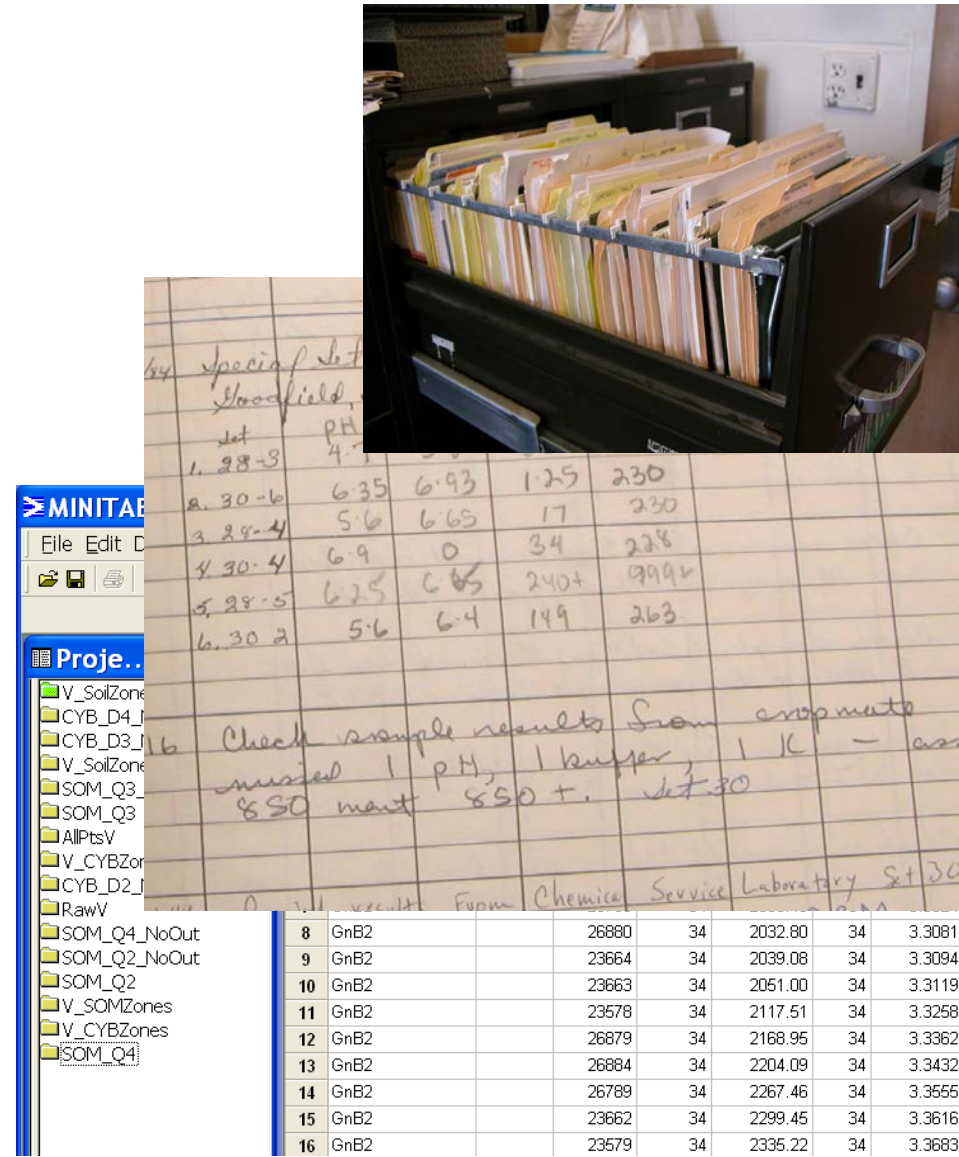
Tomorrow, we may both be in the dark...

Precarious Nature of Data Lifecycle: Scientifically proven that my ability to understand and find these data will erode extremely rapidly!



Pressing technological challenges to informatics for all agronomic efforts concern data workflow...

- **Data dispersion**
 - Take advantage of small datasets collected by many researchers (not everything is “BIG”)
- **Data heterogeneity**
 - Varied protocols reflecting local culture & variation in 1^o purpose
- **Data provenance**
 - Need to track data through multi-step process of aggregation, modeling, analysis



The collage consists of four main elements:

- File Cabinet:** A black metal file cabinet with several drawers, each filled with numerous manila-colored file folders, representing data dispersion.
- Handwritten Notebook:** A close-up of a grid-lined notebook with handwritten notes in black ink. The notes include "Special det", "Woodfield", "det pH", and a list of data points with columns for sample numbers and values.
- Computer Screen:** A screenshot of a Windows Explorer window showing a project folder structure. The folder list includes: V_SoilZone, CYB_D4_J, CYB_D3_J, V_SoilZone, SOM_Q3, SOM_Q3, AllPtsV, V_CyBZor, CYB_D2_J, RawV, SOM_Q4_NoOut, SOM_Q2_NoOut, SOM_Q2, V_SOMZones, V_CyBZones, and SOM_Q4.
- Data Table:** A table with 7 columns and 7 rows of data. The first column contains sample IDs (8-16), the second column contains "GnB2", and the remaining five columns contain numerical values.

64 Special det
Woodfield
det pH
1. 28-3 4.7
2. 30-6 6.35 6.93 1.25 230
3. 28-4 5.6 6.65 17 230
4. 30-4 6.9 0 34 238
5. 28-5 6.25 6.85 240+ 999
6. 30-2 5.6 6.4 149 263

MINITAB
File Edit D
Proje...
V_SoilZone
CYB_D4_J
CYB_D3_J
V_SoilZone
SOM_Q3
SOM_Q3
AllPtsV
V_CyBZor
CYB_D2_J
RawV
SOM_Q4_NoOut
SOM_Q2_NoOut
SOM_Q2
V_SOMZones
V_CyBZones
SOM_Q4

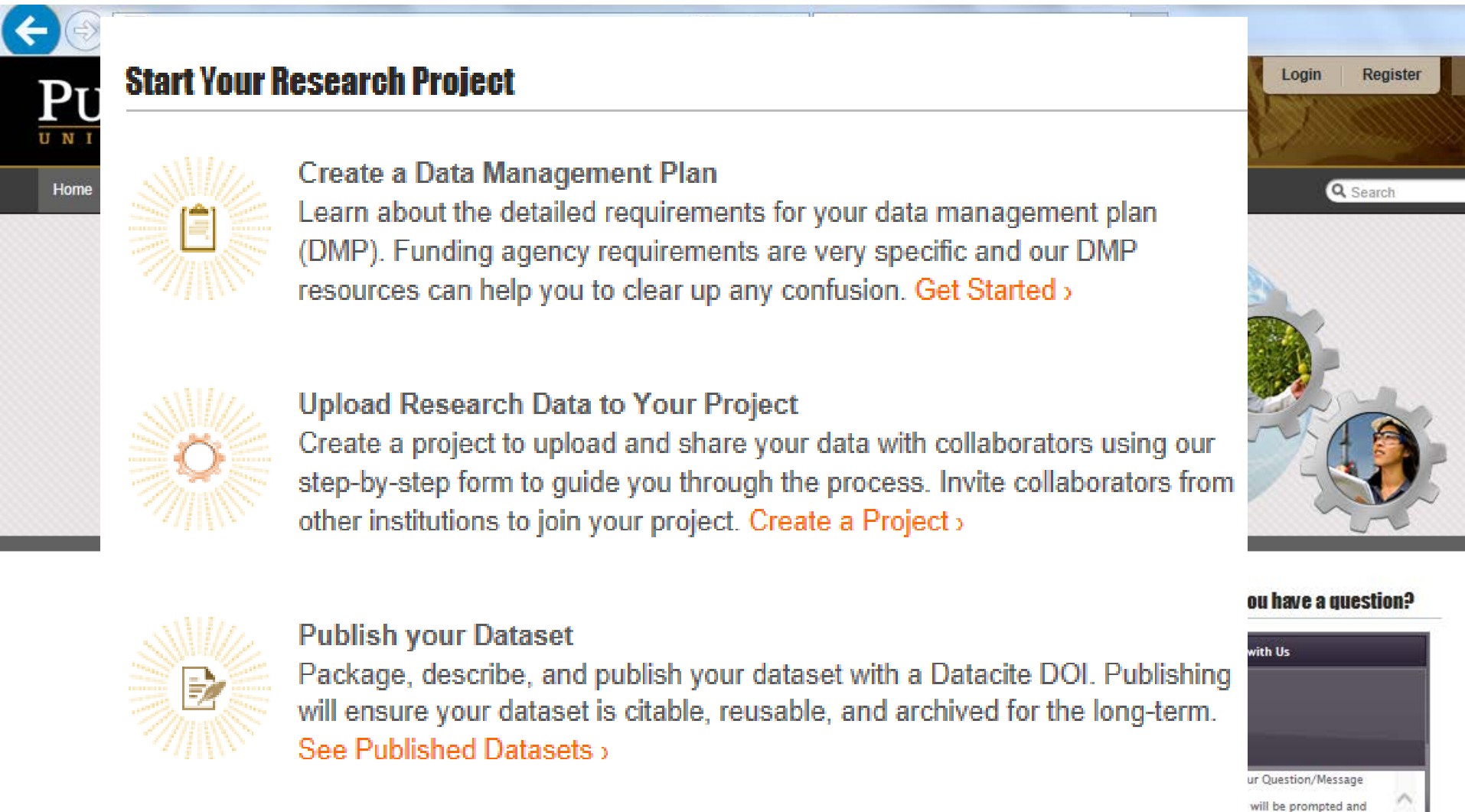
16 Check sample results from cropmate
missed 1 pH, 1 buffer, 1 K - ass
& SO mant & SO +. det 30

