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Spider Plots: A Tool for Participatory Extension Learning

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Abstract: Here we demonstrate how spider plots can be used in a participatory fashion to simultaneously assess the performance of agricultural systems. We present how we used spider plots to assess ecosystem services from cover crops at a field day and suggest how the activity can be adapted to other purposes. We conclude by providing recommendations to educators for successfully facilitating a participatory assessment using the spider plot.

Participatory Learning

Increasingly, stakeholders are requesting hands-on, interactive workshops that teach meaningful skills and information (Barbercheck et al., 2009). Participants who learn new skills by doing them are more likely to adopt those skills (Sturdy, Jewitt, & Lorentz, 2008) or adapt them to meet their own needs and circumstances (Green, Mills, & Decker, 1993). Participatory techniques are particularly well suited to adult learners, who learn through relational situations and whose diverse experiences can provide rich sources of knowledge (Knowles, 1990; Ota, DiCarlo, Burts, Laird, & Gioe, 2006).

Even though interest in methods that are flexible, interactive, and critically reflective is growing (Foster, Norton, & Brough, 1995; Franz, 2007; Green et al., 1993), there are few participatory learning tools available to Extension educators. Here we present a multi-criteria tool that engages stakeholders in the learning process.

The Spider Plot

The spider plot can assess the performance of multifunctional systems. Relevant performance indicators are selected and assigned an axis on a multidimensional plot. All axes share a common origin and are scaled equally, with optimal values distant from and least desirable values closest to the origin. The data for each indicator are ranked and plotted, and a line is drawn between plotted values on each axis to form a polygon. The larger the polygon, the better the system performance. Symmetrical polygons reflect a relatively balanced system, while asymmetrical polygons reveal functional strengths and weaknesses. Spider plots simultaneously convey the performance of multiple factors and provide a means to compare between systems without the need for interpretation of large data tables.

Spider plots, also termed "radar" (Rankin, Fayek, Meade, Haas, & Manseau, 2008) and AMOEBA plots (ten Brink, 1991) have been used to assess the economic, ecological, and cultural performance of systems (Bell & Morse, 2008; ten Brink, 1991; Gomiero & Giampietro, 2001). Displaying actual data, they can be used to evaluate the performance of any multifunctional entity, including a cropping system, farm, community, program, or organization. Spider plots can also be used as a conceptual model to compare trade-offs from hypothetical scenarios, like the potential effects of different land uses on ecosystem services (Foley et al., 2005) or the ecological impacts of different policies.

The spider plot is ideal for participatory learning because it involves stakeholder participation at multiple stages. Through interactive discussion, participants can decide upon relevant indicators and data to collect. Participants collectively gather the appropriate data and complete spider plots for one or more systems. The resulting graph provides a focal point for critical reflection and discussions about the performance of those systems.

Using the Spider Plot

The purpose of our activity was to assess ecosystem services provided by different cover crops while learning to use a multi-criteria decision-making tool to compare the potential benefits and limitations of different cover crops. The activity focused on evaluating the performance of five cover crops: two fall-planted (wheat and a mixture of rye and hairy vetch) and three spring-planted (mustard, buckwheat, and a mixture of pea and triticale). We developed the ecosystem service indicators before the event because our activity was limited to 1.5 hrs. A more participatory and educational approach would be to have workshop participants select and prioritize indicators. We assessed nutrient cycling, nutrient retention, soil quality, weed suppression, and beneficial insect habitat (Bowman, Shirley, & Cramer, 1998) and chose indicators (Table 1) that could be measured easily and rapidly in the field.

We grouped the indicator axes of the spider plot into aboveground and belowground processes (Figure 1). This helped to organize data collection, focus group discussions, and make the graph intuitive. We used a standard method for measuring the indicators and ranking the data (Table 1) based on literature values (Bowman et al., 1998; Brady & Weil, 2002). When optimal and suboptimal values for indicators were not available, we based the rankings on our own observations. For example, when evaluating the ability of the cover crop to suppress weeds, we assigned a weed density of 30 or more weeds per 2.69 ft² (0.25 m²) quadrat as low (rank = 1). While this brings subjectivity into the ranking system, the educational value of the spider

plot is not necessarily in its scientific application, but in its practical use. Stakeholder involvement in indicator development ensures that the spider plot reflects the practical reality of the system being assessed.

