IPM Plan Guide Sheet Practices for Vegetable Production

This tool has been designed as a guide for developing the integrated pest management (IPM) component of an NRCS Pest Management Plan.

Integrated Pest Management, or IPM, is a long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest-management-related strategies. It coordinates the use of pest biology, environmental information and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources and the environment. IPM provides an effective strategy for managing pests in all arenas from developed agricultural, residential, and public areas to wild lands. IPM serves as an umbrella to provide an effective, all encompassing, low-risk approach to protect resources and people from pests. (IPM Roadmap, USDA, 2004)

IPM can help protect resource concerns by reducing pesticide use and impacts.

Soil - Reducing pesticide use reduces the amount of pesticide in the soil and/or on the soil surface, and potential for impacts on soil biology, and carryover to subsequent crops.

Water - Reducing pesticide use reduces potential for leaching or runoff of pesticides into water and impacts on aquatic life, wildlife, and humans.

Air - Reducing pesticide use reduces potential for drift, air contamination, inhalation toxicity to humans and other animals and deposition on non-target surfaces.

Plants - Reducing pesticide use reduces potential for off-target movement and phytotoxicity to non-target plants.

Animals - Reducing pesticide use lessens potential for exposure and impacts on beneficial and other non-target organisms.

Humans - Reducing pesticide use reduces exposure potential and impacts on applicators, consumers, and others.

The first step in the planning process is to develop a basic pest management plan. NRCS will use the WIN-PST program to evaluate the environmental and human risks of the pesticides to be used. Soil type, methods of pesticide application, and other factors will influence this assessment. NRCS will evaluate which, if any, mitigating practices may be needed to reduce the potential risks and will develop a plan to reduce risks related to runoff, erosion, and/or leaching to groundwater which is specific to the site and resources. Alternatively or in addition, a producer may choose to substitute pesticides that pose less risk in accordance with WIN-PST. Pesticide application setbacks and buffers from sensitive areas will be identified (such as surface waters, schools, residences, neighboring crops, etc.) based upon label instructions for each pesticide and marked on field maps. (Labels may also be viewed at: http://www.greenbook.net/.)

The addition of IPM practices to a pest management plan reflects a higher level of management, with the objective of further reducing the impacts of pesticides used. Implementing IPM practices can enhance the environmental benefits of a plan, and improve the health of crops and the farm system.

To develop an IPM component of a Pest Management Plan, the following requirements apply.

- Pesticide applicators must be properly licensed as per their state regulations. However, it is recommended that all IPM adopters become certified.

- Producer will obtain a copy of the regional IPM guidelines or vegetable production guide for reference and for use in developing the IPM plan. (Contact state Cooperative Extensions. *New England Vegetable Management Guide* available on-line at <http://www.nevegetable.org>. Hard copies available from UMCE Highmoor Farm: 207-933-2100 or University of Massachusetts Outreach Bookstore: 413-545-2717.)

- Develop a pest management plan with NRCS, as above, that includes needed mitigation practices.

- Develop an IPM plan. In addition to items in the pest management plan, you will need to choose appropriate practices from each major category (Prevention, Avoidance, Monitoring, Suppression) in the "IPM Practices" table below. Utilize this table to choose general practices and refer to the regional IPM guidelines, New England Vegetable Management Guide, and/or other references for crop-specific recommendations.

- Keep records. Records form the basis for decision-making including selection of crop rotations, economic thresholds, and suppression options. Keep records of scouting results including pest incidence and distribution, crop plantings/rotations, yields for each crop and field, pesticide applications, cultivations, and other activities.

NRCS encourages the building of soil health as an important part of an IPM plan. Increasing soil organic matter, reducing soil compaction, and managing nutrients will lead to healthier, more pest-resistant plants and reduce the need for chemical or other interventions. Practices that enhance soil quality include:

- Cover crops
- Crop rotation with high residue crops (grains/grass/legumes)
- Residue management/reduced tillage
- Nutrient management
- Mulching with compost or other organic materials
- Manure utilization
- Limiting traffic/tillage on wet soils

IPM PRACTICES FOR VEGETABLE PRODUCTION

PRINCIPLE	PRACTICES	REFERENCES
PREVENTION *"Preventing Pest Populations"* Preventing pest problems reduces the need for pesticide applications and thus potential impacts of pesticides on resource concerns.	Use certified pest-free seeds and pest-free transplants where available. (Example: Purchase certified seed and ensure plants are free of insects, diseases, and weeds before transplanting.	
	Prevent weeds from going to seed. (Example: Cultivate, pull, mow, flame, etc.)	Flaming[9], Organic Weed Management[23]
	Reduce moisture on plant surfaces to prevent disease incidence. (Example: Use drip irrigation or avoid overhead irrigation between 6 p.m. and midnight to minimize disease.)	
	Employ methods to avoid spreading pests (pathogens, weeds and insects). (Example: Work crop when dry, work infested fields last, hose down equipment between fields, etc.)	Organic Weed Management[23]
	Destroy and/or remove crop residues for field sanitation procedures. Include fall tillage where appropriate to control weeds and break pest cycles. (Example: Plow under corn refuse in the fall to control European corn borer.)	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], & NYS IPM Elements[3]
	Eliminate unmanaged plants that serve as pest reservoirs, such as abandoned crops, volunteers from previous crop, or weed hosts of viruses.	
	Test soil or plant tissue annually to determine proper fertility and pH levels for crop and time application according to crop needs. Apply nutrients, fertilizers, and pH-adjusting agents according to recommendations.	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], & NYS IPM Elements[3]