8	GnB2	26880	34	2032.80	34	3.3081
9	GnB2	23664	34	2039.08	34	3.3094
10	GnB2	23663	34	2051.00	34	3.3119
11	GnB2	23578	34	2117.51	34	3.3258
12	GnB2	26879	34	2168.95	34	3.3362
13	GnB2	26884	34	2204.09	34	3.3432
14	GnB2	26789	34	2267.46	34	3.3555
15	GnB2	23662	34	2299.45	34	3.3616
16	GnB2	23579	34	2335.22	34	3.3688

How hard/expensive can it be???? (Why is posting data on a website NOT enough...)

- Lack of longevity
 - I depart and my webpage may or may not be maintained (the original source is responsible for preservation and curation).
 - Web pages are updated and links are not
 - Lack of forward formatting (who remembers Lotus 1,2,3?)
 - Data provenance disappears (where DID this number come from)
- Lack of rigor, standardization and process
 - You annotate your data in a way YOU think describes it adequately but no one else reviews it... not standardized because you are not following a protocol (we love to make up our own terms ~ part of showing novelty of endeavor)
 - Not “tagged” for searching
 - Does not have a Digital Object Identifier (DOI: unique & persistent identifier)

Purdue University Research Repository: What libraries are to books, PURR is to data (plus so much more!)



The image shows a screenshot of the Purdue University Research Repository (PURR) website. The main content area is titled "Start Your Research Project" and features three primary actions, each with a sunburst icon:

- Create a Data Management Plan**: Learn about the detailed requirements for your data management plan (DMP). Funding agency requirements are very specific and our DMP resources can help you to clear up any confusion. [Get Started >](#)
- Upload Research Data to Your Project**: Create a project to upload and share your data with collaborators using our step-by-step form to guide you through the process. Invite collaborators from other institutions to join your project. [Create a Project >](#)
- Publish your Dataset**: Package, describe, and publish your dataset with a Datacite DOI. Publishing will ensure your dataset is citable, reusable, and archived for the long-term. [See Published Datasets >](#)

The right sidebar contains a navigation menu with "Login" and "Register" buttons, a search bar, and a section titled "Do you have a question?" with a "Contact Us" button and a form for submitting questions or messages.

Very first PURR data publication: Volenec

Alfalfa data looks like Navarrete K data (mostly)...

Q1098															140				
1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
2	Year	Month	Rep	Plot No.	Treatment	K, kg/ha	P, kg/ha	ield (kg/h	stems/m2	plants/m2	ss/shoot	P (mg/kg)				K (mg/kg)			
												0-2	2-4	4-6	6-8	0-8	0-2	2-4	4-6
1113	2000	4	4	411	19	400	50					24.5	7.0	9.3	5.3		290.0	112.0	93.0
1114	2000	4	4	412	3	0	50					29.1	8.0	7.0	5.1		90.0	84.0	80.0
1115	2000	4	4	413	15	300	50					30.2	7.8	7.2	5.9		220.0	92.0	80.0
1116	2000	4	4	414	2	0	25					18.3	7.3	7.2	7.2		90.0	84.0	80.0
1117	2000	4	4	415	6	100	25					19.1	7.0	7.1	6.3		110.0	92.0	84.0
1118	2000	4	4	416	9	200	0					9.2	6.5	7.7	6.4		190.0	108.0	84.0
1119	2000	4	4	417	5	100	0					10.0	7.0	7.3	7.7		120.0	92.0	80.0
1120	2000	4	4	418	10	200	25					19.5	7.8	8.3	7.7		150.0	84.0	72.0
1121	2000	4	4	419	4	0	75					35.1	10.1	10.1	27.3		80.0	84.0	84.0
1122	2000	4	4	420	11	200	50					26.3	7.6	7.7	7.6		150.0	80.0	76.0
1123	2000	5	1	101	8	100	75	5566.0457	401.76453			57.7	18.7	9.5	12.1		90.2	92.0	96.0
1124	2000	5	1	102	19	400	50	5908.9126	368.11068			36.8	9.8	10.5	11.2		239.8	120.0	84.0
1125	2000	5	1	103	3	0	50	5933.606	436.74415			17.7	8.6	7.2	9.3		70.1	98.0	96.0
1126	2000	5	1	104	13	300	0	4455.2046	478.95126			12.0	7.0	5.8	7.7		299.9	103.0	104.0
1127	2000	5	1	105	17	400	0	5280.7465	469.14948			8.3	5.0	3.9	6.8		329.8	120.0	96.0
1128	2000	5	1	106	20	400	75	5990.6994	424.63137			72.7	8.0	7.6	12.2		170.0	124.0	96.0
1129	2000	5	1	107	12	200	75	5673.7468	430.67761			80.5	14.3	12.8	13.1		139.9	96.0	100.0
1130	2000	5	1	108	9	200	0	5698.6962	635.16453			23.7	15.2	14.3	14.9		140.1	96.0	92.0
1131	2000	5	1	109	1	0	0	6102.5182	436.39289			22.4	17.9	18.5	19.0		99.8	100.0	104.0

You can "google" data published in PURR...

The screenshot shows a web browser window with the URL <https://purrr.purdue.edu/publications/1004/about>. The page header includes the Purdue University logo and the text "Purdue University Research Repository" and "PURR". A navigation menu contains "Home", "Publications", "Projects", "Get Started", "Policies", and "Contact Us". A search bar is located in the top right corner.

The main content area displays the following information:

- Abstract:** This is a master file of merged excel files with data from several studies on the influence of phosphorus and potassium nutrition on alfalfa. It includes numeric data such as yield, plant mass, plant counts, and tissue concentration of various nutrients. Conventional wisdom states that plants that are poorly fertilized and do not have adequate phosphorus and especially low potassium will become winterkill. This study showed that plants did not necessarily die in winter with low potassium stress.
- Study dates:** 1997 to 2004.
- Location/Latitude and Longitude:** Throckmorton Purdue-Agricultural Center located 15 km south of West Lafayette, IN (40°N and 87°W)
- Cite this work:** Researchers should cite this work as follows:
Jeffrey J Volenec, (2012), "Phosphorus and Potassium Influence on Alfalfa Nutrition": (DOI: 10.4231/D3251FJ7S)
[BibTex](#) [EndNote](#)
- Tags:** Alfalfa, Forage composition, Forage legumes, Forage quality, Medicago sativa, Nutritive value, Phosphorus fertilizer, Potassium fertilizer, Soil fertility, Winter hardiness, Yield components
- Version 1.0 Notes:** Citations:
Berg, W.K., S.M. Cunningham, S.M. Brouder, K.D. Johnson, B.C. Joern, and J.J. Volenec. 2005. Influence of phosphorus and potassium fertilization on alfalfa yield and yield components. *Crop Sci.* 45: 297-304.

On the right side of the page, there are statistics: 0 review(s), 0 questions, 3 citation(s), and 92 user(s). A "Share:" button with a Facebook icon is also visible.

Red circles highlight the "Study dates" and "Location/Latitude and Longitude" fields, and a large red oval highlights the "Cite this work" section and the "Tags" section.

The workflow is predetermined when publishing ~ you are prompted to be comprehensive in the info you provide ~ PU Lib. Information Specialists review it prior to publication...

