Optimizing Human Health and Nutrition:
AFRI SAS From Soil to Society
Year 3 Social Media Study
Appendix A – Methodology and Limitations

The USDA AFRI SAS Soil to Society project (S2S) has requested the external evaluators of the Office of Educational Innovation and Evaluation (OEIE) to assist in the evaluation of their program. As a part of these services, OEIE has gathered the project's social media data from X (formerly, Twitter) and LinkedIn between August 2023 through August 2024. The data was then analyzed and prepared as an infographic. The information provided is intended to assist the program gather evidence toward their project goals of outreach and information dissemination as well as provide insights into how to optimize the use of the project's social media accounts. Appendix A provides an overview of the methodology employed in this pilot study, in addition to its limitations. Appendix B provides the summative results of the pilot study.

Methods

Data Collection

As mentioned previously, data was collected between August 2023 (where the previous social media study ended) and August 2024 to allow enough time for analysis and preparation for the annual meeting. All data that was publicly accessible and retrievable through the platform's internal analytical software were collected. Due to the differences in data types and data retrieving tools available from platform to platform as well as new paywalls, the data collection methods and the type of data available varied as such (see Appendix B for a full list of metrics gathered):

- X: Due to changes in X's data mining accessibility, Atlas.ti23's API was disabled for an unknown time and details provided in the internal data export were less detailed than the last study. As such, each post was opened, saved as a JPEG or PNG, then metrics were recorded from the expanded post analytics.
- LinkedIn: LinkedIn data was collected through the LinkedIn analytics for the Soil to Society LinkedIn page. As LinkedIn was not included in the Year 3 social media analysis, there is no comparison to prior year's data. During the data collection window, visitor analytics data was not available through LinkedIn analytics due to the relatively low number of unique visitors to the project page.

For a discussion on limitations, please refer to the section on limitations below. When applicable, duplicate posts were removed and self-comments were excluded from analysis.

Data Analysis

After data was compared and optimized for accuracy, all data was inductively coded for naturally occurring themes using Microsoft Excel and the qualitative software Atlas.ti23 (a computer-aided qualitative data analysis software or CAQDAS program). Atlas.ti23 is a software that does not analyze data but rather is a tool that supports the process of systematic qualitative data analysis (Friese, 2019).

Thematic analysis was employed to analyze qualitative data by searching for repeated patterns of meanings across a given dataset (Percy, Kostere, & Kostere, 2015). These themes were collected with respect to the content of the post message itself, the type of media that was used in the post (i.e. image, URL link, video) if at all, and the hashtags used. By coding 'ground up' from the data as opposed to coding with presupposed theories and frameworks, the analysis results yield a more accurate reflection of perceptions and beliefs of the social media posts (Braun & Clarke, 2006; Glaser, 1992). Data were coded

independently and then compared for intercoder reliability and consistency. Upon agreeing on consistent codes and themes for intercoder reliability, the social media data were coded accordingly and then the frequencies of code occurrences were quantified for further analysis. Thematic analysis yielded several themes that are documented and summarized in Appendix B.

To see if there was a relationship between these thematic components and post interaction metrics (i.e., if utilizing images in posts garnered more attention than a URL link), OEIE used Atlas.ti23 to run co-occurrence correlations (relative frequencies only; not a significance test) between themes and interaction metrics respective to the platform being analyzed, then visualized the results in Atlas's force-directed graphs (see Appendix B for results).

Limitations

The social media pilot study comes with the following limitations that should be heeded when considering the findings of the analysis:

- Metrics vary by platform and how they are measured. As such, definitions have been provided (see infographic) to help navigate discrepancies in metrics. When comparing results, one should keep in mind that definitions may vary and thus may not be completely comparable across platforms.
- Data analysis relied on correlations; however, they may reflect user's posting behavior as well.

Because of these limitations, the social media analysis results should be considered as representative of overall patterns and trends rather than a precise portrayal of social media interactions.

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Appendix B – Compiled Results Summary

The following provides summary tables of the descriptive statistics of the metrics gathered by each platform, along with a visualization of average engagements and impressions by month. The descriptive statistics are then followed by an overview of force-directed graphs and their brief interpretations. Additional data (i.e., list of hashtags and frequencies) that were too expansive to include in this appendix can be provided upon request. Media and content themes are the naturally occurring themes that were inductively coded from the types of media included in a given post (former) and the actual content of the posts' message (latter). Please refer to the infographic for other metric definitions.

From the results below, it can be interpreted that the Soil to Society (S2S) project's social media efforts have been useful platforms through which project information and awareness can be disseminated. The primary evidence for this notion is derived from the above-average engagement rate of viewers with LinkedIn (550% greater) and X (540% greater) compared to their respective platform standard rates identified by Adobe Express (2022; See Table 6; Note that few sources on standard rates could be found). This is particularly impressive considering that in comparison to the previous year's analysis of X, the average of interaction metrics have decreased, hence the previous year was likely even higher than the standard (LinkedIn was not analyzed in the previous year so no comparison is available).

