ISRI Harmonic Radar Grant Proposal- N. C. Leppla, PI

1. Cover Page:

<u>Title</u>: A novel harmonic radar system for tracking invasive insect species

<u>Priority area</u>: (iv) novel technology to improve biosecurity policies or management solutions.

<u>Primary contact</u>: PI: Norman C. Leppla, ncleppla@ufl.edu

<u>Co-PIs</u>:

Tan Wong (Electrical and Computer Engineering)
Jasmeet Judge (Agricultural and Biological Engineering)
Isaac Esquivel (Entomology and Nematology)
Marcelo Wallau (Agronomy)

<u>Graduate students</u>:

David Greene (Electrical and Computer Engineering, Ph.D. student)
William Piwowarek (Entomology and Nematology)

<u>Project start date</u>: Immediate

<u>Budget request</u>: $49,398

Abstract:

This project aims to significantly improve our ability to track new invasive species of insects so populations can be located and eradicated before they reproduce and spread. Tracking invasive insects is critical for understanding insect movement and behavior, leading to effective intervention. However, widespread utilization of radar for invasive species management is still in its infancy, particularly for tracking small insects because they must be fitted with a transponder. The proposed project is an unprecedented opportunity to significantly improve harmonic radar and demonstrate its effectiveness by tracking the movement of a small parasitoid wasp, *Larra bicolor*, that attacks invasive mole crickets in pastures. The wasp requires nectar to supply the energy for hunting mole crickets. The harmonic radar system will enable us to determine the maximum distance the wasps will fly from the nectar plants to hunt mole crickets. Additionally, plants that provide the greatest amount of nectar will be identified and recommended for planting by producers. Thus, our project addresses the mission of the UF Invasion Science Research Institute (ISRI) to facilitate interdisciplinary research that generates innovative approaches to reduce invasions and their impacts. It combines the knowledge and expertise of UF faculty from Electrical and Computer Engineering, Agricultural and Biological Engineering, Entomology and Nematology, and Agronomy Departments. Moreover, two of the co-PIs are early-career faculty members, along with two graduate students, are being trained as next generation invasion scientists. The direct outcome of this project will be availability of a new harmonic radar system for tracking invasive insect species and more effective biological control of invasive mole crickets in pastures across the Southeast.

3. Project Description:

A. Background and Significance: Improvements in harmonic radar are urgently needed to track the yellow-legged Asian hornet, *Vespa velutina*, that is spreading across Europe and has recently been detected in the state of Georgia. This serious pest of honey bees, *Apis mellifera*, kills adults and consumes larvae and pupae. The estimated annual cost of controlling this hornet in Europe is $34.4 million (Alaniz et al. 2020). In order to track hornets, individuals are captured and each is fitted with a small transponder and released to be tracked to its nest. The nests is thereby located and destroyed. Harmonic radar is capable of tracking a hornet over hilly and woody environments for at least several hundred meters. The technology has been improved incrementally during the past 30 years to track insects over more complex terrain and greater distances (Tahir and Brooker 2011, Maggiora et al. 2019).

Less adaptable Radio telemetry has been used to track the Asian giant hornet, *Vespa mandarinia*, that recently invaded North America (Wilson et al. 2020). This hornet also is a major pest of honey bees and other pollinating insects, and can be a threat to humans. Like the yellow-legged Asian hornet in Europe, it is native to Central and Southeast Asia. A nest was detected and destroyed in British Columbia in 2019 and Washington state in 2020. Another four nests were discovered in Washington in 2021 by tracking hornets carrying very high frequency (VHF) transmitters (Looney et al. 2023). The nests contained 418 to 1,329 hornets so this pest has the potential to spread rapidly across the Pacific Northwest and much of eastern North America (Nunez-Penichet 2021). At risk in the United States is at least $15 million in pollination services and another $300 million in honey bee products. Additionally, annual control costs could exceed $31 million.