Phosphorus and Potassium Influence on Alfalfa Nutrition

By Jeffrey J Volenec

Data from several studies on the influence of phosphorus and potassium nutrition on alfalfa. It includes numeric data such as yield, plant mass, plant counts, and tissue concentration of various nutrients

Listed in [Datasets](#)

[Download \(XLS\)](#)

[Additional materials available \(1\)](#)

Version 1.0 - published on Feb 22, 2012
doi:10.4231/D3251FJ7S - [cite this](#)

[About](#) [Supporting Docs](#) [Versions](#) [Reviews](#) [Questions](#) [Citations](#)

Supporting Docs

[DS2.pdf \(PDF | 19.88 Kb\)](#)

Supporting documents accessible with datasets.... Alfalfa P/K study

<u>Column</u>	<u>Description</u>
A	Calendar year when samples were obtained (1997 to 2004)
B	Month within calendar year when samples were obtained (1 to 12)
C	Field replicate (1 to 4)
D	Plot number (101 to 420)
F	Treatment number (1 to 20)

Summary:

This is a master file of merged excel files with data from several studies on the influence of phosphorus and potassium nutrition on alfalfa. It includes numeric data such as yield, plant mass, plant counts, and tissue concentration of various nutrients. Conventional wisdom states that plants that are poorly fertilized and do not have adequate phosphorus and especially low potassium will become winterkill. This study showed that plants did not necessarily die in winter with low potassium stress.

Study dates: 1997 to 2004.

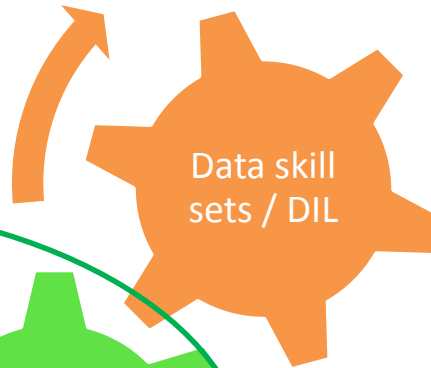
Location/Latitude and Longitude: Throckmorton Purdue-Agricultural Center located 15 km south of West Lafayette, IN (40°N and 87°W)

Background:

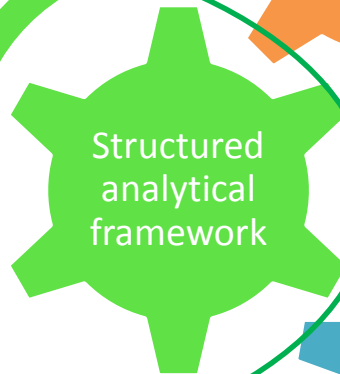
In April 1997, a 1.4-ha site was seeded to Pioneer Brand '5454' alfalfa. This site was selected for study because soil tests indicated low concentrations of extractable P (9 to 15 mg kg⁻¹ Bray P1) and low to

“Smarter Agriculture” ~ Evidence & Eminence in recommendation and policy development

Better data skill sets (Data Information Literacy curriculum)



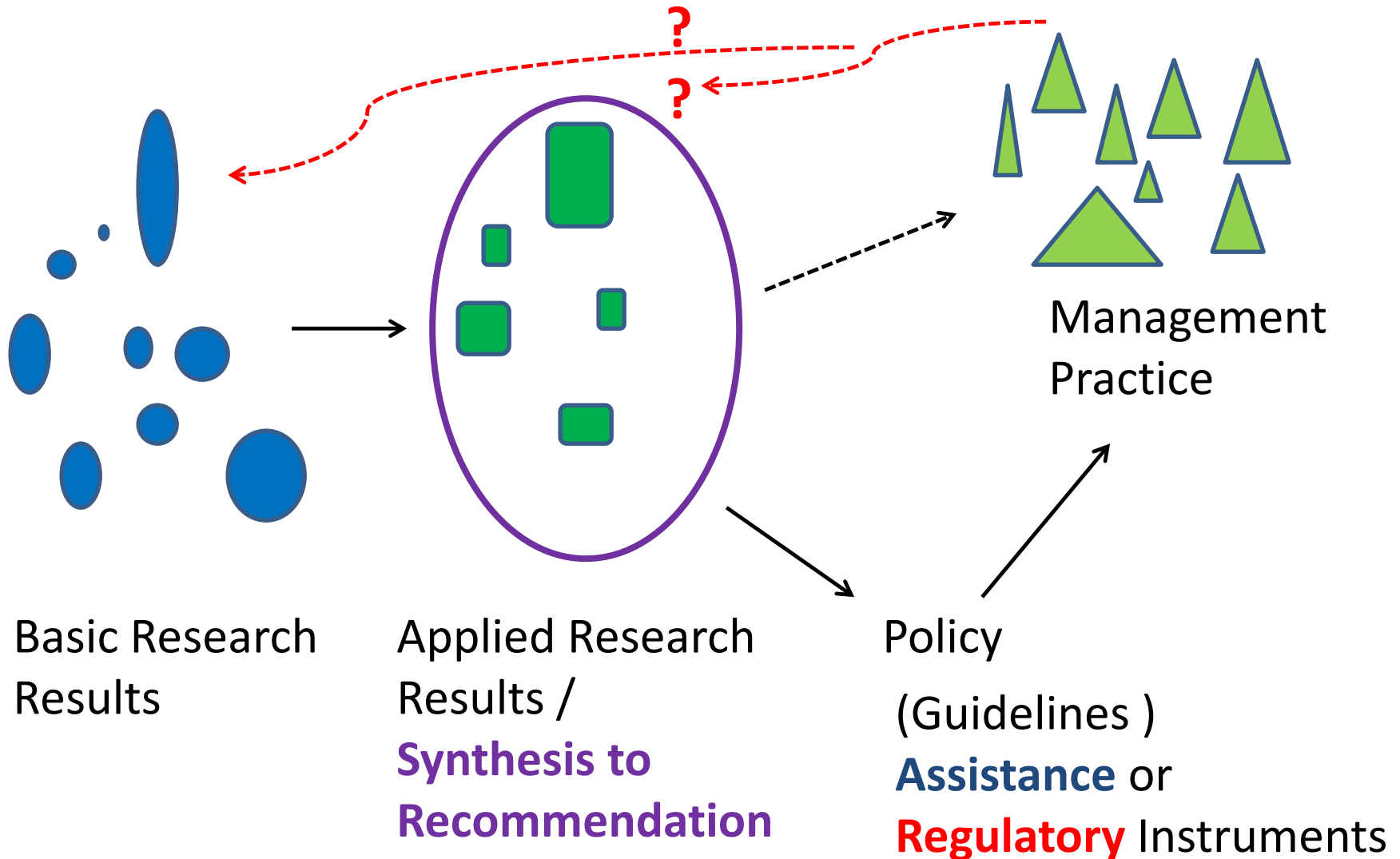
Better framework for organizing & systematically reviewing data as it accumulates