Posting suggestions for leadership can be gleaned from the results by comparing themes found and their associations with interaction metrics. From the bar graphs in Figures 1-4 that depict average engagement behavior compared to posting behavior, there appears to be no strong correlation between the volume of posts and interactions just like last year. From these results, it can be inferred that posting more or less will not necessarily impact interactions. Furthermore, it can be inferred that the analysis results here forth may be more robust, reflecting actual patterns of interactions with content themes, post timing, media content, etc. as it may be less influenced by the volume of posting. Lastly, from a visual analysis, there are some consistent trends across the seasons for interactions to be higher in the Fall and Spring (Figures 1-4), which is understandable as this reflects University activity as well. These natural highs and lows of interactions can likely be anticipated in the future and thus should not be taken as a user issue if posts do not receive as many interactions during the low seasons. Taking these caveats into account, the following suggestions are based on observed results:

- **Posting Days:** Posting days by platform be considered when posting on the respective platforms if leadership wishes to optimize the impact of their social media. For these platforms, Tuesday and Thursday appear to be ideal by association with the highest interaction metrics whereas the weekend and Mondays are least ideal.
- **Posting Times**: Time of posts was not available for LinkedIn. For X, however, the ideal posting times by association with the highest interaction metrics to optimize interactions are 13:00 or 17:00, which is similar to the previous year's window of 15:00-17:00.
- **Post Content:** Like previous years, post content that involves acknowledgement (shoutouts) to team members or the team in general as well as education and outreach content receive the highest average interaction metrics (Table 6; Figures 5 and 8). Leadership should consider continuing to post this content to optimize interactions. Working with extension and perhaps

including team member spotlights may be also helpful in creating consistent content within these themes while facilitating inter-team interactions.

- **Media Content**: While the media content themes associated with the highest-interactions (images of team members at events and links to articles) were in relative congruence this year between LinkedIn and X, they depart from the previous year's themes of informational images (Table 6, Figures 6 and 9). Overall, perhaps a broader theme of images of project related content, whether it is project information or team members engaging in events, should be considered for future posting content to optimize interactions.
- **Hashtag Use**: Similar to the media content, there was congruence with LinkedIn and X's hashtag use, with #plantbreeding receiving some of the highest associations with interaction metrics. Leadership could consider reviewing this year's and last year's most popular hashtags and see if they can utilize more content in the future with those specific hashtags to optimize interactions.
- **LinkedIn User Demographics**: LinkedIn provides a unique platform from which to collect user demographic data to determine who is interacting with project content. User demographic data was collected and analyzed for a sample of Soil to Society posts (*n*=27; 64.3%). LinkedIn users who directly engage with project posts through reactions or reposts are most frequently researchers who are not members of the project research team and who are not currently employed or studying at a project institution. This provides evidence towards the platform being useful for reaching external audiences. Users most commonly work in the disciplines of plant breeding, agriculture, and agronomy (Tables 3-5).

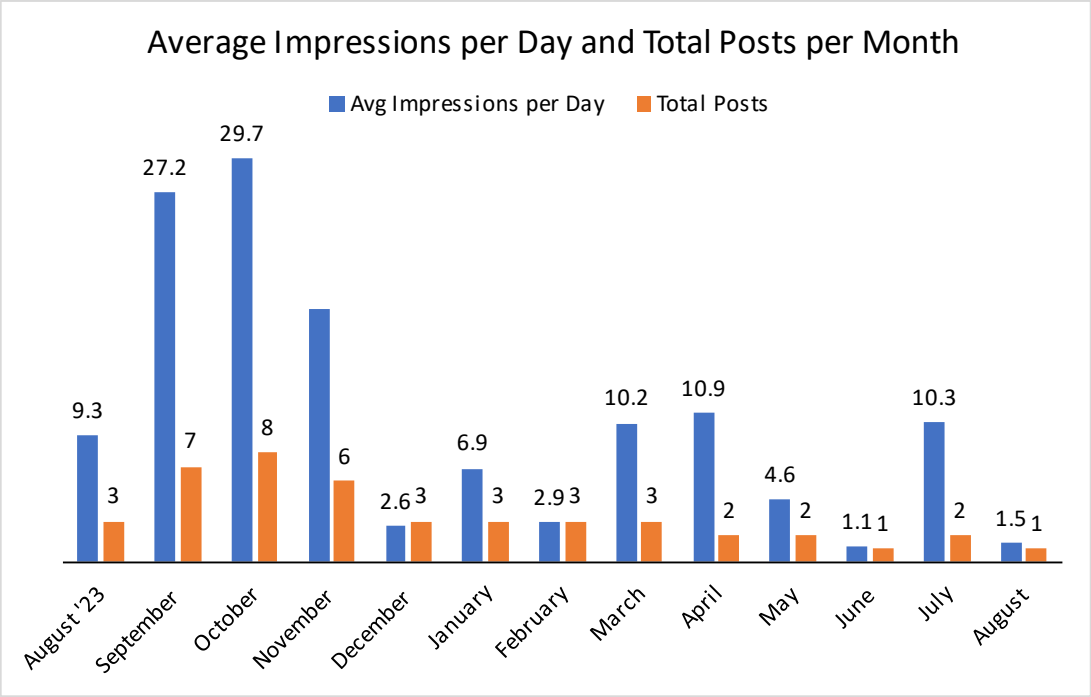
X(TWITTER): Descriptive statistics of post metrics (*n*=44)