Current harmonic radars are unable to track small insect species. Using state-of-the-art technology, we will develop a novel harmonic radar system (HRS) for tracking relatively small invasive insect species and demonstrate it by following *Larra bicolor*, a wasp less than half the size of the hornets. *Larra bicolor* is a parasitoid imported to manage invasive *Neoscapteriscus* spp. mole crickets in the Southeast (Frank and Sourakov 2002). The wasp requires nectar to supply the energy for hunting mole crickets that cause extensive damage to vegetable seedlings and turfgrasses, including potentially about $13.6 million per year in annual pasture losses (Mhina et al. 2016). There are two primary pest species: the tawny mole cricket, *N. vicinus*, and southern mole cricket, *N. borellii* (Kerr et al. 2021). The unique harmonic radar system will enable us to determine the hunting range of the wasp and distance from nectar sources it will hunt mole crickets. Radar tracking of the wasp may also reveal alternative food sources, sheltering sites, and behaviors that may be exploited to make the wasps more efficient in suppressing mole cricket populations.

B. Specific Aims/Objectives: The two main objectives of the proposed research are to: 1) design and construct a novel harmonic radar system for tracking various invasive insect species, and 2) demonstrate the ability of the system to track a small 2.2 cm long *L. bicolor* wasp, as a test-case. This is a significant advancement because the radio tracking equipment currently used for the hornet species in North America depends on a sizable VHF transmitter that could not be carried by smaller insects. The mass of a hornet worker ranges from 0.36 g to 1.41 g and they are about 5.08 cm long (Gill et al. 2020, Looney et al. 2023). The harmonic radar system used to track the yellow-legged Asian hornet in Europe requires a small transponder attached to the insect. The system used in Europe is unique and nothing like it is available commercially.

The harmonic radar system will be tested by tracking *L. bicolor* wasps as they feed on plant nectar and search for mole crickets. The maximum distance between nectar source plots must be specified to gain full control of an infested area. The plants must be distributed near mole crickets and in a density that supports feeding by *L. bicolor* wasps. Producers will be informed about how best to deploy the plants in pastures to enable the wasp to maintain pest mole crickets below the economic threshold. Specific objectives include: 1) track *L. bicolor* wasps in the plots of nectar plants and mole cricket habitats to identify the best plant species to attract the wasps and enhance parasitism of pest mole crickets, 2) determine the distribution of nectar sources that maximizes the abundance and effectiveness of *L. bicolor* wasps in managing mole crickets in pasture systems, and 3) Measure the impacts of mole cricket biological control on pasture grass density and growth.

We will plant plots containing buckwheat, *Fagopyrum esculentum*, and sweet alyssum, *Lobularia maritima*, in addition to shrubby false buttonweed, *Spermacoce verticillata*, to determine *L. bicolor* floral preferences. These plants were selected based on previous observations of high attraction for *L. bicolor* and meeting the required plant criteria. The plants must be non-invasive, reasonably inexpensive, and attract large numbers of wasps, as well as easy to establish in Florida agricultural areas and ideally produce an abundance of flowers for long periods. We also will sample mole crickets near the nectar plant plots and control plots of pasture grass to determine if the flowering plants increase parasitism of the mole crickets by the wasps, decrease the number of mole crickets, and improve the pasture grass.

C. <u>Innovation/Potential Impact of Proposed Research</u>: A new harmonic radar system could be a major advancement in the capability to effectively track and eradicate harmful invasive insect species. "Harmonic radar represents a major step forward in our capacity to study insect flight" (Riley and Smith 2002). An average of more than three invasive species enter Florida each month and many are insects capable of long-distance flight. The pest species must be tracked and eradicated if possible. Pests of plants and animals may construct nests or aggregate on hosts for feeding and oviposition. A tracked insect could lead to others that otherwise would be undetected. For example, a tagged male moth, such as the fall armyworm that has recently invaded Africa, could lead to calling females. The effectiveness of experimental traps and lures is evaluated by capture rather than interactions of the insects with the traps. This interaction may occur at night when observation is not possible. Capturing, tagging, releasing, and tracking invasive pests, such as the Africanized honey bee and Mexican bromeliad weevil, with harmonic radar could enable them to be located and eliminated. Another application for this technology would be to track predatory insects to determine if they successfully locate and consume an invasive crop pest. The frequency and duration of visits by imported commercial pollinators, such as honey bees and bumble bees, to certain crops could confirm their effectiveness. Invasive pest detection could be facilitated by tracking a tagged insect to the most attractive locations in a crop. Some of these applications could be tested on the Old World bollworm, *Helicoverpa armigera*, and other potentially invasive pest species before they enter the United States. Harmonic radar systems have been used to track honeybees in the United Kingdom (Woodgate et al. 2021) and invasive hornets in Italy (Maggiora et al. 2019) but no systems are currently being used in the United States. We envision that the new prototype system developed in this project could become the first commercially available harmonic radar for invasive insect species applications. We will test and use it to design an effective and affordable method for sustainably controlling invasive mole crickets in pastures.