Better place to store data

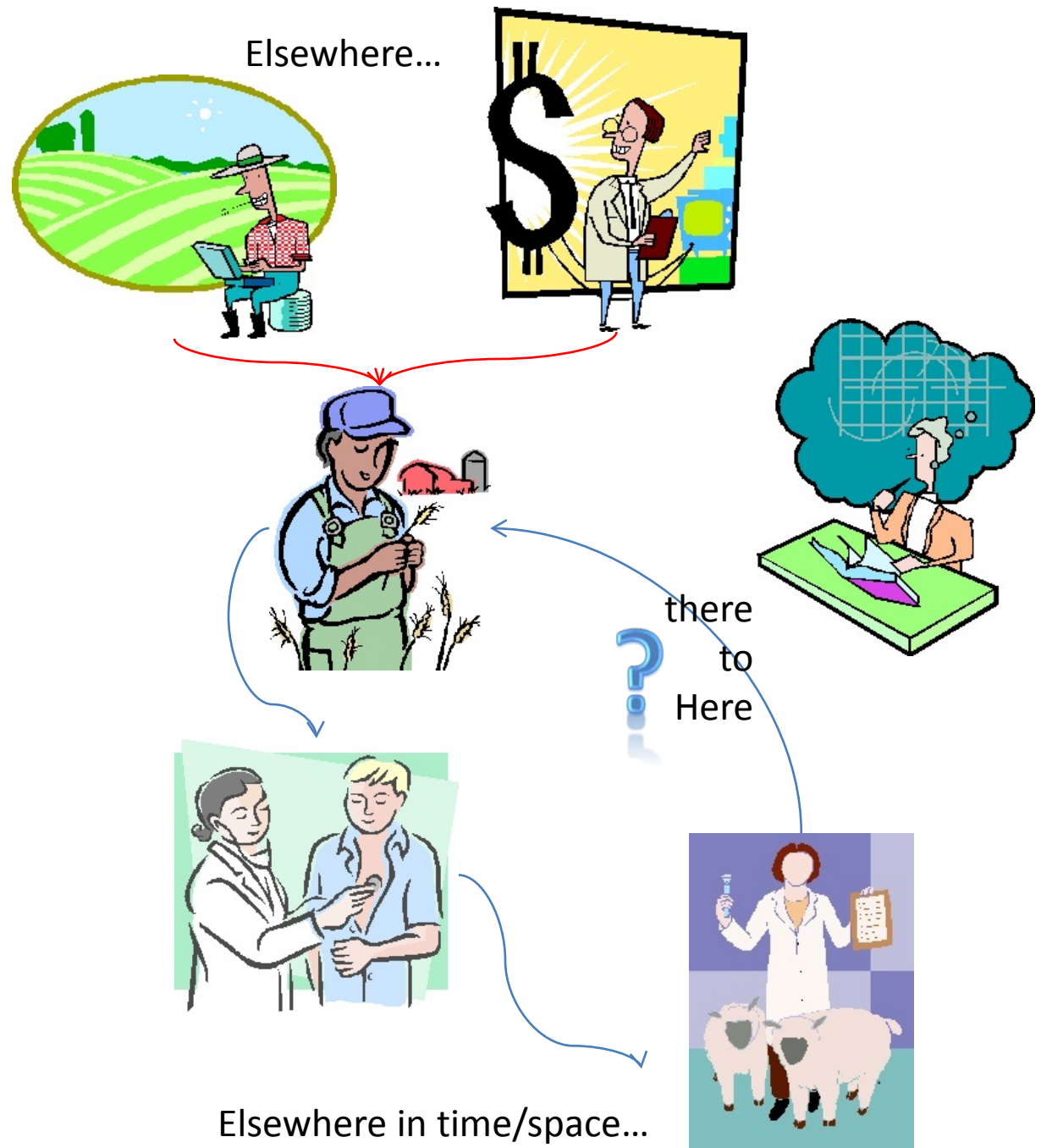
Purdue sees fantastic opportunities for Extension...

Ag. Extension Model for Knowledge Creation/Translation Pathway

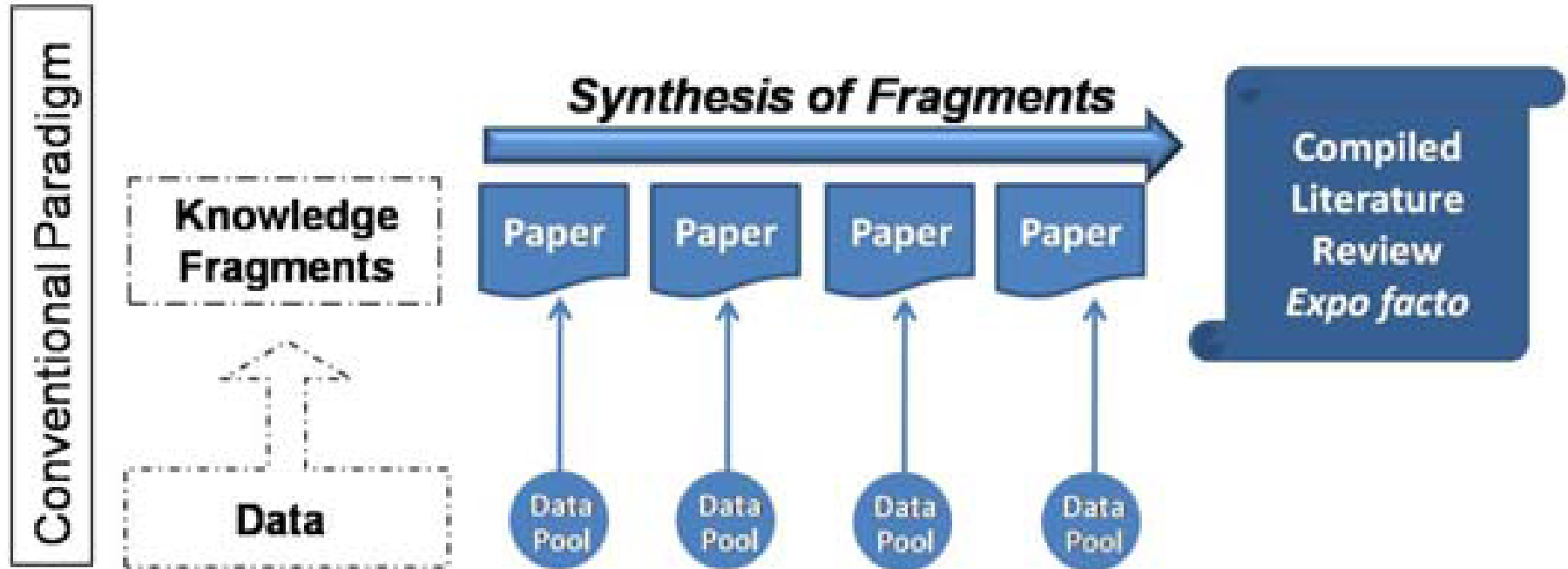


“Eminence” Model: The Extension Specialist’s Purview to...

- Transform data / research into practical knowledge
- Adapt research results to the farm / farmer environment / context



Current “conventional” way of synthesizing applied & basic research pieces into “big picture” results (e.g. fertilizer recommendations, policy) ~ **selection bias favors “peers”**



Individual
Research Prgm

Purdue

Ohio State

Michigan State

Applied Res. Philosophy:

- ✓ Data owned by PI
- ✓ Don't share raw data
- ✓ Peer review pubs not essential

Reliance on “best professional judgment” (qualitative review)

What's the problem with a strictly or primarily “eminence” –based framework?

- We are just not using all the data we could or should be using & the amount of data that we could use is skyrocketing (The “Moneyball” Extension Allegory)
 - Extension Specialists are human beings and prone to biases and lapses in judgment at a rate similar to the general population
 - We tend to rely on data that we are familiar to a greater extent than data more distant from us.
 - Training in scientific theory and practice may help overcome this.
- “Best professional judgment” ought to be considered in this light to ensure equal parts eminence and evidence (Note: as experts we are not alone in this problem)

**If you've seen it, you expect to see it, you are prone to diagnose it...
the power of the “change up” pitch!**

What's the problem cont.

- Can't find the original data/publications to reanalyze/augment → unnecessarily have to redo portions of research (\$\$\$\$\$)
- Guidelines and recommendations not specific enough to satisfy most farmers
- Policy instruments unsatisfying / contentious:
 - Assistance programs don't seem to be achieving desired outcome (e.g. CEAP); costly
 - Regulations perceived as burdensome, inappropriately targeted, ineffectual, suppressing of profitability and economic growth

More!

We need to use data....



...differently, more
comprehensively, more
quantitatively...



Medical Data and the Grassroots Effort to Make it Available for Evidence-based, Clinical Use

