Summary from the Crop Protection and Quarantine National Program Workshop

In May 2008, ARS scientists and administrators met with customers, stakeholders and partners at a workshop that was designed to discuss major issues and priorities for the Crop Protection and Quarantine National Program. Based on these in-depth exchanges, the research priorities were identified for: Grain, Corn and Sugar Crops; Oilseeds, Legumes, and Cotton; citrus, Tropical Crops, Nursery, Ornamental, Turf, and Greenhouse; Tree Fruit, Nut, and Small Fruit; Vegetables, Natural Ecosystems; and Postharvest and Quarantine.

Grains, Corn, and Sugar Crops

Invasive Pest Arthropods and Weeds

- Predict future invasive pests using knowledge from other regions and develop management plans to quickly react when and if they arrive.
- Partner with agencies with primary goal of mediation of invasive species and provide systematic, detection and monitoring, and networking support to assist with their goals.

Biology, Ecology, and Genetics of Pest Arthropods and Weeds

- Seed bank dynamics for key weed species
- Genetics underlining weed or insect pest characteristics for targeting in novel pest management strategies
- Resistance management strategies for genetically enhanced crops

Resistance Management in Genetically Enhanced Grain Crops and Corn

- Improved economic thresholds (or other tools) for weeds, that incorporate seed bank longevity
- Scouting or monitoring tools for detecting herbicide resistance in weeds and insecticide resistance in insects
- Seed mixtures and stacked events of transgenic and non-transgenic seeds on resistance development and management
- Herbicide resistance (especially glyphosate) management protocols for weeds

Pest Management in Genetically Enhanced Grain Crops and Corn

- Incorporate genetically enhanced crops into integrated management systems
- Evaluate ecological changes to agroecosystems (and secondary pests) from adoption and implementation of genetically enhanced crops
- Area-wide implications of suppression of target pests using transgenics (especially to organic producers)

System-Level Production Practices for No-till, Reduced Input, and Organic Systems

- Identify the unique challenges for pest management (cover crops, cultural control, mechanical methods)
- Economics (costs and benefits) of various cropping systems.

Pest Management for Grains, Corn, and Sugar Crops for Biofuel Production:

- Potential pests of energy crops
- Energy crops as pests
- Biomass removal effects on crop production, pest management

Oilseeds, Legume, and Cotton

Lygus and Other Piercing/Sucking Insects

- Sampling
- Thresholds
- Host Plant Resistance
- Natural Enemies
- Dispersal – Intercrop Movement

Herbicide Resistance Management

- Alternative Chemistries/Modes of Action
- Basic Physiology/Ecology
- Genomics, Genetic Basis of Resistance
- Integrated Management – Diversity of Tactics

Insect Resistance Management

- Alternative Products/Modes of Action
- Basic Physiology/Genetics of Resistance
- Pest Ecology and Movement
- Integration of Tactics

Boll Weevil/Pink Bollworm Eradication Sustainability

- Identification of Re-Infestation Sources
- Effective Monitoring
- Predictions of Dispersal Patterns

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Citrus, Tropical Crops, Nursery & Ornamentals, Turf, Greenhouses

- Systematics and germplasm repositories, collections and database management and rapid and reliable identification systems for pests and natural enemies

- A systems approach to pest management that includes cultural, biological and compatible chemical controls and includes the grower from the beginning of the project
- IR-4 succession, better responsiveness to nursery needs outside of the “food-use” paradigm
- Prioritize foreign pest threats, research in advance, then prepare for exclusion, early detection and rapid response
- Pesticide resistance prevention, detection, remedies
- Surveillance /scouting protocols: standard to high-tech, including remote sensing, image analysis, hyperspectral approaches
- Optimal application technologies for pesticides and natural enemies, including optimization of establishment of natural enemies
- Sustainable programs
- Exploration for beneficials, including identifying causes of regional differences in pest populations; for example, lower psyllid levels in Texas than Florida
- Need for basic research, applied research and technology transfer:
    - Entomology genomics
    - Weed genomics
    - Seed dormancy
    - Systematics based on need
    - Invasives and domestic pests that are of a high priority have significant quarantine issues
    - Long-term research
    - Utilize resources across multiple commodities
    - Question if arthropods and weeds should be separate programs
    - Incorporate team development across commodities into the new action plans. For example, horticulture impacts many aspects of natural areas.
    - Better cooperation across agencies, for example APHIS and ARS
- Ask Commodity Groups for prioritized lists and Action Plans:
    - National invasive species council action plan
    - Citrus Industry
    - Nursery Industry
    - Greenhouse Industry
    - Tropical stakeholders
    - Association of Natural Biocontrol Producers