D. <u>Approach/Research Design</u>: Our approach to constructing a harmonic radar system involves four main components: 1) a sturdy ground platform to provide a solid foundation and power to the radar, 2) a digital control platform responsible for signal generation, processing, and storage, 3) the transmit and receive phased-array antennas, and 4) a suitable horn/marine-based radar system that will serve for comparison. COTS (commercial, off-the-shelf) parts will be used when available; however, most of the antenna prototyping and design will be performed by our team.

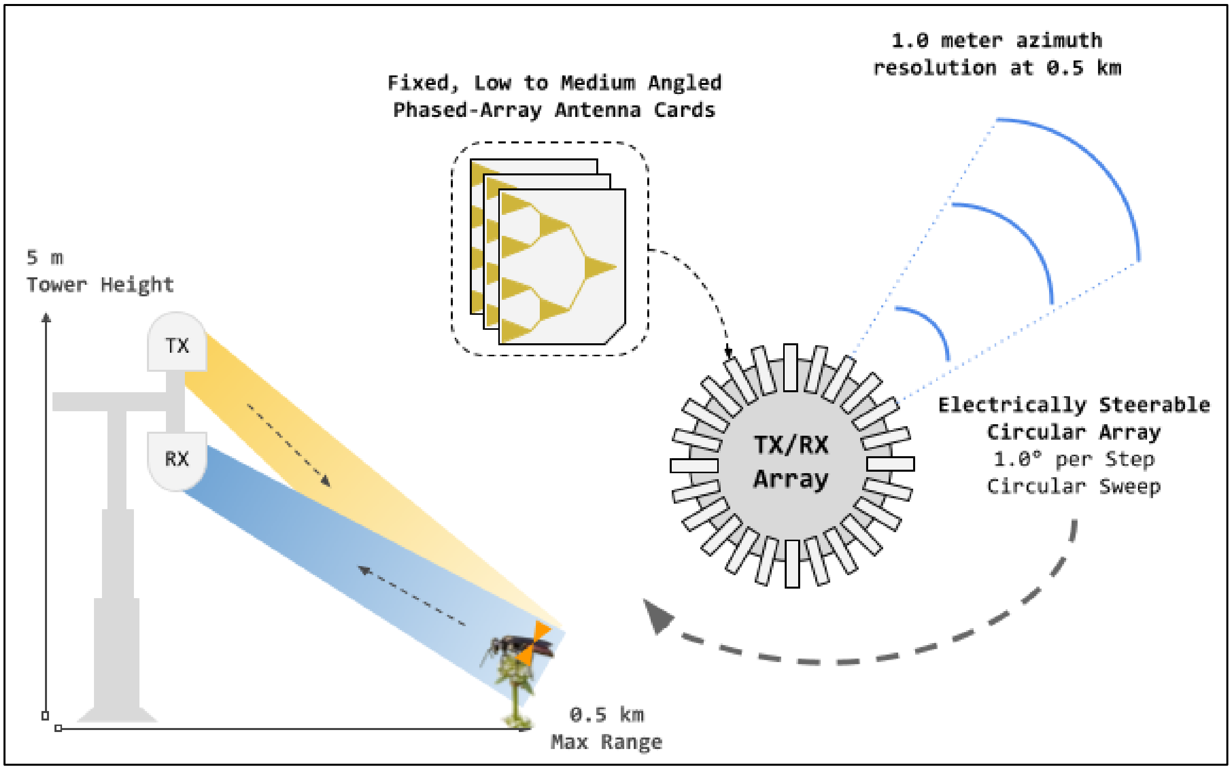

Figure 1: (a) Illustration of the harmonic radar's transmit and receive radomes attached to a telescopic mast. (b) Illustration of the TX or RX array platform, composed of a phase control board and separate vertical riser cards to provide full azimuth overage.