Figure 1.
Spider Plot Diagram Used To Evaluate Ecosystem Services from Cover Crops

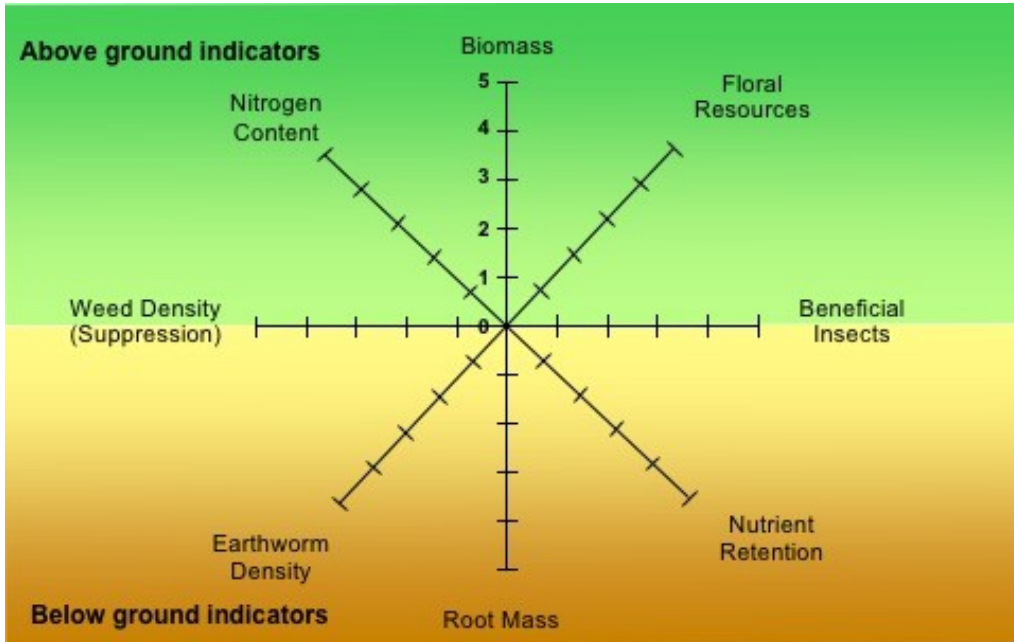


Table 1.
Ecosystem Service Indicators Used To Evaluate Cover Crops

		Ranks				
Indicators	Sampling Unit	1	2	3	4	5
Beneficial Insect Diversity (# of different groups)	2 min. observation	≤ 1	2 ≤ 3	4 ≤ 5	6 ≤ 7	≥ 8
Floral Resources (% floral cover)	2.69 ft ² quadrat	1 ≤ 19	20 ≤ 39	40 ≤ 59	60 ≤ 79	80 ≤ 100
Weed Density (#/2.69 ft ²)	2.69 ft ² quadrat	≥ 30	20 ≤ 29	10 ≤ 19	1 ≤ 9	0
		≤ 5,999				≥ 12,000

Cover Crop Biomass (lbs/acre)	2.69 ft ² quadrat		6,000 â≤ 7,999	8,000 â≤ 9,999	10,000 â≤ 11,999	
Nitrogen Content (lbs/acre)	2.69 ft ² quadrat	≤ 29	30 â≤ 59	60 â≤ 89	90 â≤ 119	≥ 120
Cover Crop Root Mass (lbs)	1 shovel full of soil	≤ 0.01	0.02 â≤ 0.04	0.05 â≤ 0.07	0.08 â≤ 0.10	≥ 0.11
Earthworm Density (#/2.69 ft ²)	1 shovel full of soil	0	1 â≤ 3	4 â≤ 6	7 â≤ 9	≥ 10
Nutrient Retention (C:N of plant residue)	Not applicable	10 â≤ 19	20 â≤ 29	30 â≤ 39	40 â≤ 49	≥ 50

