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Fostering Student Engagement and Leadership Development in Integrative Precision Agriculture Across Borders

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Abstract. *Efforts to advance integrative precision agriculture technologies are growing exponentially across the globe with the common interest of upholding food security and developing more sustainable food and fiber production systems. Countries such as the United States and Brazil are among the biggest crop producers in the world and will play an even bigger role in food security in the next decades. It is of utmost importance that countries can advance together to overcome future food production challenges related to land availability and conservation, resource scarcity, and extreme and unpredictable weather changes. Promoting close collaborations among different countries can be a powerful strategy to achieve rapid and more robust developments in the field of crop production using innovative technologies. This premise was the basis for the beginning of a new, and active research collaboration between Dr. Lorena Lacerda's research group from the University of Georgia (UGA), United States of America (USA), and Dr. Adao F. dos Santos's team from the Federal University of Lavras (UFLA), Brazil. This collaboration started with a focus on combining knowledge and different perspectives being implemented in the agricultural sector in both countries to advance precision agriculture practices, and it has developed into an opportunity to engage students by combining research and education. Undergraduate and graduate students in several science disciplines will comprise the next generation of professionals and scientists in the field of precision agriculture. Enhancing their learning experience through the development of critical thinking and leadership skills in a dynamic and diverse environment can be as crucial to their success as learning applied science concepts. To achieve this goal, Dr. Lacerda and Dr. Santos are working to develop a student engagement program across borders by starting an international collaboration between student club organizations in both institutions. Dr. Lacerda is working with two accomplished graduate students to start the Integrative Precision Agriculture Student Club (IPAC) at UGA, while Dr. Santos mentors the Extension and Research Group in Digital*

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Agriculture (GEPAD) at UFLA. In addition to common individual club activities to engage students interested in the field of precision agriculture, and to provide training and guidance, the two clubs will be interlinked through virtual meetings, student exchange opportunities to conduct research, and in-person events. Official activities between the clubs started in 2024 with two events: 1) a week-long visit to UFLA for student engagement activities, workshops, discussions, and a symposium in which UGA students will share the results of their research with stakeholders in Brazil, and with 2) a research exchange opportunity, in which two students from GEPAD will spend several months in the USA conducting research, learning new skills, and engaging with students at UGA. The ultimate goal is to develop and secure a strong and active collaboration between the two institutions through the sibling student associations to foster not only knowledge exchange across borders, but also improve undergraduate and graduate students' learning opportunities and professional development.

Keywords. *Student Leadership, Student Organizations, Precision Agriculture.*

Introduction

Precision agriculture (PA) is a modern agriculture concept that can be defined in multiple ways. Onyango et al. (2021) define PA as a management tool to monitor crops and increase input application efficiency to reduce environmental damage and improve crop management by providing more accurate decisions in space and time. PA has also been regarded as a high-technology management practice that ensures quality production using artificial intelligence and information technology (Raj et al., 2022). The International Society of Precision Agriculture defines PA as a “management strategy that gathers, processes and analyzes temporal, spatial and individual plant and animal data and combines it with other information to support management decisions according to estimated variability for improve resource use efficiency, productivity, quality, profitability, and sustainability of agriculture production”. Irrespective of the definition, efforts to advance integrative precision agriculture technologies are growing exponentially across the globe with the common interest of upholding food security and developing more sustainable food and fiber production systems (Lee et al., 2021).

The adoption of new technologies has shown a great impact on agricultural development throughout history. New technological advancements in sensing, artificial intelligence (AI), and global positioning systems (GPS) have enabled the use of PA on larger scales reaching a worldwide development (Raj et al. 2022). Farmers' interest in PA technologies has also increased, although at a slower pace due to the complexity of handling high data amounts, lack of technical support, issues with software and equipment, and costs (Lee et al., 2021). To overcome barriers to the more widespread adoption of PA practices a multitude of factors, institutions, professionals, and governments are needed to streamline and facilitate the flow of information and knowledge transfers.

Countries such as the United States and Brazil are among the biggest crop producers in the world and will play an even bigger role in food security in the next decades (USDA, 2023). It is of utmost importance that countries can advance together to overcome future food production challenges related to land availability and conservation, resource scarcity, and extreme and unpredictable weather changes. Promoting close collaborations among different countries can be a powerful strategy to achieve rapid and more robust developments in the field of crop production using innovative technologies.