The ground platform (shown in Figure 1.a) consists of a telescopic mast, capable of supporting up to 250 pounds of equipment, that can extend up to 6.3 meters into the air using a hand crank. The platform is supported by four legs that can be levelled and supported with weight to create a structure resistant to wind or wildlife. A 12V DC lithium-ion polymer battery will serve as the main power source for the radar's operation; rated for 100 amp-hours, it should be capable of allowing the radar to operate for approximately one week of continuous operation (the duty cycle can be scaled down to significantly extend the battery life). Additional power regulators and conditioners will ensure the digital and radio-frequency (RF) equipment have clean operating power.

The digital control platform will be placed towards the top of the telescopic mast in a weatherized enclosure. The enclosure holds the Real Digital 4x2 RFSoC (Radio Frequency System on Chip) board, an external USB storage drive for housing received data, a GPS receiver and antenna to provide accurate placement location and time, and various components to support the operation of the RFSoC board. The RFSoC board runs a Linux operating system, capable of controlling, as providing status and health information, the operation of the radar. Here, a 150 MHz, pulse-shaped Zadoff-Chu sequence will be generated, upconverted to a digital IF (intermediate frequency) signal, and then sent out over the onboard, high-speed analog-to-digital converters. The transmit IF is then sent over to the TX antenna where it will be upconverted to an appropriate X-band frequency near 3 cm wavelength (pending FCC approval). Likewise, IF signals from the various outputs of the RX phased-array will be sent to the RFSoC board and digitally sampled using the onboard, high-speed analog-to-digital converters. Digitally, the signal will be conditioned and the range and azimuth of a reflection from a harmonic transponder will be measured and stored.

The transmit and receive antennas are housed in separate, polycarbonate domes. Each assembly contains the necessary components (oscillators, mixers, filters, amplifiers, etc.) to convert between IF and RF in the X-band region. Additionally, the transmit and receive assemblies utilize an AESA (active electronically scanned array) design, dramatically decreasing the time required to sweep the mainlobe through a complete revolution and increasing the number of looks we can obtain from a target reflection. Instead of requiring a motor to physically rotate a directional antenna, the phase of independent antenna branches are precisely controlled to allow beamforming. For the TX array, a circular approach is being designed that will provide a wide transmit beam to a specific area in the azimuth. Several implementations are being vetted regarding the design of the RX array, as careful consideration must be taken into obtaining fine azimuth resolution (approximately 1.0 meters at 0.5 kilometers). Specifically, we will weigh the cost/benefits of a circular array consisting of a single PCB (printed circuit board) against a multi-board solution, where multiple boards would increase the cost of assembly and testing but yield a significantly sharper mainlobe to provide a greater return from a target.

Finally, to serve as a comparison to designs proposed in research papers, as well as aiding in the calibration procedure, a comparable horn antenna system will be developed using COTS parts. An X-band horn system will provide data similar to what was observed in other entomological papers and help in judging the benefits and costs of our AESA approach. Additionally, horn antennas act as excellent calibration and test instruments; these types of tools are required to calibrate and fine tune our AESA products.

The harmonic radar system will be deployed at two sites: the Plant Science Research and Education Unit (2556 Co Hwy 318, Citra, FL 32113) and a private farm near Hawthorne infested with mole crickets. Each site will have three treatment and three control plots. Treatment plots will contain three subplots each in a randomized block design containing buckwheat, sweet alyssum or shrubby false buttonweed. The control plot will be maintained with bahiagrass, the current forage species at both locations. Plots will be planted with a no-till drill, and bahiagrass chemically suppressed to reduce competition during establishment. The plots will be separated by 400 m (Portman et al. 2010). Linear pitfall traps will be placed five meters from each plot (Lawrence 1982). This will enable collection of mole crickets of all life stages to determine their population size and *L. bicolor* parasitism rates in the vicinity of the plots We will use the harmonic radar to track the wasps beginning when the plants start flowering and continuing each week for the study period. Wasps will be captured at or near the treatment plots and a transponder will be glued to the back of each of them before they are released and tracked for 24 hours. Statistical analysis of data on wasp and mole cricket abundance and parasitism data will be performed in R (R Core Team 2023). The final models will likely consist of mixed models based on these distributions, including block as a fixed factor and appropriate plant and weather data as random factors. Statistical significance will be determined by performing type II ANOVAs on these models at P=0.05. Harmonic radar data will be analyzed qualitatively, with the quantitative portion consisting primarily of the average maximum hunting distance of the wasps from treatment plots, hunting and nectar foraging time per day, and time spent on treatment plots vs other flowers in the area.