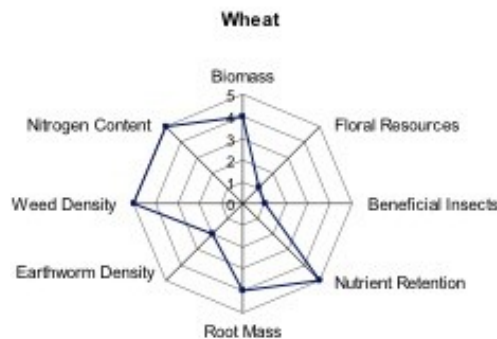
Leading the Exercise

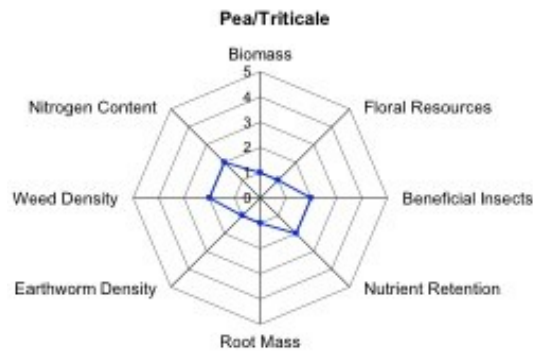
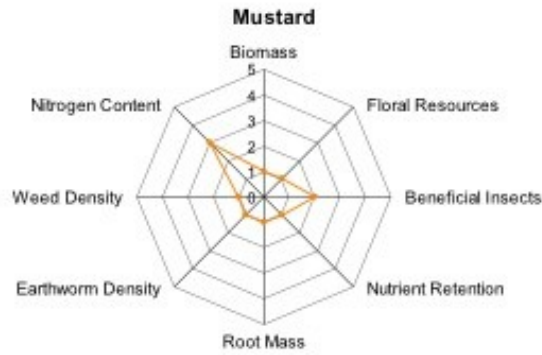
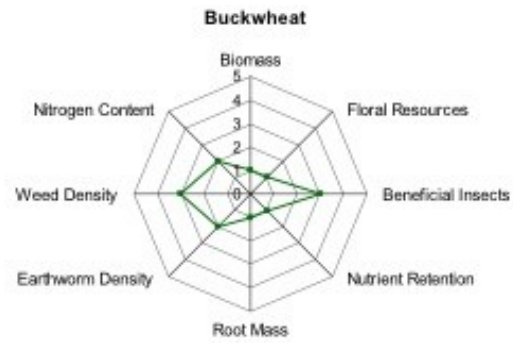
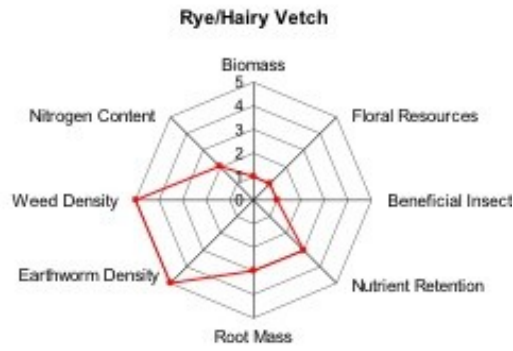
Depending on numbers, participants may be organized into several small teams for data collection. We recommend having assistants to help facilitate the activity. As in many hands-on activities, participants will have questions and comments regarding data collection and their observations. A detailed protocol and instructor's guide for this activity is available at <<http://agsci.psu.edu/organic/academic-courses>>.

After the data are collected, the groups can plot their ranked data on the spider plot. If more than one team is assigned to evaluate a cropping system, each can use different colored markers on the same spider plot to compare results. The final step is to discuss as a group the results for each crop (Figure 2).

Figure 2.

Spider Plots of Ecosystem Service Indicator Data Collected from Five Different Cover Crops Created by Field Day Participants





Adapting the Spider Plot

Spider plots can be adapted to stakeholder needs. For example, some participants may have preferred alternative indicators, such as water infiltration, soil compaction, or percentage cover. These indicators can be added as axes or substituted for indicators of less interest. Stakeholder involvement in identifying and prioritizing the indicators can provide opportunities for needs assessment, which can inform Extension program development. Finally, while we focused on ecological indicators, social and economic indicators (e.g., revenue, labor, and social capital) could be incorporated into a spider plot (Bell & Morse, 2008).

Planning for Success

Participatory activities generally involve considerable logistical coordination. To ensure the activity progresses smoothly, we offer several recommendations.

- First, practice the exercise with volunteer participants. The dry runs provide an opportunity to test equipment, assess field conditions, and determine the time frame for the exercise.
- Second, recognize that participatory workshops are reflexive and require more facilitation than do lecture-style presentations. Educators can strengthen their facilitation skills by participating in experiential learning and facilitation workshops and by referring to the literature (Brookfield, 1986; Silberman & Auerbach, 1990).
- Finally, create a climate conducive to learning (Knowles, 1990). If weather and field conditions are limiting, consider mixing outdoor activities like data collection with indoor activities like group discussion.

While a participatory activity can be more challenging than a traditional presentation, the learning process can be extremely rewarding and transformative for both participants and presenters.

Evaluation of the activity revealed that 100% of the participants thought that the instructional techniques moderately (47%) or considerably (53%) improved their ability to understand the presented concepts. In particular, participants' understanding of ecosystem services increased from 38% prior to the event to 95% after participating in the assessment using spider plots.

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