Kay Dickersin, MA, PhD

Smarter Agriculture: A Dialogue on Critical Data for
Agriculture

Potomac, Maryland

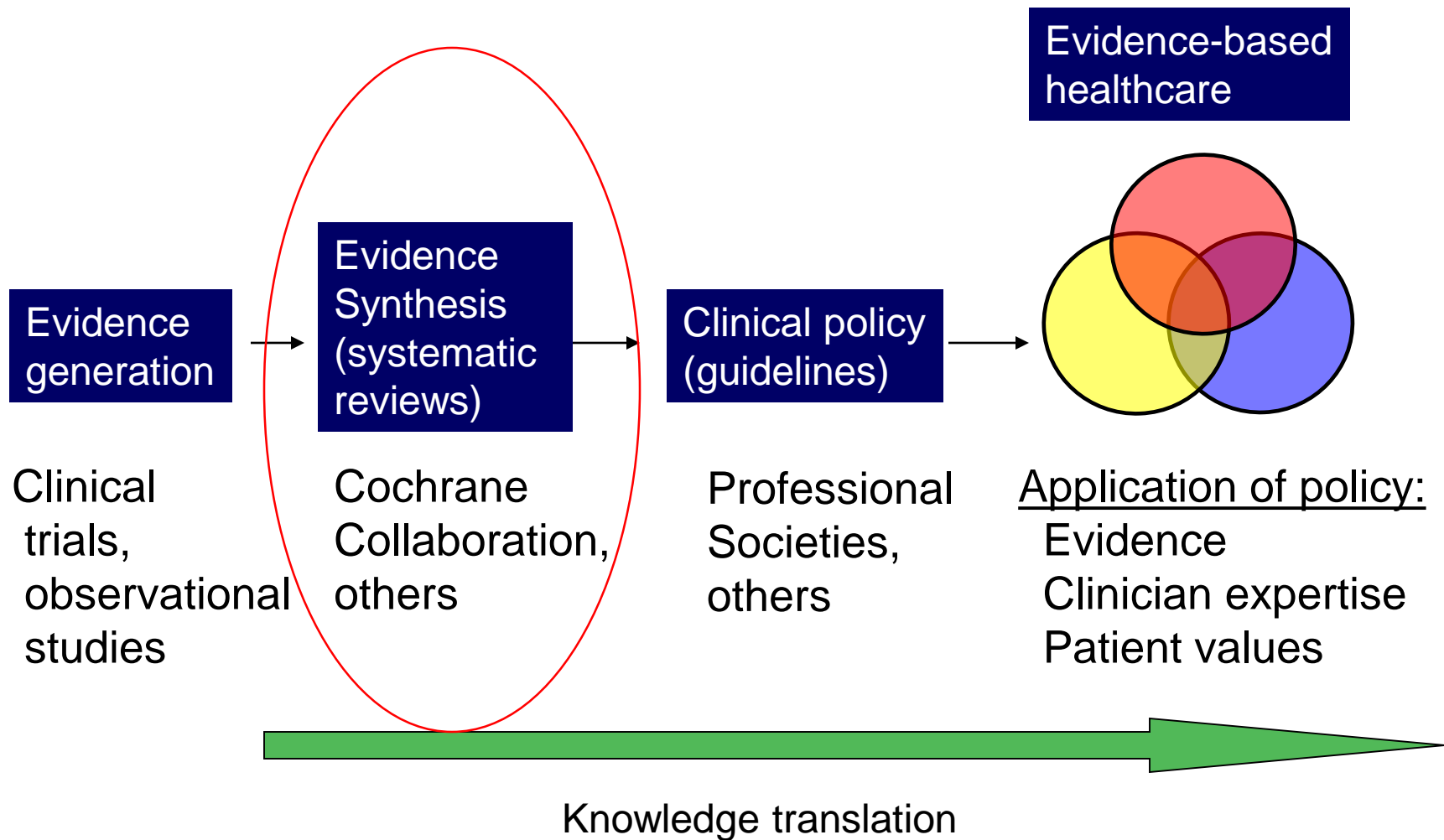
October 10, 2013

Dickersin: Reviews essential in health

- Research evidence generally available in short published papers. Researchers try to publish a lot of them
 - Literature is large and growing (eg, 20,000 biomedical journals)
 - Literature is not organized
 - Reviews of primary research necessary for coping with information overload
-



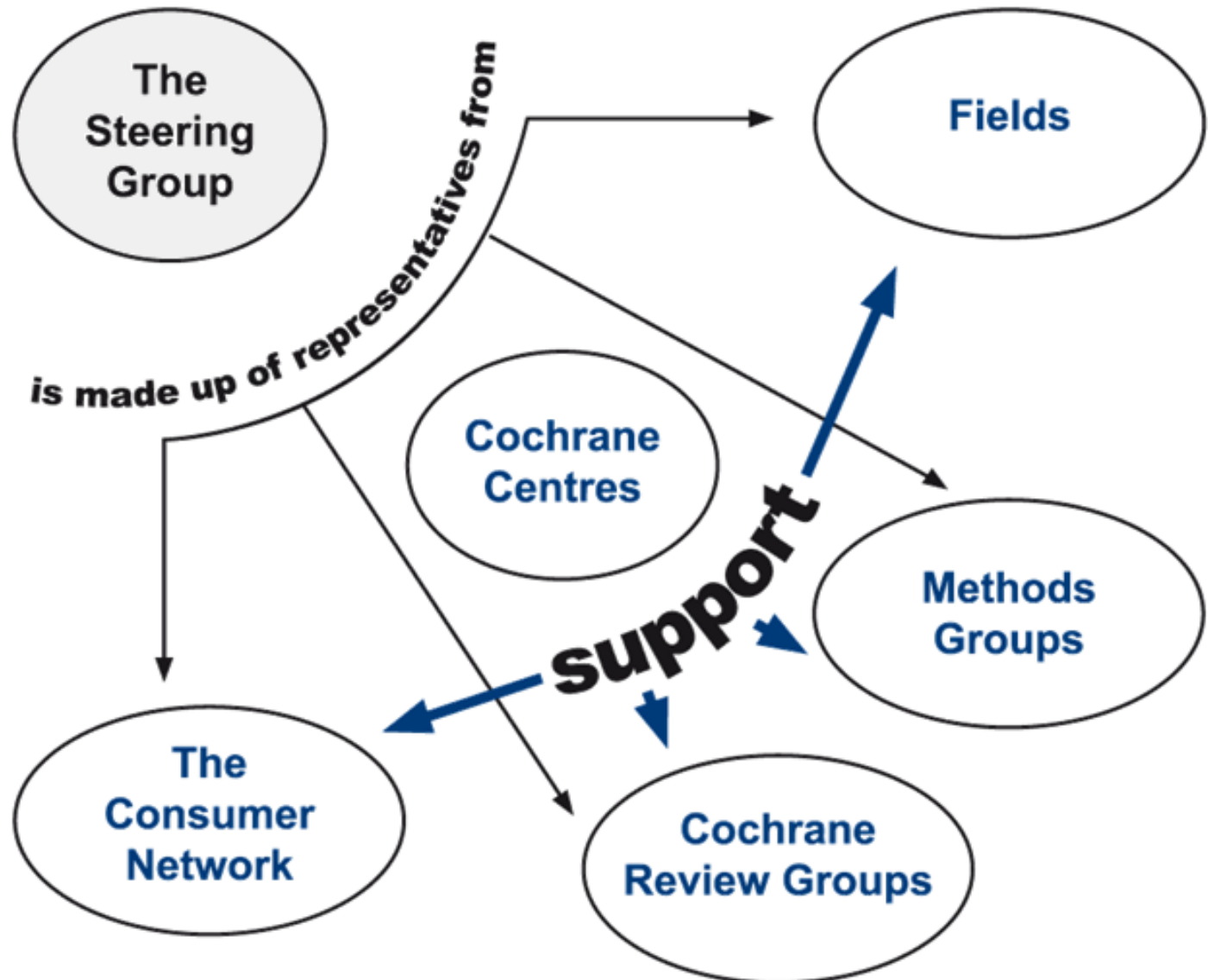
Dickersin: Knowledge translation: From clinical research to practice decisions



Dickersin: What is a systematic review?