4. Project Budget & Justification:

Category	Estimated Cost
Salaries and Benefits	
David Greene- 0.25 FTE for 12 months + 11.8% benefit rate	$25,760.00
William Piwowarek- OPS + 1.7% benefit rate	5,594.00
Engineering Materials (harmonic radar system)	
Ground Platform Components	1,461.00
Digital Platform Components	2,922.00
Phased Array Antenna Components	4,277.86
Horn Antenna Components	7,578.88
Field Materials (seeds, planting, plot maintenance)	800.00
Travel Costs (Gainesville to Citra and Hawthorne)	1,004.00
Total	**$49,398.00**

EST	Horn Antenna Components	Part ID	Supplier	Count	Item Cost	Total Cost	Part Link
	Equipment Enclosure	STEEL-01, 17.8"x13.8"x8"	Namunanee	1	$150.00	$150.00	https://www.amazon.com/Namunanee-Electrical-Cold-Rolled-Ventilation-Waterproof/dp/B0C5J4ZXM9?th=1
	DC Surge Protector	CHLT-40PV	Jeankak	2	$18.00	$36.00	https://www.amazon.com/Jeankak-Protector-Voltage-Arrester-Protection/dp/B09NM1PZVS
	12V LiPO Battery	LFP100AH	Miady	1	$280.00	$280.00	https://www.amazon.com/gp/product/B09NR12YQ6?th=1
	12V DC Power Regulator	C121212	Cocar	1	$50.00	$50.00	https://www.amazon.com/Voltage-Stabilizer-Regulator-Protector-Protection/dp/B08BRN3R5Y
	Inline 20 Amp Circuit Breaker	HBD20A	Bumbesti	1	$13.00	$13.00	https://www.amazon.com/Bumbesti-Resettable-Circuit-Inverter-Automotive/dp/B09NSYRX4G
	Stationary, 19' Raised Platform	-	Tech Tongda	1	$890.00	$890.00	https://www.amazon.com/TECHTONGDA-Stands-Lighting-Supporting-Capacity/dp/B08DTQBS5B
	50' 18AWG 4 Conductor Wire	18/4CMP-Shielded	Syston	1	$32.00	$32.00	https://www.amazon.com/Syston-Cable-Technology-Conductors-Resistant/dp/B0BZT7DPCZ
	3-Way SPDT Toggle Switch	R13-401-103	DalerTek	1	$10.00	$10.00	https://www.amazon.com/DalerTek-Toggle-Switch-Automotive-Position/dp/B07SN7BY8V