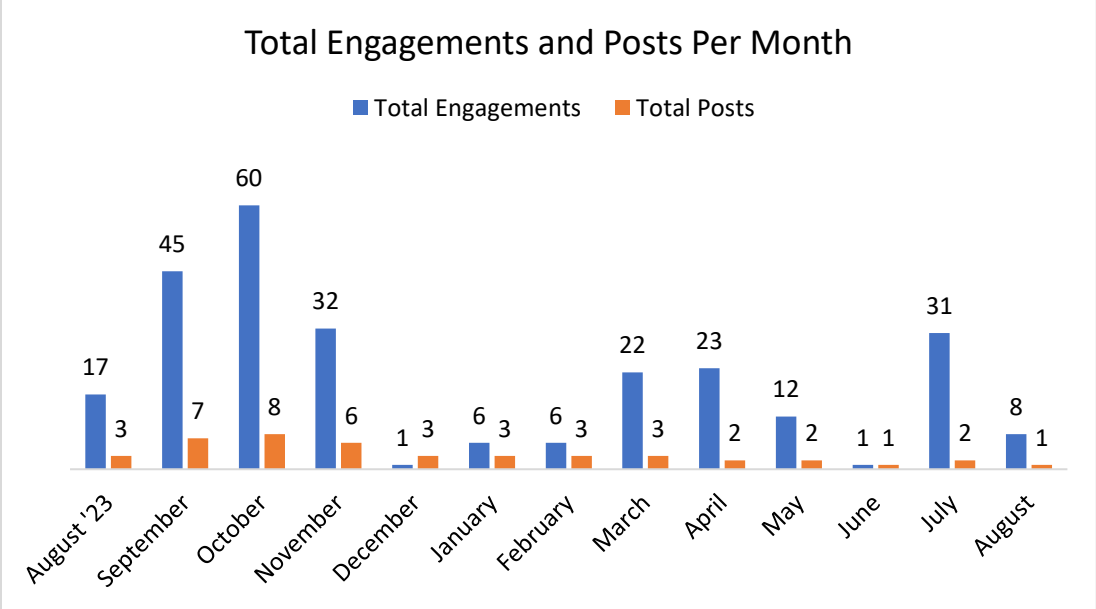
Best days and times to post: Tuesdays and Thursdays (closely followed by Friday) around 13:00 or 17:00.
Least ideal day(s) to post: Mondays

Table 1. Descriptive Statistics for X's Post Metrics

	Engagements	Impression	Reposts	Likes	Detail Expands
Average	6	94	<1	2	<1
Mode	0	58	0	0	0
Max	22	449	3	8	8
Min	0	10	0	0	0
Total	264	4,142	22	87	38

Figures 1-2: Overview of X posting behavior and viewer response metrics by month





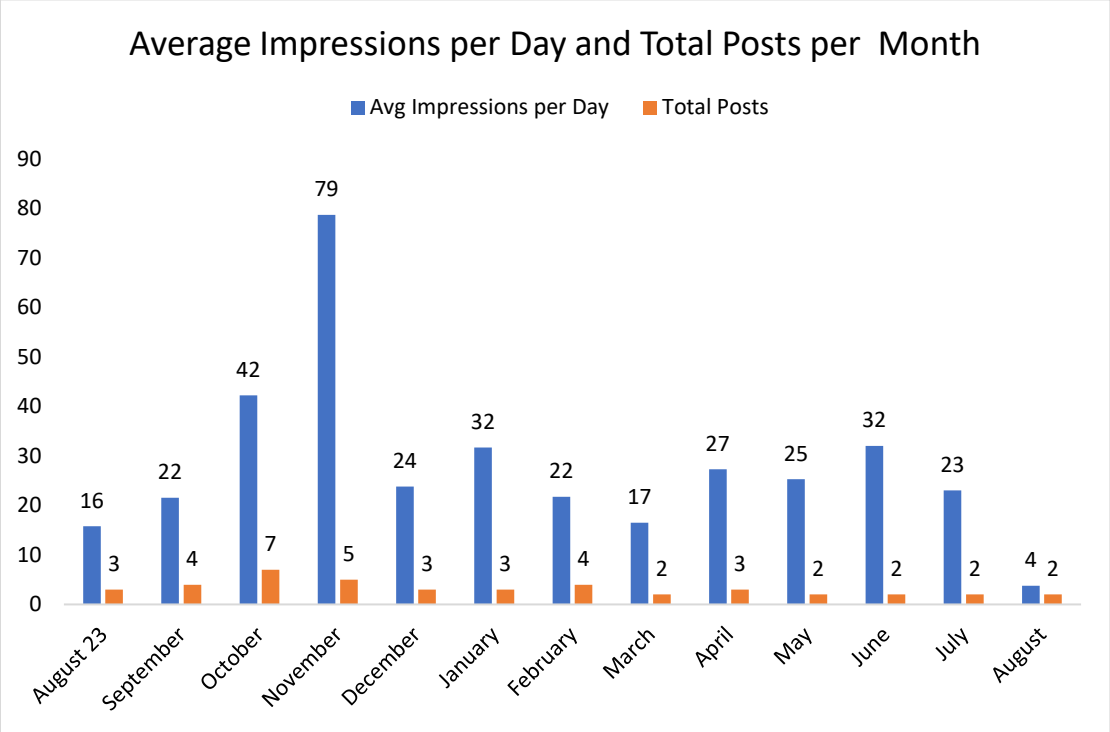
LinkedIn: Descriptive statistics of post metrics (*n*=42)