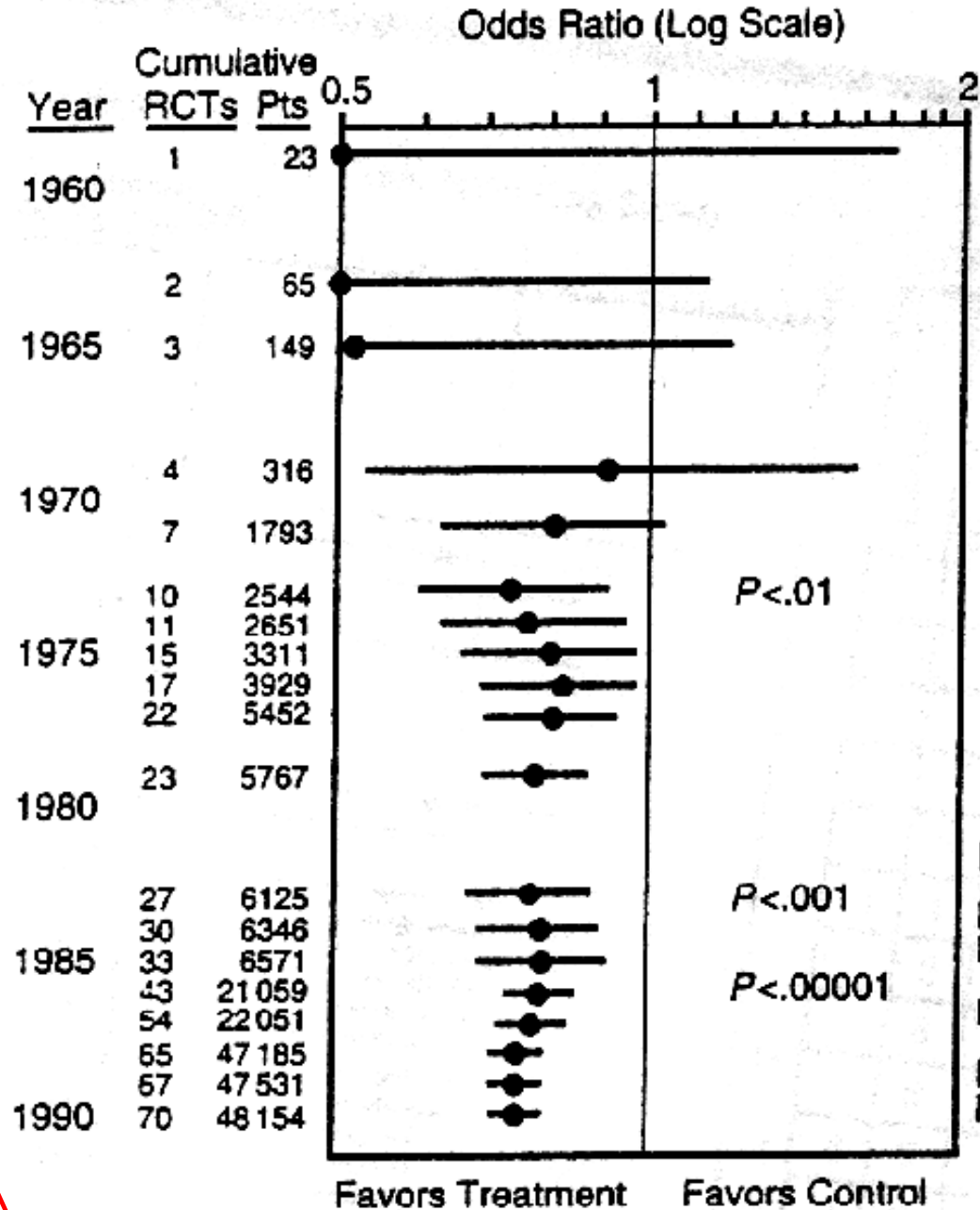
- A review of existing knowledge that uses explicit, scientific methods:
 - Structured and transparent process
 - Comprehensive search for relevant articles
 - Explicit methods of appraisal and synthesis
- Summarizes methods and results of similar but separate studies
- May or may not combine results quantitatively (meta-analysis)

Explicit framework for rigorous SR Vs. reviews conducted as low cost, ad hoc, un-structured, grad student level, endeavor...



Dickersin: A “cumulative meta-analysis” showed us how important it is that we synthesize what we know in an **ongoing** fashion

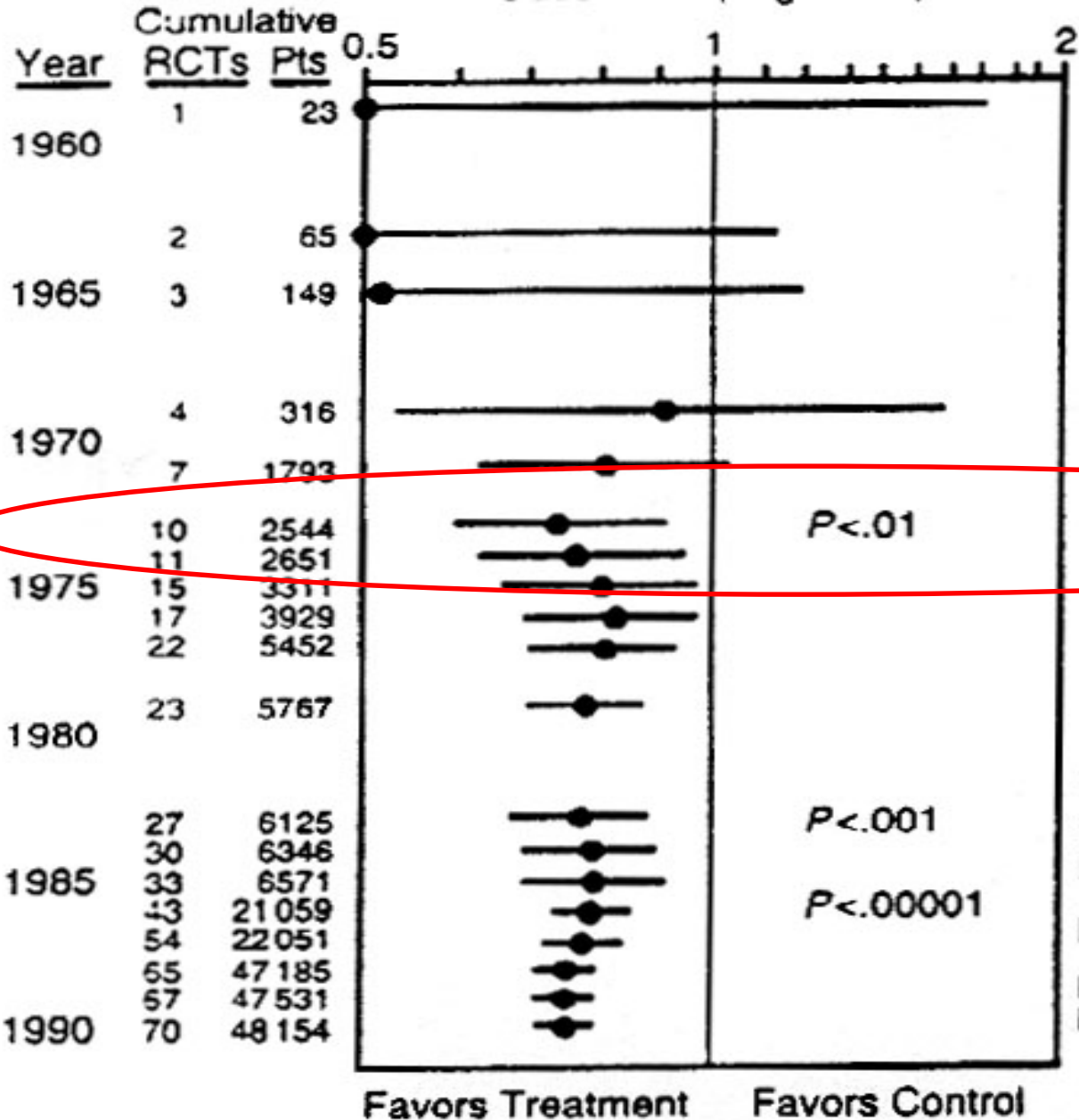
A. Thrombolytic Therapy



Allows updating!!!

A. Thrombolytic Therapy

Odds Ratio (Log Scale)



Textbook/Review Recommendations

	Routine	Specific	Rare/Never	Experimental	Not Mentioned
					21
					5
				1	10
				1	2
				2	8
					7
					8
		1			12
M		1		8	4
M		1		7	3
M	5	2		2	1
M	15	8			1
M	6	1			

Dickersin: Who is doing systematic reviews?

- Selected topic areas
 - Clinical interventions
 - Animal studies
 - Assessment of risk
 - Toxicities
 - Methodologists
 - Education
 - Social welfare
 - Crime and justice
 - International development
- Cochrane Collaboration
- Groups interested in policy (professional societies, governments, payers)
 - Dept. Education, EPA, health insurance
- Businesses: Hayes, ECRI (contracting to pharma)

**Not
Agriculture (yet)**

Closer to home: Use of science in conservation policy...



HOME

ABOUT US

INFORMATION FOR...

TRAINING

EE LIBRARY

WORKING GROUPS

Google™ Custom Search

Search

Welcome to CEE - Serving environmental management in the public interest

The Collaboration for Environmental Evidence is an open community of scientists and managers working towards a sustainable global environment and the conservation of biodiversity. The collaboration seeks to synthesise evidence on issues of greatest concern to environmental policy and practice.