EST	Horn Antenna Components	Part ID	Supplier	Count	Item Cost	Total Cost	Part Link
	Equipment Enclosure	STEEL-01, 15.7"x11.8"x5.9"	Namunanee	1	$120.00	$120.00	https://www.amazon.com/Namunanee-Electrical-Cold-Rolled-Ventilation-Waterproof/dp/B0C93J3B17
	80mm 12V DC Fan	80x80x25mm	WDERAIR	1	$13.00	$13.00	https://www.amazon.com/dp/B0BXSJYFMJ
	12V Power Distribution Board	HD037	HCDC	1	$28.00	$28.00	https://www.amazon.com/Screw-Mount-Position-Distribution-Module/dp/B08LPS7HPX
	RFSoC Board	RFSoC 4x2	Real Digital	1	$2,149.00	$2,149.00	https://www.realdigital.org/hardware/rfsoc-4x2
	External 10MHz Reference	OX200-SC-010.0M	DigiKey	1	$121.00	$121.00	https://www.digikey.com/en/products/detail/connor-winfield/OX200-SC-010-0M/3986804
	72" SMA-SMA RF Cable	P1CA-SAMSAM-085CJ-72	P1dB Inc.	6	$42.00	$252.00	https://www.digikey.com/en/products/detail/p1db-inc/P1CA-SAMSAM-085CJ-72/16521997
	1TB USB 3.0 IP65 Storage	SDSSDE61-1T00-G25B	SanDisk	1	$85.00	$85.00	https://www.amazon.com/SanDisk-1TB-Extreme-Portable-SDSSDE61-1T00-G25B/dp/B0C5SDQVNL
	Waterproof Outdoor Camera	IMX291	Arducam	2	$59.00	$118.00	https://www.amazon.com/Arducam-IMX291-Camera-Lightburn-Waterproof/dp/B0C36ZVQ5G
	USB 3.0 Powered Hub	AK-68ANHUB-BV7A-0004	Anker	1	$36.00	$36.00	https://www.amazon.com/Anker-7-Port-Adapter-Charging-iPhone/dp/B014ZQ07NE

EST	Horn Antenna Components	Part ID	Supplier	Count	Item Cost	Total Cost	Part Link
	Wave Launch SMA Connector	SM06FS005	WithWave Co.	6	$29.00	$174.00	https://www.digikey.com/en/products/detail/withwave-co-ltd/SM06FS005/18635569
	Board Edge Connector	PCIE-036-02-F-D-TH	Samtech Inc.	128	$2.02	$258.82	https://www.digikey.com/en/products/detail/samtec-inc/PCIE-036-02-F-D-TH/6561616
	Card Slots	SSD-400	Bivar Inc.	128	$0.43	$55.04	https://www.digikey.com/en/products/detail/bivar-inc/SSD-400/3101286
	PCB - RX Azimuth Controller	-	-	1	$300.00	$300.00	TBD
	PCB - RX Fixed Elevation Array	-	-	64	$4.69	$300.00	TBD
	PCB - TX Azimuth Phase Controller	-	-	1	$300.00	$300.00	TBD
	PCB - TX Fixed Elevation Array	-	-	64	$4.69	$300.00	TBD
	24" Polycarbonate Dome	GDOME-24PC3	Replacement Domes	2	$250.00	$500.00	https://replacementdomes.com/product/24-universal-dome-0-118-thick-polycarbonate/
	28" Aluminum Base Disc	HATP24	American Metalcraft, Inc.	2	$25.00	$50.00	https://www.amazon.com/American-Metalcraft-HATP24-Thickness-Aluminum/dp/B00575KT9K
	SMT Mixer	SMIQ-6243H	Mini-Circuits	6.00	$60.00	$360.00	https://www.minicircuits.com/WebStore/dashboard.html?model=SMIQ-6243H%2B
X	LPF	-	Mini-Circuits	1	$300.00	$300.00	
X	Bandpass Filter	-	Mini-Circuits	1	$300.00	$300.00	
X	Frequency Source	-	-	1.00	$600.00	$600.00	
	RX Phase Shifters	F6121SAVGI	Renesas Electronics	8	$60.00	$480.00	https://www.digikey.com/en/products/detail/renesas-electronics-corporation/F6121SAVGI/18160701

EST	Horn Antenna Components	Part ID	Supplier	Count	Item Cost	Total Cost	Part Link
	4KW 24" Marine Radar	M92652-S	Raymarine	2	$350.00	$700.00	https://www.ebay.com/itm/204425054352
	Wideband Horn Antenna	PowerLOG 40400	Aaronia	2	$2,519.00	$5,038.00	https://www.stratatek.com/product-page/aaronia-powerlog-40400-broadband-horn-antenna-4ghz-to-40ghz
	Mixer	ZMDB-24H	Mini-Circuits	2	$320.44	$640.88	https://www.minicircuits.com/WebStore/dashboard.html?model=ZMDB-24H-K%2B
X	LPF	-	Mini-Circuits	1	$300.00	$300.00	
X	Bandpass Filter	-	Mini-Circuits	1	$300.00	$300.00	
X	Frequency Source	-	-	1.00	$600.00	$600.00	