Background

The premise of knowledge exchange between countries was the basis for the beginning of a new, and active research collaboration between Dr. Lorena Lacerda's research group from the University of Georgia (UGA), United States of America (USA), and Dr. Adao F. dos Santos's team from the Federal University of Lavras (UFLA), Brazil. This collaboration started with a focus on combining the knowledge and different perspectives being implemented in the agricultural sector in both countries to advance precision agriculture practices, and it developed into an opportunity

to engage students by combining research and education. Undergraduate and graduate students in several science disciplines will comprise the next generation of professionals and scientists in the field of precision agriculture. Enhancing their learning experience through the development of critical thinking and leadership skills in a dynamic and diverse environment can be as crucial to their success as learning applied science concepts. To achieve this goal, Dr. Lacerda and Dr. Santos are working to develop a student engagement program across borders by starting an international collaboration between student club organizations in both institutions. The ultimate goal is to develop a secure, strong, and active collaboration between the two institutions through the sibling student associations to foster not only knowledge exchange across borders, but also improve undergraduate and graduate students' learning opportunities and professional development.

Initial Activities

Student Organization Framework

Dr. Lacerda is working with two accomplished graduate students to start the Integrative Precision Agriculture Student Club (IPAC or IPA club) at UGA, while Dr. Santos mentors the Extension and Research Group in Digital Agriculture (GEPAD) at UFLA. The IPA club has been officially registered within the University of Georgia system and has 10 members. All current members are graduate students from the Athens and Tifton UGA campuses and are involved in various areas related to PA. The club's proposed activities and framework are centered around five main internal areas related to leadership, professional development, research, career guidance, and social gatherings, and an exchange area in collaboration with GEPAD, the “sibling” club from Brazil (Fig. 1). The main goal of the club is to create a community for undergraduate and graduate students interested in learning more about precision agriculture technologies, develop their technical and interpersonal skills, and become more informed in potential career paths for PA professionals in academia and industry. The club is being supported and sponsored by the UGA Crop and Soil Sciences Department, and the UGA Institute of Integrative Precision Agriculture (IIPA). The IIPA was established in 2022 to serve as a bridge between UGA PA extension, research, education, and outreach and outside partners inside and outside the state of Georgia. The institute has been successful in its 2 years of existence in facilitating multidisciplinary collaborations, providing funding and support for new research and infrastructure, and connecting agribusiness professionals through networking events. The IPA club aims to be an extension of the institute focusing on engaging students from multidisciplinary areas and providing tools for students to be better prepared as future professionals in the agricultural industry.