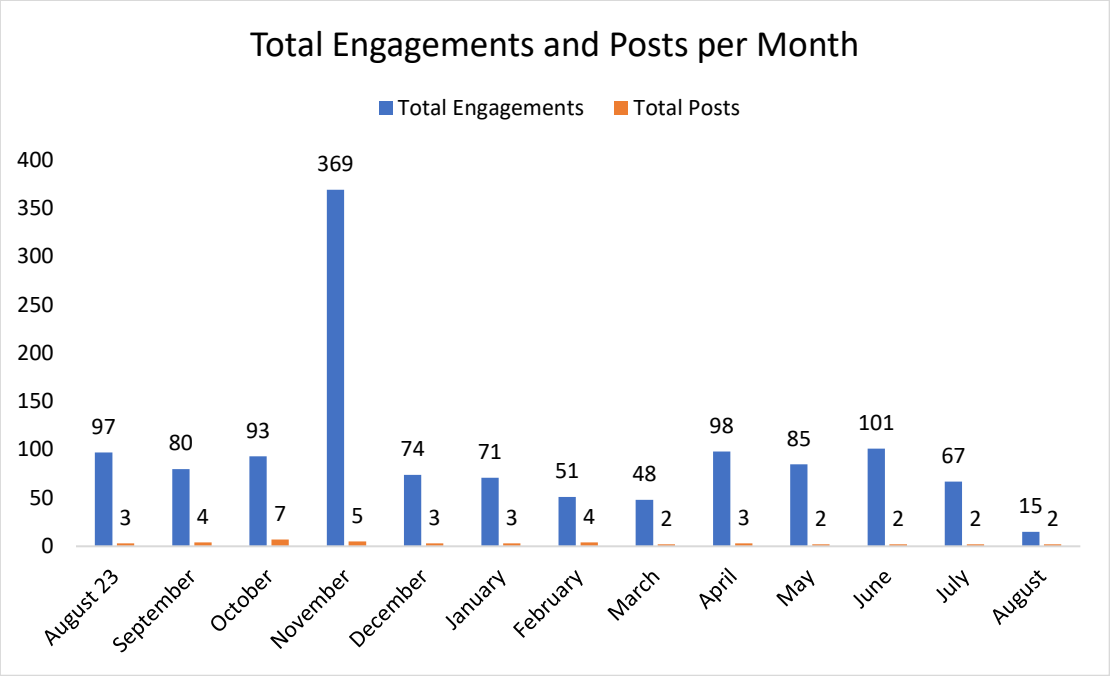
Best days and times to post: Tuesdays and Thursdays. LinkedIn does not provide metrics on post times.
Least ideal day(s) to post: Friday through Sunday

Table 2. Descriptive Statistics for LinkedIn's Post Metrics

Posts	Impressions	Likes	Comments	Reposts	Clicks	Click-through Rate	Engagement rate	Video views
Average	285	11	<1	1	26	0.07	0.13	25
Mode	68	5, 10	0	0	5	0	-	-
Max	1,651	64	7	11	295	0.34	0.64	699
Min	14	1	0	0	0	0	0.01	136
Total	11,969	458	20	51	1,076	-	-	994

Figures 3-4: Overview of LinkedIn posting behavior and viewer response metrics by month





LinkedIn: Sampling of User Demographics (*n*=27)

User demographics were analyzed for a sample of LinkedIn posts (*n*=27; 64.3%). LinkedIn users who engage with Soil to Society posts (*n*=46) are most commonly:

Table 3. Team Member Status and Institutional Affiliation

	Member of S2S Team	From an S2S Institution
Yes	6 (13.0%)	10 (21.7%)
No	40 (87.0%)	36 (78.3%)

Table 4. Disciplines of Profile Visitors

Most Common Visitor Disciplines*		
Plant breeding	7	15.2%
Agriculture	5	10.9%
Agronomy	4	8.9%
Food production/industry	3	6.5%
Education	2	4.3%
Farming associations/groups	2	4.3%
Human health & nutrition	2	4.3%
Soil science	2	4.3%

Table 5. Role of Profile Visitors

Most Common Visitor Roles**		
Researcher	19	41.3%
Entrepreneur	3	6.5%
Agriculture outreach/consulting	2	6.5%
Agronomist	2	6.5%
Graduate student	2	6.5%

*Other less frequently mentioned disciplines included crop science, plant biology, agroecology, microbial ecology, brewing, policy, extension, advertising, medical tourism, language learning, and software development.
**Other less frequently mentioned roles include post-doctoral researcher, extension specialist, policy analyst, grant specialist, producer, brewer, nurse, technologist, account executive, architect, software developer, and sales.

OVERALL INTERACTION SUMMARY: Average metrics per post and top themes by platform
Best days to post across all platforms: Tuesdays and Thursdays
Least ideal day(s) to post: Mondays

Table 6. Overall interaction analysis summary by platform

Platform Averages	Impressions	Engagements	Engagement rate*	Likes	Top Content Theme	Top Media Type	Top Hashtag(s)
X(Twitter)	94	6	6.4% (+540%)*	2	Education/outreach; shout outs to team members	Images of team members at events; links to articles	#nutrition; #plantbreeding
LinkedIn	285	38	13.0% (+550%)*	11	Education/outreach; shout outs to team members	Images of team members at events; links to non-journal articles and partners	#research; #plantbreeding

*LinkedIn "standard engagement" rate is 2% and X(Twitter)'s "standard" engagement rate is 0.5%-1%, according to Adobe Express (2022). The percentages listed within brackets represent the percent difference between S2S's engagement rate and the respective standard provided by Adobe Express. The conservative 1% standard was used to compare X's engagement rate.