**JOIN THE COLLABORATION
(it's free) !**

(read more about how & why by clicking)



**Visit the CEE Environmental
Evidence Journal**



**View the Guidelines for
systematic review in
environmental management**

News Headlines

04/12/13 - Read the latest protocols published in the CEE Library and Environmental Evidence [here](#)

03/12/13 - Systematic Review on the human wellbeing impacts of terrestrial protected areas [Read the full review here](#)

13/11/13 - Follow CEE on twitter @EnvEvidence [here](#)

16/09/13 - Evidence Aid is awarded the Unorthodox Prize 2013. See why Evidence Aid was chosen [here](#)

15/07/13 - 3ie Systematic Review Call. 3ie invites proposals for systematic reviews around seven policy-relevant questions on the

Collaboration for Environmental Evidence now using this framework to improve use of science in conservation policy

Systematic Review Protocol **Environmental impacts of f** **evidence**

Neal R Haddaway, David Style
Environmental Evidence 2013,
[Abstract](#) | [Full text](#) | [PDF](#) | [ePI](#)

Systematic Review Protoco **Does production of oil palm**

Sini Savilaakso, Yves Laumoni
Environmental Evidence 2013,
[Abstract](#) | [Full text](#) | [PDF](#) | [ePI](#)

Systematic Review Protoco **How effective are created c** **review protocol**

Magnus Land, Wilhelm Granéli
Environmental Evidence 2013,
[Abstract](#) | [Full text](#) | [PDF](#) | [ePI](#)

[Open Access](#)



**View the Guidelines for
systematic review in
environmental management**

[regions: a systematic map of the](#)

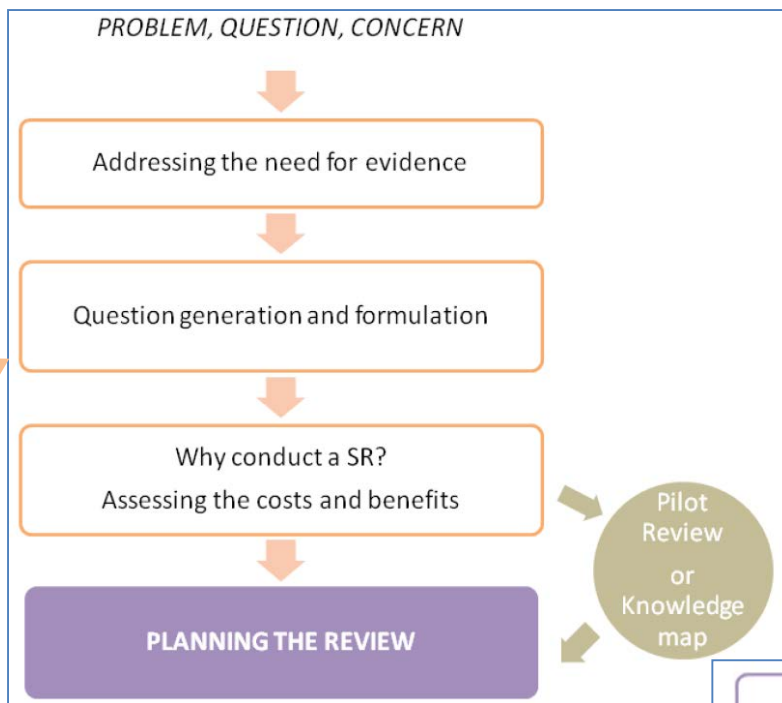
[system functions in tropical forests](#)

[phosphorus removal? A systematic](#)

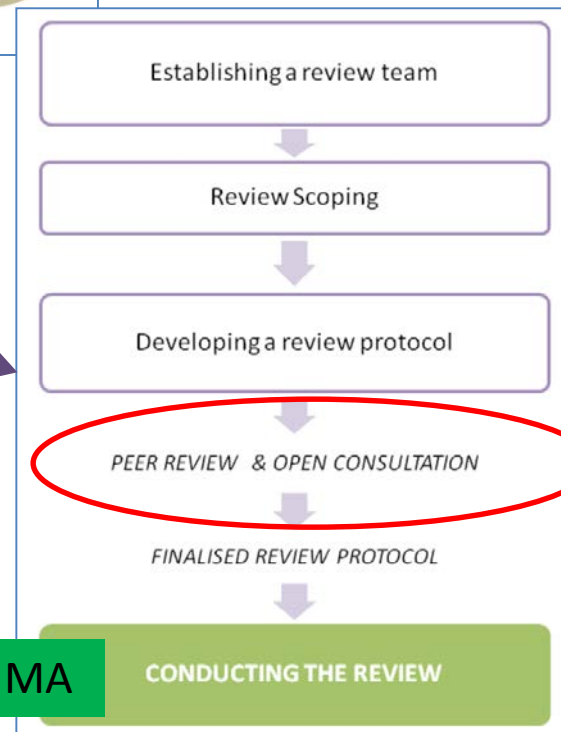
[in S Tonderski, Jos TA Verhoeven](#)

More than Meta-Analysis: Systematic Review (SR) methodology widespread / standard for accessing, appraising and synthesizing scientific information...

Form of scientific inquiry that must be taught...



Collaboration for Environmental Evidence: Guidelines for Systematic Reviews in Environmental Management (Version 4.0, May 2010)



SR process helps ID types of bias in independent studies and give pragmatic quality ranking...

Types of bias:

- Selection
- Performance
- Attrition
- Measurement

“Publication”

Field	Comments
Baseline appropriate / representative	Category (Yes, No, Uncertain) & comment on rationale
Management Intervention relevance	Category (High, Low, Uncertain) & comment on rationale (e.g. if farmer survey, potential confounding factors are distributed across baseline & intervention treatments (improved seed, access to inputs, labor, etc.))
Experiment execution concerns	Descriptive: problems with design relative to question (bias), methods concerns (publication bias if a review), externalities, data loss, attrition
<i>Data Extraction concerns</i>	<i>Not all pieces of data appropriately presented; data in the wrong format; no variance measure</i>
Level of record/data review	Categorical: Peer-reviewed journal (impact factor), other peer-reviewed format, agency report, unpublished data, etc.
Overall subjective quality assessment	Category (High, Medium, Low, Uncertain) with respect only to the a priori question

Extension's Future: A decade of reflection & two “shoulds” for ensuring we are the/an unbiased source of knowledge for mgmt practice and policy in a data-rich world...

Repositories: Make data (Vs synthesized results) available for additional/future research

- Requires:
 - Infrastructure
 - Change in culture
 - Better data hygiene

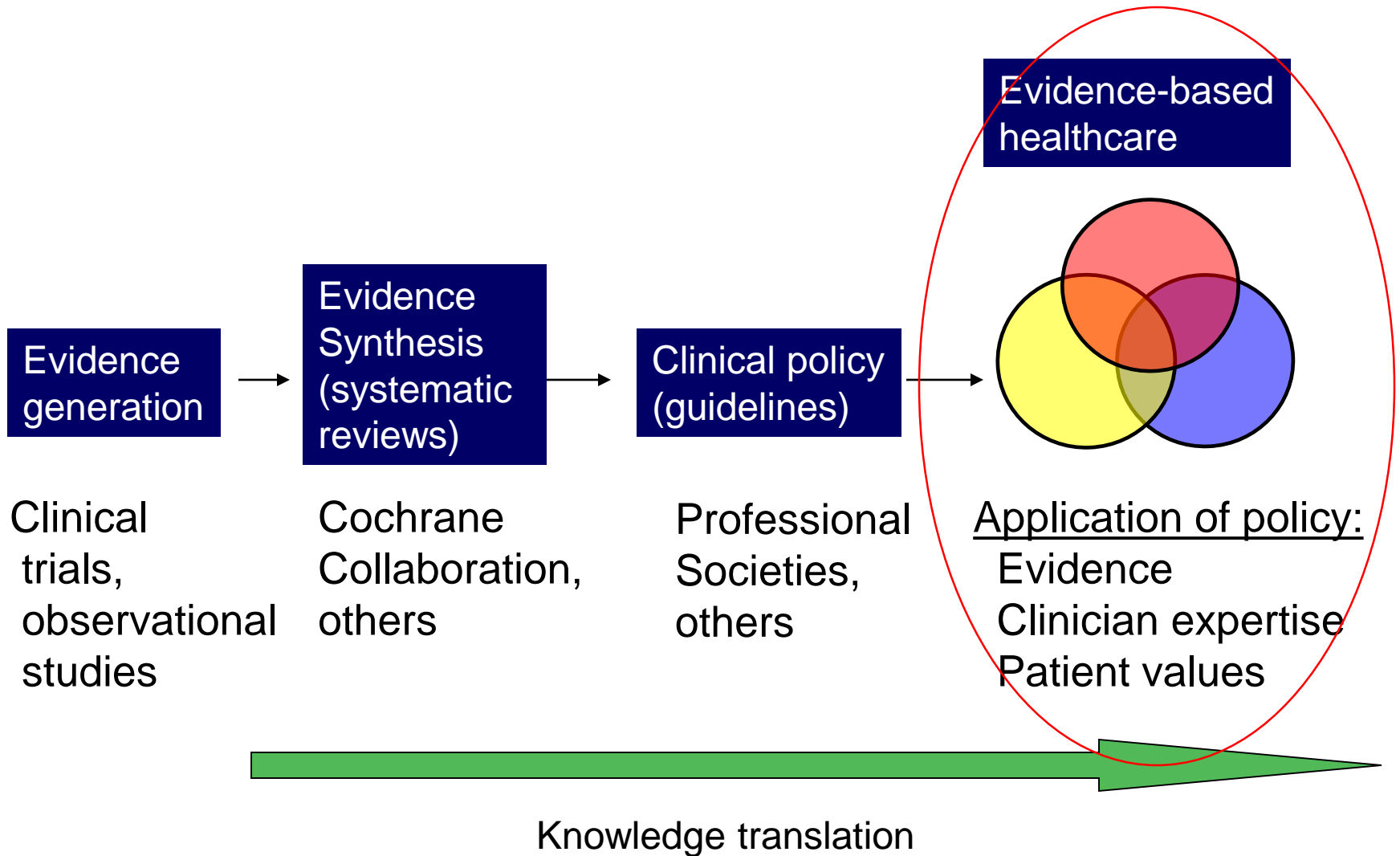
Meta-analysis: Make systematic reviews w/ quantitative methods a “tool of the trade” for tomorrow’s Extension Specialist