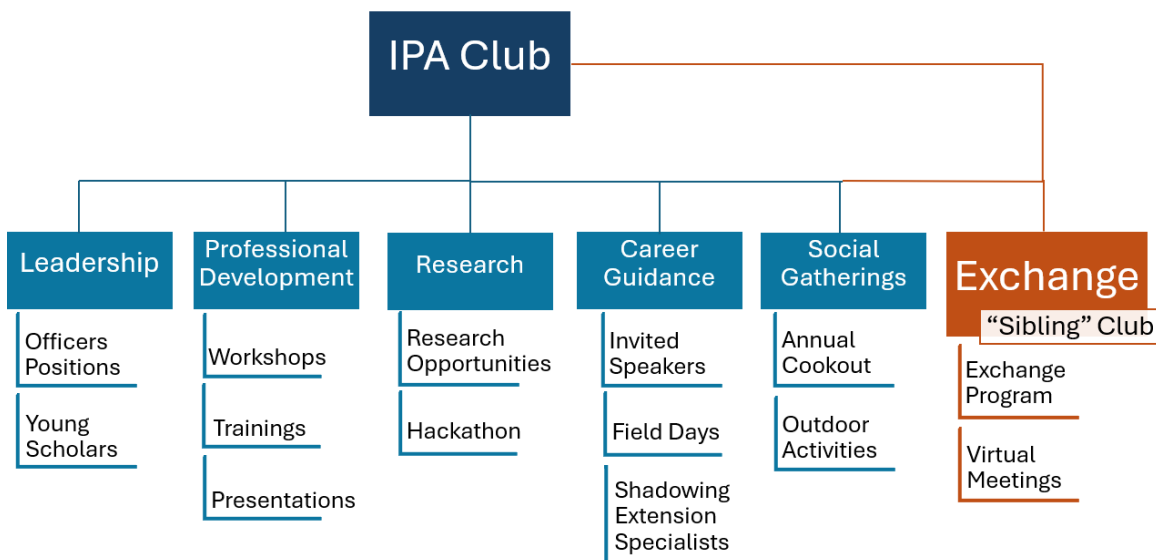


Fig 1. University of Georgia Integrative Precision Agriculture Club Framework of proposed area of focus and activities.
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The initial plan for the club framework involves specific activities focused on each development area. Active club members from undergraduate and graduate schools will have opportunities to hold officer positions as president, treasurer, secretary, social media leader, and communication and networking spokesperson. Club members will also be encouraged to participate in events with young scholars and youth development to showcase their work and increase interest in PA among younger students. These activities aim to help members improve their leadership and communication skills. Professional development and career guidance-related activities will complement what students learn in their respective programs. Students from multidisciplinary backgrounds can learn new skills by participating in workshops and training sessions that will be organized by the club mentor and offered to all members. Students will also be encouraged to give presentations on topics of interest within PA applications. Professionals from academia, industry, and Extension will be invited to talk about different career paths, give students an inside perspective of what each job entails, and answer questions students may have to help them make more informed decisions about their career prospects. The club mentor and officers will organize, in collaboration with UGA Extension specialists for club members to participate in field days with stakeholders and witness firsthand the university and state Extension and outreach program through the work conducted by Extension specialists and county agents.

Research opportunities will be offered to undergraduate students to develop student-led research summer projects through small research grants and awards. This initiative aims to encourage students to gain hands-on experience with research to apply concepts and ideas they are learning in the classrooms and give them experience with scientific research and writing. Similarly, the club will organize at least one competition event each year to keep members fully engaged in the club activities and allow them to express their creativity and problem-solving skills using real-world agriculture datasets. Lastly, at least one in-person social gathering and/or outdoor activity will be planned each year to engage students from the different UGA campuses. In addition to common individual club activities to engage students interested in precision agriculture and provide training and guidance, the IPA club will be involved with its sibling club in Brazil. The two clubs will be interlinked through an annual virtual meeting, potential student exchange opportunities to conduct research and in-person events. Official activities between the clubs started in 2024 with two events: 1) a week-long visit to UFLA for student engagement activities, workshops, discussions, and a symposium in which UGA students shared the results of their research with stakeholders in Brazil, and with 2) a research exchange opportunity, in which two students from GEPAD are spending several months in the USA conducting research, learning new skills, and engaging with students at UGA.

UGA Students Exchange Visit to Brazil

Two Ph.D. students from the Crop and Soil Sciences Department at UGA involved in the creation of the IPA club were selected to spend a week at UFLA, Brazil to participate in international exchange and collaboration activities alongside four UGA faculty and UFLA faculty and students. Dr. Lacerda and Dr. Santos organized visits to different UFLA labs in the Agriculture, Soil Sciences, Agricultural Engineering, and Seed Technology departments, as well as visits with stakeholders, farmers, and to historical sites in the southern region of the state of Minas Gerais in Brazil. UGA students and faculty visited a young, diversified farmer in Brazil who runs multiple operations within a multigenerational family farm and learned about the fertilizer management for Brazilian soils in the region, cover crops, soybean/corn rotation, interplanting between coffee and *Brachiaria* grass, and milk production (Fig. 2a, b, d, e). The UGA Ph.D. candidate Emily Bedwell and Ph.D. student Amrinder Jakhar participated in a student engagement activity in which they had the opportunity to meet with UFLA students who are extremely active in student organizations and junior companies in Brazil (Fig. 2c). The students led discussions about early involvement in research and extension programs and the framework of different student organizations.

One of the highlights of the visit was the I Minas Precision Agriculture 2-day Meeting, organized by Dr. Santos and GEPAD students, with the support of collaborators and industry partners (Fig. 3). Researchers from renowned institutions from both the USA and Brazil were invited to present about new advancements in PA technologies in both countries in topics related to machinery,

sensors, precision irrigation, decision support tools, precision nutrient management, remote sensing, nanoparticles, and spraying drones.