Tree Fruits, Nuts and Small Fruits

Biological and systems based pest management

- Classical and augmentative biological control, cultural practices, host resistance
    - Mass rearing and production of agents
    - Methods for quality assessment of agents
    - Survey and discovery of agents
- Systems approaches
    - Augment and replace chemistry

    - Chemical compatibility: biological and environmental
- Predictive capability
    - Insect monitoring and robust modeling based on detection, weed emergence based on models

Basic Insect and Weed Biology

- Analysis of research for practical field implementation
- Applying our basic understanding of insect physiology and transmission of pathogens for management strategies (e.g. GWSS)
- Industry outreach

Invasive Insects and Weeds

- Alternative quarantine techniques and systems approaches
- Utilization of IPM PIPE, relates to basic biology and weather on a regional basis (e.g. soybean rust)

Environmental Quality Concerns Over Weed and Insect Control (fumigants, insecticides, herbicides)

- Generate data to inform regulatory agencies
- Develop alternative techniques

Alternatives to Fumigants/Pre- and Post-harvest

- Risk probability
- Packing line quality sorting
- Relating management tactics, detection and modeling to reach an acceptable risk level
- Improved detection of infested commodities

Risk Assessment and Research Related to Quarantine and Phytosanitary Issues

- A review of pest
- Research in overseas lab
- Team-building across institutions (including land-grant, cooperative extension, APHIS, state regulatory agencies)

Weed Management

- Herbicide resistance among weeds
- Non-chemical management
- Focus on perennial weeds
- Management in new orchards, vineyards, small fruits, nurseries
- Management in BERM
- Tech transfer and collaboration
- Multi-institutional approach, industry partnership

Pest Laundry List

- Olive fruit fly
- Vine mealybug

- Light brown apple moth
- Glassy winged sharpshooter
- Navel orangeworm
- Twig borer
- Oriental fruit moth
- Olive psyllid-emerging pest of concern
- Plum curculio
- Perennial broadleaf (wild brambles, morning glory)
- Weeds (4 in CA) resistant to herbicides

Vegetable Breakout

Crops represented:

Potatoes (Pan), Chile Peppers, specialty veggies (NM), Diverse vegetables (FLA)

Key Pest Insects (and complexes)

- Virus-aphid complex (potatoes)
- Whiteflies, esp. as virus vectors (FL)
- Trips
- Wireworms (potatoes, FL veggies)
- Diverse lep pests
- Spider mites
- Pepper Weevil (FL)

Key Weeds

- Pigweed
- Nutsedges, purple and yellow
- Nightshades
- Kochia
- Annual/perennial grasses: foxtails, quackgrass, etc.
- Bindweed
- Morning glory
- Goose grass (SE)
- Canada Thistle
- Velvetleaf, other Malvaceae
- Oxalis (in greenhouse)
- Black medic,
- Hard-seeded winter annuals

Key issues:

- Multidisciplinary research addressing multitrophic interactions among
  - Viruses
  - Their insect vectors
  - Weeds, as reservoirs **<u>and</u>** their role in the disease dynamics
  - For example: Whitefly management for virus control in Florida:
    - starts with emergence of the plant and continues through the season.
    - Need to better understand multitrophic interactions in such cases
    - to better manage the crop system and reduce chemical usage.
  - →Through interdisciplinary approaches and teams
- IPM strategies: prediction of when and where management is needed to prevent outbreaks
- Better predictive models for the specific pests