ATLAS.TI RESULTS

The qualitative software Atlas.ti23 (a computer-aided qualitative data analysis software, or CAQDAS program) was used to thematically analyze the social media data. Please see Appendix A for methodological details of thematic analysis. Thematic analysis results, in addition to likes, impressions/views, days of the week that the message was posted, and the time of posting, are summarized below. The hashtag data was too expansive to include in this appendix but can be provided upon request.

Table 7. Posts made across the week

Day of the Week	X	LinkedIn
Monday	5	6
Tuesday	12	10
Wednesday	6	9
Thursday	11	10
Friday	10	5
Saturday	0	1
Sunday	0	1

Table 8. Distribution of post likes

Likes	X	LinkedIn
0	14	0
1	6	2
2	12	1
3	4	3
4	2	3
5	1	4
6	4	3
7	0	3
8	1	4
9	0	9
10	0	4
11	0	0
12	0	3
13	0	2
14	0	2
15	0	2
16+	0	3

Table 9. Distribution of the time of posts.

Time of Post	X
900	1
1000	4
1100	5
1200	2
1300	10
1400	2
1500	3
1600	4
1700	8
1800	5

Note. Any time outside of the hours listed here did not receive any posts.

Table 10. Distribution of views and impressions of posts.

Views/impressions	X	LinkedIn
Less than 25	8	1
25-100	21	6
101-200	10	15
201-300	3	8
301-400	1	1
401-500	1	6
501-600	0	0
601-700	0	1
701-800	0	0
801-900	0	2
901-1000	0	0
1000+	0	2

Table 11. Themes of media types used in posts across platforms.

Media Type	X	LinkedIn
Event Link	3	11
Image - Informational	5	6
Image – Planting/farming (Ag/Crops)	4	13
Image – Team members engaged in events	9	13
Image – Other (i.e., scenic, food)	7	9
Link to article (i.e., journal article)	9	4
Link to news article (that's not WSU)	3	14
Link to WSU page (not S2S)	5	9
Link to S2S website	6	5
Link – Other (i.e., another post or profile, blog)	3	8
Video	4	4

Table 12. Themes of post content across different platforms.

Content Themes	X	LinkedIn
Call for hiring (students)	1	1
Call for sign-ups (i.e., newsletter)	3	2
DIY craft/Cooking	3	3
Education/Outreach effort (includes events like SoilCon)	21	25
Partner/external shoutout to S2S	1	1
Project objectives	2	8
Research/research findings	9	13
Shout out of team/team member	14	22
Shoutout to partner/leadership/advisory	8	16
Team progress and events	11	5
Other (i.e., politics, comments of the season)	2	0

Force-Directed Graphs

Force-directed graphs are a unique feature of Atlas.ti23's data visualization package and were used in this analysis to help gain insights into the social media data. Force-directed graphs utilize algorithms that impose similar physics as van der Waal forces onto the data network, based on the correlations between the codes (nodes).

- The **size of the node is** a function of **integration** - the larger the node, the more relationships that node has with other nodes.
- The **length of the 'edges'**, or lines between nodes, is a function of **how strong the correlation is** (a shorter length indicates those two nodes occur more frequently together than with others).
- The **thickness of the edges is** a function of **density** - the more frequently those nodes.

Central themes that emerged from analysis were graphed against different interaction metrics, including likes, reposts (retweets), views, etc. The type of interaction metric varied by platform, hence each visual may have slightly different interaction metrics. The following identifies the highlights of the force-directed graphs for each platform, identifying the top themes and hashtags (as indicated by the strongest relationships with interaction metrics). These top themes can be interpreted as the media type, message content, and hashtags that evoke the greatest interaction response from viewers. It is suggested that these themes be considered when posting on the respective platforms if leadership wishes to optimize the impact of their social media posts.

LinkedIn: Interaction metrics (Likes (15+), engagement rates (0.21+), reposts, Impressions (500+), and clicks (50+)) are most strongly correlated with the following:

- Content themes: Education/outreach; shoutouts to team members
- Media type: Images of team members at events; images of Ag/crops; Links to non-journal articles; Links to partner profiles
- Hashtags: #research; #plantbreeding