- Requires:
 - Infrastructure
 - New knowledge

Goal: Using disparate data – in aggregate – to strengthen “inference space”

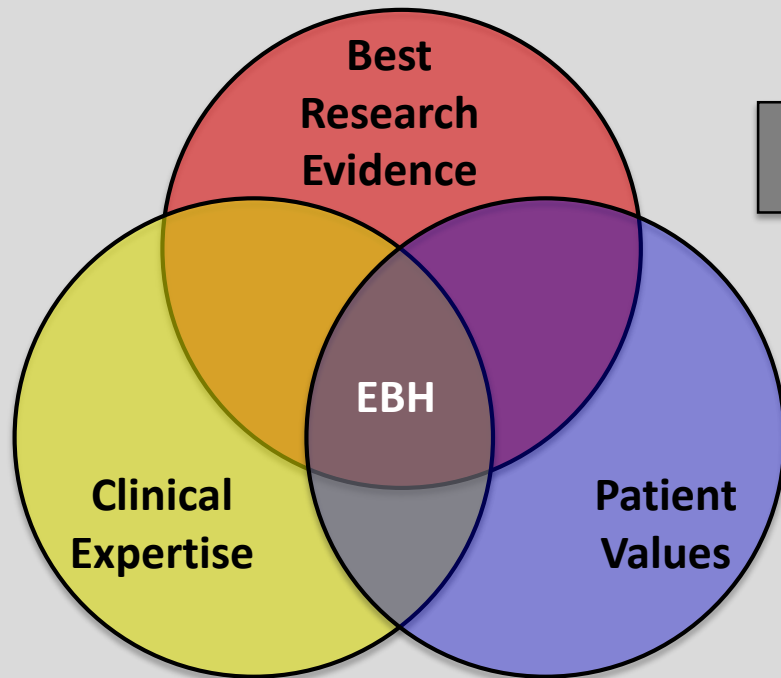


Dickersin: Knowledge translation: From clinical research to practice decisions



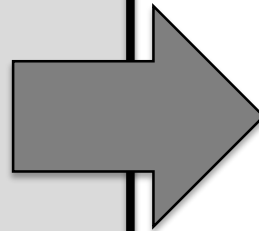
Evidence-Based Healthcare

“The integration of best research evidence with clinical expertise and patient values”



Evidence-Based Agriculture

“The integration of best research evidence with management expertise and stakeholder priorities?”



Sackett, 2000. Referenced in Dickersin, K. and M. Mayer. 2012. Understanding evidence-based healthcare: A foundation for action. US Cochrane Center. Available online at <http://us.cochrane.org/understanding-evidence-based-healthcare-foundation-action>

T. Scott Murrell, IPNI

Who has data w/ potential for evidenced-based ag. in the clinical setting... e.g. for a fertilizer rec. or for policy on conservation structure installation/cost share, etc.?

Intensive research (fewer)

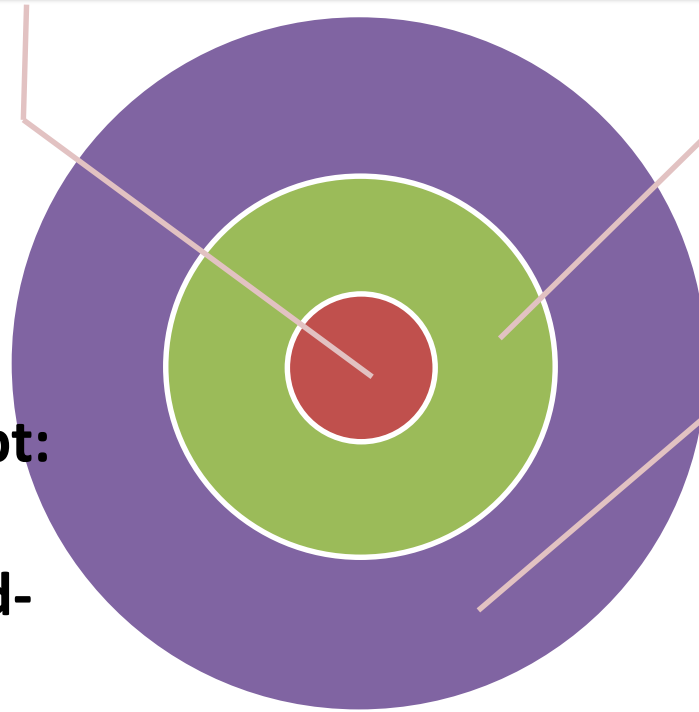
- Long-term exp. w/ regionally relevant benchmark trts for "Mitigation" mgmts
- Evolved agro-ecosystems w/ data records
- Intensive C/N/H₂O measures

Replic. / Demo. exp (more)

- Fully-replicated, experiments
- Newly est. trts. of imp. mgmt. variants.
- High risk &/or emerging tech.
- Less intensive routine measures + targeted sampling campaigns

Commercial Sites (many)

- Farmer Practice vs. improved mgts. (EI)
- "Adaptive Mgmt." approach
- Limited # of trts. & measures
- Focus on trts. w/ near-term, measurable impacts



**New Concept:
"Living
Recommend-
ations"**

“Smarter Agriculture” ~ New Curriculum for DIL

Better data skill sets (Data Information Literacy curriculum)

Data skill sets / DIL

Better framework for organizing & systematically reviewing data as it accumulates

Structured analytical framework

Data repositories

Better place to store data



Purdue sees fantastic opportunities for education mission...

Smarter Ag Workshop: Sample stakeholder feedback ~ Farmer participation in **“open access” data & the data value chain requires...**

- Data Modification: Scholarly data not directly useful to farmer – data needs to be subsetted/distilled in the context of important questions.
- Access to more environmental data (weather & climate specified)
- Data “translation” tools for multiple users
- Multiple forms of delivery to span synthesis for quick digestion (“does it work?”) to more nuanced analysis for iterative practice improvement (“adaptive mgmt.”)
- Protocols & minimum datasets for on-farm research; farmer input must be sought & protocols should not be arbitrarily inflexible
- (Privacy / security policy – assumed to be taken care of?)

Blending different ag data streams at different ed. levels requires new skills & DIL curricula (**“Library Sciences should be solicited to educate all...”**)

Future farmer or ag. industry employee (BS level)

- Everyone needs environmental info. mgmt that teaches how data are produced/used (“data in my life”)
- Array of educational trajectories are needed from most basic level to specific endpts.
- Future farm managers need data skills in context of business mgmt & systems analyses
- Be able to understand data from outside their degree & be able to ascertain data quality

Future consultant, CCA, policy maker, Agent, Ext. Specialist (MS, PhD level)

- Understand exp. design, statistics & probability (risk)
- Understand geospatial data
- Curricula should use open-source software & “workforce-available” statistical tools
- Be able to translate science into lay language w/ context
- CCA: Certificate in Ext. Prgm should cover 12 data competencies
- Capstone data experience
- Ext. Spec. competent in Systematic Reviews; data mgmt plans / repositories part of degree