- Better management models involving multiple pest/weed, in multiple crop systems
- Understanding why an insect or weed is a pest in one region but not another – what environmental and insect pest characteristics contribute to pest significance?
- Weed ecology: Understanding weeds in their ecosystems; competitive interactions between weeds and specialty crops
- Taxonomic work to understand biotypes of pest, nematode and weed species relevant to mgt strategies
- Seed dormancy: fundamental understanding of, triggers to breaking dormancy, and seed bank ecology
- ARS continue to take on challenging, long range research goals:
    - Integrating weed management with other components;
    - Understanding more about ecology/biology of the weeds, including molecular based systematics, poplin genetics;
    - Why are weeds so invasive?
    - What traits are involved? traits that could be transferred to crop plants
- Mechanisms & basis of herbicide resistance

ARS consider in all its research outcomes in pursuing technical solutions:

- Ag profitability of all recommendations & tools
- Sustainability of age practices in face of public pressure for greener foods
- Water availability/quality
- Food safety
- International trade issues
- Weed science NPL needs to be filled ASAP and by a Weed Scientist (not Entomologist)
- Weed science is rendered a disservice by the division of components among the several National Plans
- All the Weed Science research should somehow be unified
- At the same time there are issues requiring the attention of weed scientists: e.g., role of weeds and weed control in plant pathogen transmission, that argues against grouping of these scientists.

Natural Ecosystems I

Define and Determine Harm caused by invasive species (contract with economist if necessary)

Quantify Negative Impacts caused by the 100 worst invasive species and estimate benefits of control

- Ecological and economic
- Expand research on invasive species in additional non-agricultural systems, and in areas of overlap between agricultural and natural areas
- Don't just kill weed and insect pests, conduct integrated vegetation/ habitat management (IVM)
- Measure/ model invasion rates and expansion of range under current/ changing climate conditions. Use biological control agents as example agents of spread

- An additional list of 30+ invasive species were identified as priorities in natural areas (beyond supplied list, attached to breakout notes)
    - Examples include, Arundo, Azolla, Lep. Larvae, LBAM, Ludwigia, Skunkvine, Thistles, Zebra muscles, etc.
- Invasion biology, ecology, systematics, control methods (chemical, cultural & biological) all essential.
    - Keep and expand existing programs that have been excellent in the past and are continuing to be needed.
    - Weed pathology needs to be increased (use new Davis Quarantine Facility and improve the Frederick Facility)
- Address the spread of invasive species within and between natural ecosystems and agricultural areas
- Be BOLD and audacious in Experimentation:
    - Large-scale studies should be conducted on critical issues.

Don't be afraid to try and fail.

- Question initial assumptions, even if difficult
- Study Basic Biology of weed and insect pests and their natural enemies at the genetic, organismal, population, and community levels
- Conduct "systems-level" research on target species, their encompassing habitats and area-wide management (Think IVM and IPM)
- Synthesize to construct BIG PICTURE views
- Evaluate invasive species at different spatial and temporal levels of scale to address key biological and management issues.
- Improve monitoring, assessment, control systems and decision aids for land managers.
- Need predictive tools for restoration and revegetation based on experimental biology
- Develop landscape level tools to assess invasive species and other decision support tools that use modern technologies such as those developed by NASA (remote sensing, modeling)

Regulatory Assistance

- Need new methods to kill invasive species in cargo shipments
- Proactive pest assessment before entry.
- Identify pathways of entry and assess the invasive potential from different geographic areas.
- New monitoring tools for detection and ID.
- Develop enhanced methods for invasive species Control at Ports of Entry.
    - In cargo (pre and post arrival) and in adjacent areas around ports.
- Design methods to Assist Regulatory Agencies in the rapid identification and control of invasives before they reach natural areas (exclusion and containment)
- Increase meta-populations studies to improve Early Detection and Rapid Response Programs. Look at post-release biological control studies as models.
- Assess the DHS/CBP list of invaders and work on invaders that are commonly found at ports of entry.