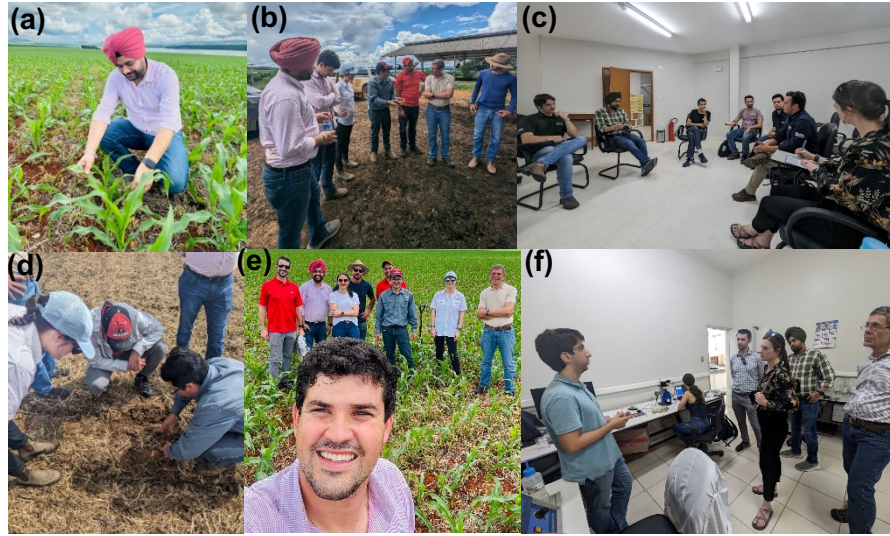


Fig 2. The University of Georgia (UGA) faculty and students participated in several activities during the 1-week visit to the Federal University of Lavras, Brazil. Ph.D. student Amrinder Jakhar looking at the corn stages and cover crop coverage (a), UGA and UFLA visitors learning about the dairy production system from the farmers (b), student engagement meeting (c), Ph.D. candidate Emily Bedwell learning about soil health with the UFLA soil specialist Dr. Silvino Pereira (d), UFLA and UGA visitors with the collaborating grower Mateus Araujo (e), and UGA faculty and student visit to the soil sciences department (f).

The main goal of the meeting was to promote discussions and knowledge exchange between researchers from different countries and to identify technologies and PA management practices that have been tested and developed in one country that could potentially be implemented and tested in the other. Moreover, students and stakeholders present at the meeting had the opportunity to learn more about the application of varied technologies, their benefits, and challenges.

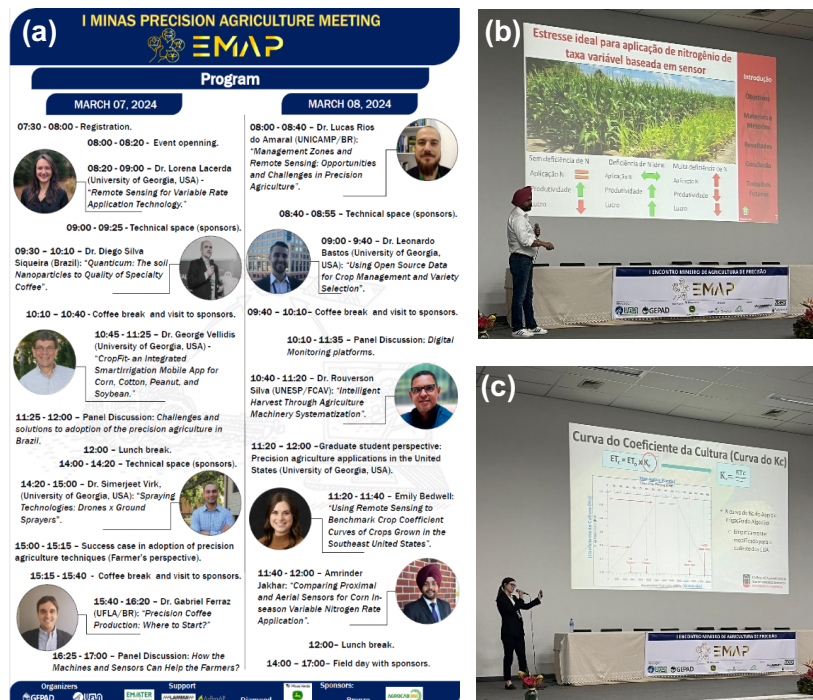


Fig 3. I Minas Precision Agriculture Meeting detailed program (a), Amrinder Jakhar presentation on the use of remote and proximal sensors for variable nitrogen management in corn (b), and Emily Bedwell presentation on the development and benchmarking of the NDVI-Crop Coefficient (Kc) curve for sweet corn to be added to the SmartIrrigation CropFit App.