Summary	Estimated Cost
Ground Platform Components	$1,461.00
Digital Platform Components	$2,922.00
Phased Array Antenna Components	$4,277.86
Horn Antenna Components	$7,578.88
David (0.25 FTE for 12 months) + 12% Benefit	$25,760.00
Total	$41,999.74

5. Literature Cited

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6. Key Personnel:

<u>Norman Leppla</u> (Entomology and Nematology)- UF/IFAS Professor of Entomology and Program Director, IPM will serve as projector director (PD) for the project, cooperatively draft and submit the ISRI research proposal, supervise MS student William Piwowarek, with the student and other co-PIs design field testing of the harmonic radar system, participate in the field work and Extension activities, and lead preparation of reports and publications.

Tan Wong (Electrical and Computer Engineering)- UF Professor of Electrical and Computer Engineering: will advise the engineering process of designing, assembling, testing, and calibrating the harmonic radar and transponder tags, and will work with other PIs to develop proposal(s) to external funding agencies.

Jasmeet Judge (Agricultural and Biological Engineering)- UF/IFAS Professor of Microwave remote sensing and Director, Center for Remote Sensing, will provide expertise in algorithm development to help with analyzing and interpreting tracking signals. She will also collaborate with the co-PIs to seek external funding for wider applicability of the proposed project.

Isaac Esquivel (Entomology and Nematology)- UF/IFAS Assistant Professor of Entomology, Agroecosystems will provide guidance of MS student Piwowarek and assist with experimental design and analysis methodology. Further, he will be involved with the other co-PIs in bringing this information to our producer clientele.

Marcelo Wallau (Agronomy)- UF/IFAS Assistant Professor of Agronomy and Forage Extension Specialist, will coordinate with MS student Piwowarek the field trials, providing assistance on designing, planting and maintaining the experiment. Furthermore, along with co-PI Esquivel, will be responsible for the Extension component of the project, taking the findings to stakeholders via direct communication, newsletter, related field days, and other diffusion strategies.

David Greene (Electrical and Computer Engineering)- UF/ECE graduate student (Ph.D.) will design, assemble, prototype/test, and calibrate the harmonic radar and transponder tags. Supervised by Dr. Tan Wong, they will be responsible for delivering the radar, post-processing software, and a brief operator's manual. Time and resources permitting, David will be assisting with in-field setup and post-processing the obtained datasets.

William Piwowarek (Entomology and Nematology)- MS graduate student fall 2024 (currently OPS) will carry out data collection for the duration of the project, including setting up and running the experiment, performing wasp counts, collecting and surveying mole crickets, conducting plant surveys, and operating the harmonic radar tracking system. Following data collection, perform data analysis, prepare the manuscript for publication, and write a master's thesis.

7. Plans to obtain continuing external support for the project:

The ISRI grant funding is needed to design, construct and test a novel harmonic radar system. This multidisciplinary and multi-unit team also plans to submit a proposal for additional research support to the 2024 Research Opportunity Seed Fund (ROSF), UF Research x Strategic Research Development. Our research fits this program because it is "Guided by the philosophy that diverse partnerships across the disciplines drive groundbreaking research and winning proposals, ROSF awards strive to spark research synergies that can launch exceptional long term research collaborations". Future funding will be sought from the USDA Invasive Pests and Diseases grants (https://www.nifa.usda.gov/topics/invasive-pests-diseases). A target will be the USDA, NIFA, CPPM, Applied Research and Development Program (ARDP) in the category of "Plant Protection Tools and Tactics – the discovery, development, and introduction of new pest management tools for use in IPM systems". Another potential source for continuing external support is the USDA, Agriculture and Food Research Initiative (AFRI) Sustainable Agricultural Systems (SAS) Program. The category is "protecting yield losses from stresses, diseases, and pests". The Specialty Crop Research Initiative (SCRI) fits our work, as well. The focus priority will be "Efforts to identify and address threats from pests and diseases, including threats to specialty crop pollinators". This work also fits the specialty crop block grant, farm bill funding, and NASA-Applied Science Programs.