- Conduct regional annual meetings with cooperators to discuss local needs and get feedback on progress.
    - State Depts. Ag., APHIS, various private and public land managers, ranchers and farmers (increase info exchange)
- Design methods to assist regulatory agencies in the rapid identification and control of invasives before they reach natural areas (exclusion and containment)
- Increase systematic activities
    - First and foremost, maintain classical morphologically-based systematists
    - Increase systematic efforts by adding new: researchers, support staff, collection resources, and identifiers. Add efforts in other National Programs.
    - Add molecular specialists and bio-informatics where possible, but not at the expense of classical systematics. Merge technologies with new hires.
- Where job need is high, increase training
    - Scholarships', fellowships, SCEPs in systematics
- Increase biological control efforts on both invasive weeds and insects
- New specific biocontrol projects are needed on invasive insects in natural areas (beyond forests)
- Increase support to ARS Overseas Labs
    - Personnel, biology assessments, screening efforts
- Maintain flexibility for emergency biocontrol projects
- Conduct comprehensive faunistic and floristic assessments to provide base of understanding.
- Conduct geographic assessments of critical areas where pest taxa are expected to originate.
- Link overseas and domestic labs more effectively
- Provide adequate administrative support to OBCLs
- Enhance biological control technologies for key invasive species problems
- Meet annually to discuss and assess targets, set priorities for overseas studies and quarantine assessments. Expand quarantine capacity in the United States
- Conduct new "active biological control technologies" using more aggressive methods.
    - Augmentation of numbers through the development of artificial diets, mass-production, and mass-release of control agents. Area-wide technologies and other large-scale strategies needed.
- Wide-scale distribution and assessment using modern technologies (GIS, remote sensing, etc.)
- ARS needs to include its self-assigned tasks from INSC 2008 Plan into all ARS National Programs including NP 304 (agreed upon plan attached)
- Study potential invasiveness before using in agriculture, biofuels, horticulture, etc.
- Identify and research native crops for biofuels and other crops instead of several proposed known invasive species (i.e., Arundo, Russian Dandylion)
- Incorporate the cost of IPM into biofuel and new crop costs, especially if they threaten to naturalize.

Natural Ecosystems 2

Strengthen Interagency Collaborations

- Inter-agency collaborations
- Joint Planning Workshops
- Federal Guidance/Advisory Committee
- Cooperation with trusted colleagues

Increase Systematic Support

Harmonize Diagnostic Networks for EDRR (e.g., NPDN, USFS, USGS)

Risk Analysis and Mitigation of Pests in Different Phases of Invasion

- Offshore threats (spp. invasive in other areas of the world)
- Newly introduced pests
- Well-established spp. (expanding range from climate change, fire, dispersal)
- Native pests or endemics that become problematic (e.g., mesquite, creosote bush, mountain pine beetle, tarnished plant bug)
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Improve Prioritization Process for Pests

- Economic/environmental damage caused by pest
- Genetic variability (reproduction mode(s), multiple introductions)
- Ecological amplitude of the pest
- Economically important species in potential conflict with management approach(es)
- Non-target native species in potential conflict
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Improve Prioritization Process for Pests

- Is conventional control effective or possible?
- Political/sociological considerations
- Probability of success
- Geographical origin (e.g., alfalfa weevil from Iran – past difficulties in collecting n.e.)
- IPM Potential
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Improve Prioritization Process for Control Strategies (e.g. BC and other management approaches)

- Environmental compatibility
- Cost-effectiveness
- Ease of implementation
- Probability of success
- Sustainability
- Political and social issues (e.g., human health/environmental concerns)
- Host-specificity of n.e.
- Potential for non-target impacts
- Conflicts of interest
- IPM potential
- Regulatory issues
- Risk-based evaluation of natural enemies

- Risk-based regulatory oversight
-

Aquatic and Riparian Insects and Other Animal Pests

- Emerald ash borer
- Zebra mussel
- Quaga mussel
- Nutria
- Hemlock wooly adelgid
- Emerald ash borer
- *Giant African land snail
- New Zealand mud snail