Figure 5. LinkedIn Interaction Correlations: Content Themes

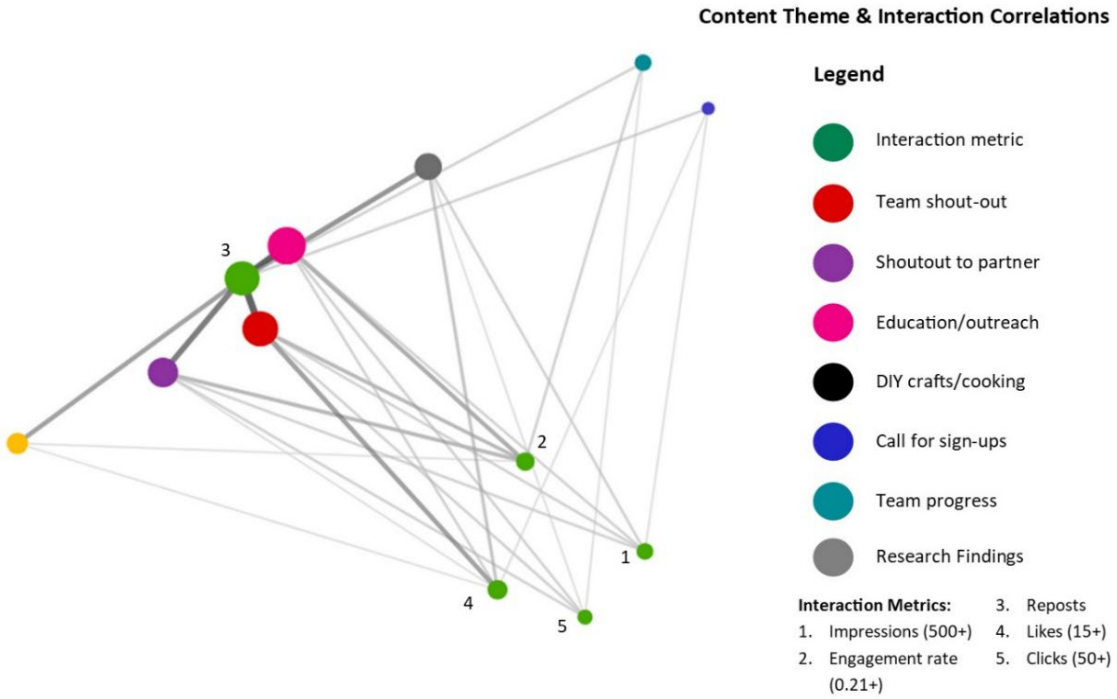


Figure 6. LinkedIn Interaction Correlations: Media Type

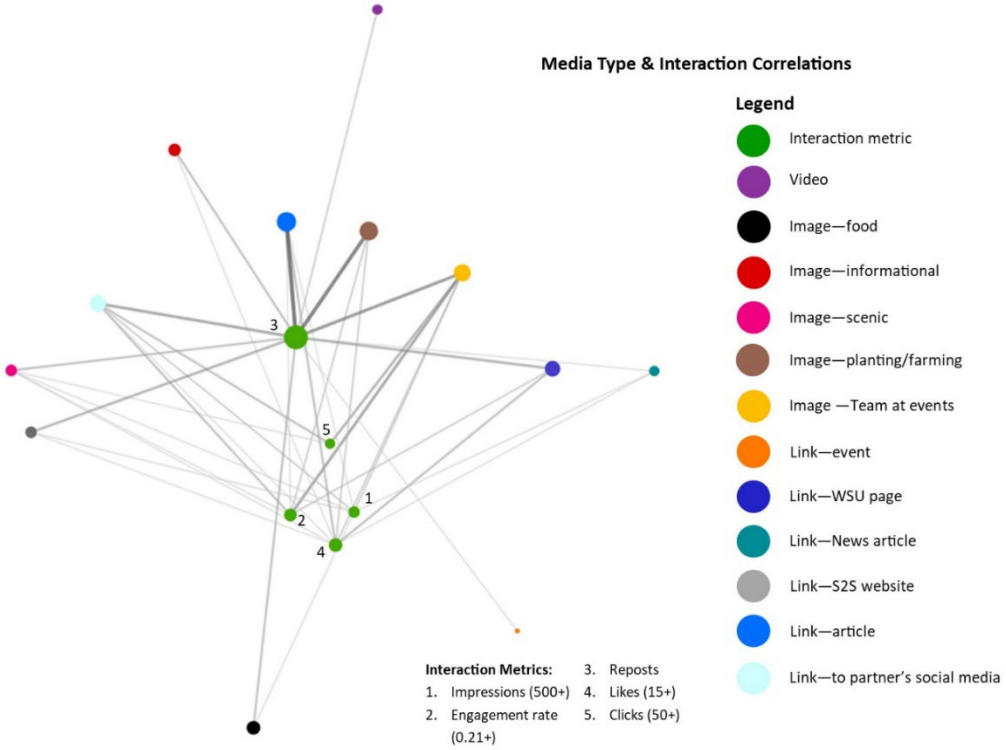
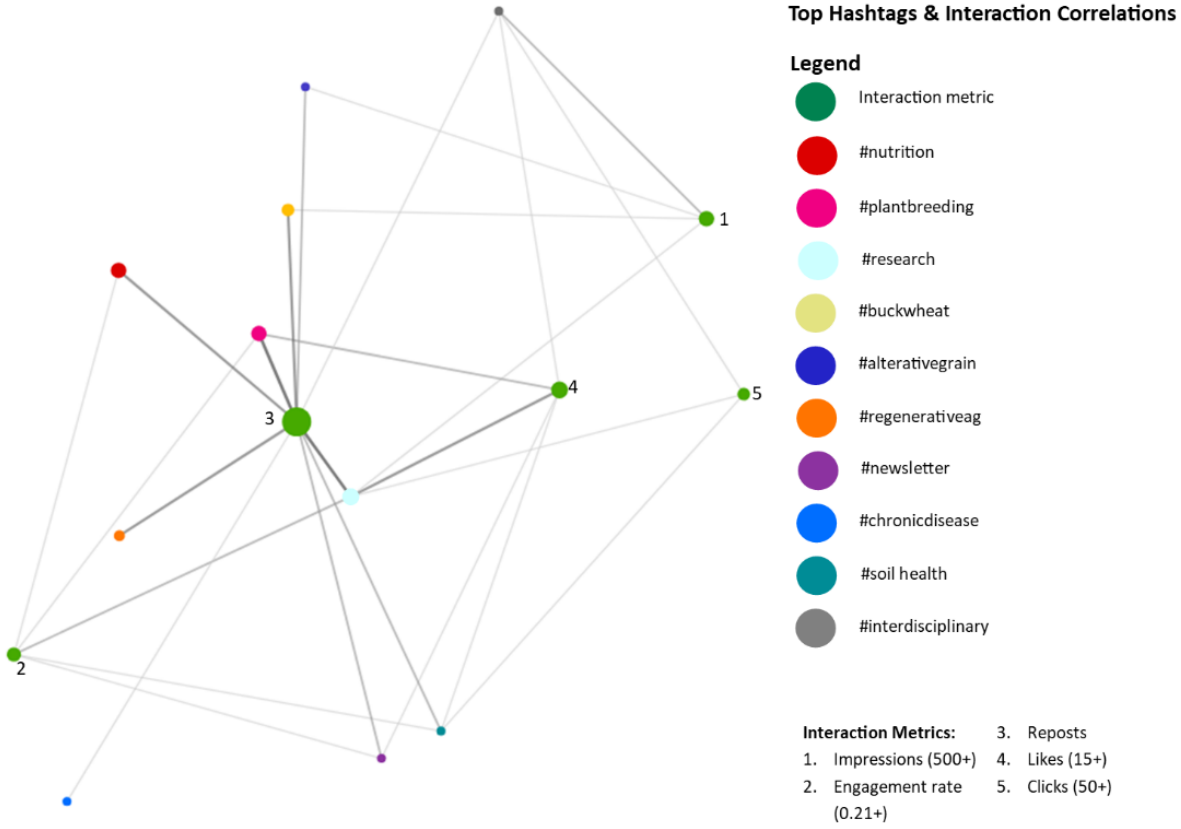