The UGA graduate students were invited to give the last two talks of the event and share their research results and expertise in the direct application of remote sensing to precision nutrient and irrigation management. The experience of presenting as an invited speaker to a diverse audience alongside faculty is an enriching opportunity for Ph.D. students preparing to start their academic careers. The total event attendance in the two days was around 150 people with the organizing committee.

UFLA Students Exchange Program at UGA

Two UFLA students from GEPAD were recruited to participate in a one-year exchange program at UGA under the mentorship of Dr. Lacerda. One Ph.D. student was selected to conduct the collaboration project between Drs. Lacerda and Santos, combining biofertilizer application and variable rate nitrogen technology to improve corn production efficiency in the USA and Brazil. Thiago Barbosa started his Ph.D. in the fall of 2023 and arrived at UGA spring of 2024 to conduct the first year of the Georgia trials. While Thiago is responsible for his own project in the USA, he is participating in several other projects working with corn, cotton, and peanuts, and several aerial and ground sensors to learn new skills that he can apply when he returns to his country. Fig. 4 shows Thiago in the field and lab, working alongside students. One of these students is Matheus Ardigueri, an undergrad student from UFLA, who is also currently at UGA. Matheus is a senior and is preparing to graduate in spring 2025. At Dr. Lacerda's lab, Matheus is enhancing his professional and interpersonal skills to pursue a master's degree. He is currently helping in at least four different research projects and has had the opportunity to work and learn more about soil mapping systems, variable rate irrigation systems, planters and sprayers, as well as multispectral, thermal, and hyperspectral remote sensing. In addition to the professional and academic opportunities, Matheus and Thiago are fully integrated into a different culture, improving their English proficiency, and working with a very diverse group of students from multiple backgrounds and countries.



Fig 4. UFLA students conducting various research activities during their exchange program at Dr. Lacerda's lab at UGA.

Future Plans

Advancing precision agriculture technologies to improve agricultural production efficiency and sustainability is a common goal for countries around the globe. Despite the major efforts to improve PA practices many challenges still pose a barrier to adoption. Increasing and strengthening international collaborations can facilitate knowledge exchange and improve understanding of the complex factors involved in agricultural production and can offer a valuable opportunity to students and young professionals to engage in leadership and professional development activities. The collaboration between Drs. Lacerda and Santos aims to not only enhance corn production through precision nutrient practices but also to encourage and facilitate student involvement in cutting-edge research and experience exchange across borders. Plans are focused on increasing graduate student participation in the club and recruiting undergraduate students. Funding will be sought to support students from both countries to participate in exchange programs similar to the ones promoted in 2024. The ultimate goal is to provide valuable professional and interpersonal experiences as well as technical skills so that UGA and UFLA

students are better equipped to become the next generation of PA professionals and scientists.

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References

- Lee, C.-L.; Strong, R.; Dooley, K.E. Analyzing Precision Agriculture Adoption across the Globe: A Systematic Review of Scholarship from 1999–2020. *Sustainability* 2021, 13, 10295. <https://doi.org/10.3390/su131810295>
- Onyango, C.M.; Nyaga, J.M.; Wetterlind, J.; Söderström, M.; Piikki, K. Precision Agriculture for Resource Use Efficiency in Smallholder Farming Systems in Sub-Saharan Africa: A Systematic Review. *Sustainability* 2021, 13, 1158. <https://doi.org/10.3390/su13031158>
- Raj, E.F.I., Appadurai, M., Athiappan, K. (2021). Precision Farming in Modern Agriculture. In: Choudhury, A., Biswas, A., Singh, T.P., Ghosh, S.K. (eds) Smart Agriculture Automation Using Advanced Technologies. *Transactions on Computer Systems and Networks*. Springer, Singapore. https://doi.org/10.1007/978-981-16-6124-2_4
- USDA, 2023. United States and Brazil- Partners in Combatting Climate Change and Food Insecurity. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=United%20States%20and%20Brazil%20%20Partners%20in%20Combatting%20Climate%20Change%20and%20Food%20Insecurity_Brasilia_Brazil_BR2023-0003.pdf. (Accessed 05/28/24)