Aquatic and Riparian Weeds

- *Hydrilla
- *Water hyacinth
- *Saltcedar
- *Giant Salvinia
- Duckweed
- Purple Loosestrife
- Water lettuce
- Hygrophila
- Torpedograss
- *Russian olive
- Eurasian watermilfoil (Myriophylum spicatum)
- Egeria densa (Brazilian waterweed)
- Ludwigia spp. (water primrose)
- Japanese knotweed
- *Cape Ivy
- Melaleuca
- Swallowwort
- *Giant reed

Forest and Shade Pest Insects

- *Asian longhorned beetle
- Asian gypsy moth
- *Emerald ash borer (co-op exists)
- *Mountain pine beetle
- *Light Brown apple moth
- Lobate lac scale
- Hemlock wooly adelgid (FS lead, co-op exists)
- Beech bark disease (via scale)

Forest and Shade Tree Weeds

- Hounds tongue
- *Garlic Mustard
- Mugwort
- Yellow nutsedge
- Canada thistle
- Morning glory sp.
- Bermudagrass
- Guineagrass, napier grass
- Tree of heaven
- *Kudzu
- Mile-a-minute
- *Cogon grass
- *Japanese stiltgrass
- *Scotch/French broom

Protected Environmental Areas Insect/Animal Pests

- Asian longhorned beetle
- Asian gypsy moth
- Giant African snail

Protected Environmental Areas Weeds

- Brazilian peppertree (*Schinus terebinthifolius)*
- *Climbing fern (*Lygodium*)
- Melaleuca
- Hydrilla
- *Chinese Tallow (*Triadica sebifera)*

- Yellow toadflax (*Linaria vulgaris)*
- Kentucky bluegrass
- Timothy
- Common tansy
- *Rush skeletonweed
- Russian knapweed
- Diffuse knapweed
- Skunk vine
- Swallowwort
- *Australian pines
- Downy rosemyrtle
- Tree fern
- Scotch broom
- French broom
- Japanese honeysuckle
- Amur honeysuckle
- Tartian honeysuckle
- Beach vitex
- Autumn olive
- Japanese stiltgrass
- **Lepidium* spp.
- Wavyleaf basketgrass

Rangeland, Pasture, Arid Land Crops - Pest Insects

- Grasshoppers
- *Mormon crickets

Rangeland, Pasture, Arid Land Crop - Weeds

- *Lepidium* spp.
- *Cheat grass
- Western Waterhemlock
- Canada Thistle
- Leafy Spurge
- Spotted Knapweed
- Absinth Wormwood
- Toadflaxes (Yellow, Dalmatian)
- *Tropical Soda Apple
- Downy brome
- Foxtail species
- Wild garlic
- Crabgrass species
- Cogon grass
- Multiflora rose
- *Yellow starthistle
- *Purple starthistle
- *Scotch thistle
- *Italian thistle
- *Musk thistle
- *Russian thistle
- Russian olive

Right-of-way insect pests

- Emerald ash borer
- Asian Longhorned beetle

Right-of-way weeds

- Ryegrass
- Bahiagrass
- Cogon grass
- Canada Thistle
- Green Ash
- Leafy Spurge
- Toadflaxes (Yellow; Dalmatian)
- Salt Cedar
- Spotted Knapweed
- Brazilian peppertree
- Bird vetch
- White sweet clover
- *Orange hawkweed
- *Yellow hawkweed
- *Gorse

Postharvests Pests and Quarantine

Top 10 Common Themes Between Post-Harvest and Quarantine Research Needs

- #10: Organics
  (also more generally: sustainable processes, early intervention, reduced pesticide, are goals in all arenas, not just in the organic market)
- # 9: Partnering with APHIS, domestic growers, customers, universities
- # 8: Offshore studies and interdictions. Collaboration with offshore partners
- # 7: Basic biology, behavior, and genomics research
- # 6: Identification of quarantined pests, taxonomy
- # 5: Detection technology
- # 4: Monitoring and interpretation of trap catches
- # 3: Identifying pathways of infestation and exclusion
- # 2: Disinfestation techniques, optimize existing technologies
- # 1: Prevention is the ultimate goal (systems approaches, IPM, etc.)