Figure 7. LinkedIn Interaction Correlations: Hashtags



X(Twitter): Interaction metrics (views, likes, reposts) are most strongly correlated with the following themes:

- Content themes: Education/outreach; Shoutouts to team members
- Media type: Images of team members at events; Links to articles (i.e., journal articles)
- Hashtags: #nutrition; #plantbreeding

Note: views in the hashtag force-directed graph were separated out into their subcategories in order to get a better visualization of the data.

Figure 8. X Interaction Correlations: Content Themes

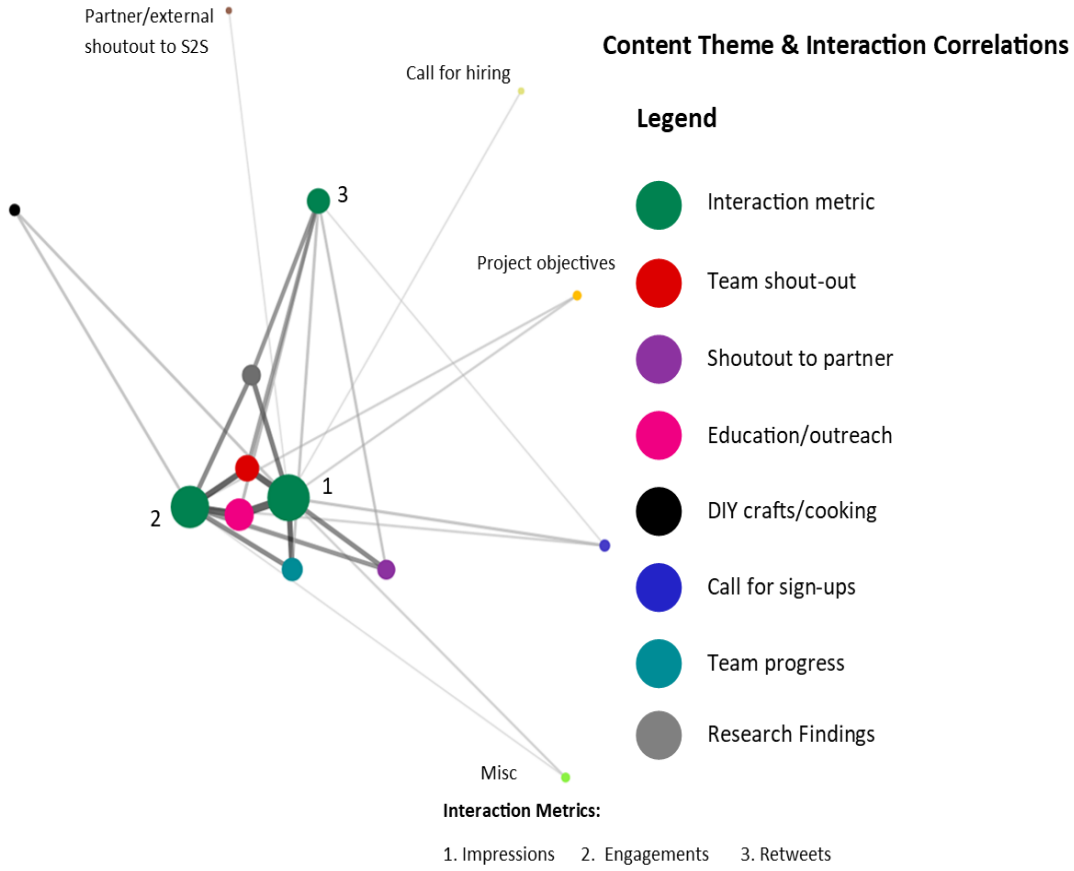


Figure 9. X Interaction Correlations: Media Type

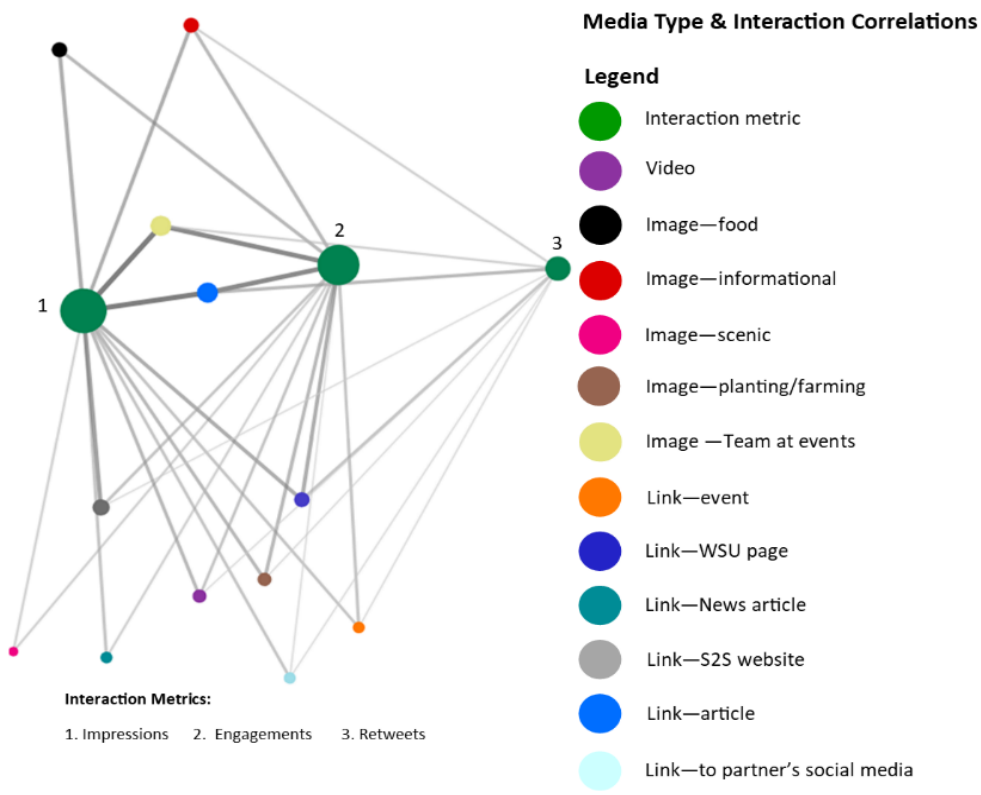
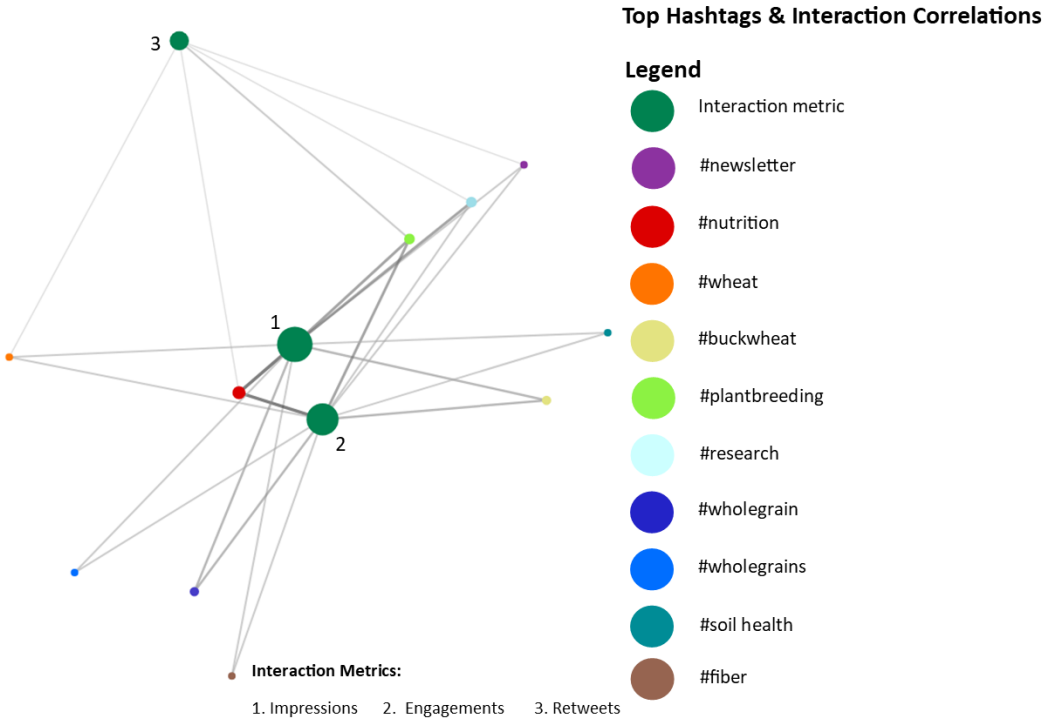


Figure 10. X Interaction Correlations: Hashtags



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