AVOIDANCE *"Avoiding Pest Populations"* Avoiding pest populations reduces the need for pesticide applications and thus potential impacts of pesticides on resource concerns.	Rotate crops that break the pest cycle. Do not plant crops from the same family at less than recommended intervals for the identified pest(s).	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], & NYS IPM Elements[3]
	Match crops to appropriate sites to optimize plant health and avoid known pests. (Example: Avoid planting crops susceptible to fungal diseases in low wet fields.)	
	Choose pest-resistant cultivars. Example: Plant virus and powdery mildew resistant vine crops.	
	Adjust planting dates and select cultivars with maturity dates that allow avoidance of early or late-season pests. (Example: Plant cucurbits after early season striped cucumber beetle activity, delay planting of brassica crops to avoid cabbage maggots.)	
	Use and manage trap crops to protect main crop from insect pests and insect-vectored diseases.	CT fact sheet on Perimeter Trap Cropping[6]
MONITORING *"Identifying the extent of pest populations and/or the probability of future populations"* Monitoring limits pesticide use to those occasions when intervention is needed to prevent economically significant damage to crops.	Monitor for pests as recommended for each crop. If no monitoring guidelines available, monitor weekly to determine presence, density, and locations of pests and to determine crop growth stage. **Record findings. Record keeping is required**. (Example: Scout crops and use other appropriate monitoring aids such as pheromone traps, disease diagnostic tests, etc. Map weeds in the fall to help plan where specific measures may be needed to target problem weeds the following spring. Utilize University of Maine Cooperative Extension pest monitoring data from newsletters and websites.)	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], NYS IPM Elements[3], Invasive Plant Atlas[17], Weed Assessment List[30], other pest identification guides, UMCE IPM[41] programs for pest monitoring services and information
	Use on-farm weather monitoring devices to measure precipitation, humidity, temperature, and leaf wetness and/or use commercial weather prediction service for prevention and control of plant diseases. (Example: Install weather station with rain gauge, hygrometer, maximum and minimum temperature recording equipment, leaf wetness sensors.)	Skybit[33], UMCE Apple IPM Program Forecast[34]

	Use pest-forecasting tools (e.g., computer modeling software) as additional guides for on-farm pest monitoring activities in conjunction with weather data to predict risk of pest infestation.	Cucurbit Downy Mildew Weather Forecaster[31], Pestwatch[32] for corn, UMCE Apple IPM forecast[34], Blite Cast or UMCE Potato Pest Alerts[42]

SUPPRESSION	CULTURAL AND PHYSICAL CONTROLS	
"Using cultural, biological, and chemical controls to reduce a pest population or its impacts" Applying suppression actions only when pest populations exceed the action threshold reduces potential impacts of pesticides on resource concerns.	Use cover crops, especially pest-suppressing crops (allelopathic), in the rotation cycle to reduce weeds and disease incidence and to improve soil quality.	See references 4, 7, 16, 18, 23, and 26 for cover crop guidance and SARE Nematode fact sheet11.
	Plant using appropriate within- and between-row spacing optimal for crop, site, and row orientation. (Example: Use row spacing and plant densities that assure rapid canopy closure.)	See New England Vegetable Management Guide[1] and NYS IPM Elements[3] for crop-specific recommendations.
	Use reduced tillage and other residue management practices to suppress weeds and maintain soil organic matter as appropriate for crop.	See NRCS practice standards 329, 345, 346 for Residue Management.
	Use mulches including plastic or reflective mulches for insect or weed control.	
	Inter-seed cover crop within or between rows to suppress weeds.	See references 4, 7, 16, 18, 23, and 26 for cover crop guidance.
	Use mechanical pest controls. (Examples: Cultivate, mow, hoe, and hand remove insects and weeds, prune diseased or insect-infested plants, remove diseased plants.)	
	Use physical pest controls and deterrents. (Example: Use flame weeding or other heat methods for insect, disease, and weed control; noise-makers; reflectors; ribbons; and predator models.)	Flaming[9], Organic Weed Management[23], Guide to Biological Control[28]
	Use exclusion devices for insects or wildlife. (Examples: Use synthetic row covers and/or fencing.)	Synthetic row covers[5, 38], Organic Weed Management[23]
	Maintain or improve soil aeration and drainage to avoid standing water and minimize plant disease. (Example: Use tile drainage, sub soiling, grassed waterways, raised beds, and organic matter additions. Avoid planting in low and wet spots in field.)	
	BIOLOGICAL CONTROLS	
	Use insect mating disruption devices, if available. (Example: Use pheromone laminate clip-ons or rings for tomato pinworm.)	
	Conserve naturally occurring biological controls. (Example: Select pesticides and time applications to minimize impact on	New England Vegetable Management Guide[1], Environmental Impact of Pesticides (EIQ)[19], Guide to Biological

	beneficials, use floral perimeter crop to attract and support beneficial insects.)	Control[28]
	Release beneficial organisms where appropriate. (Example: Release predatory mites for control of two-spotted mites and thrips.)	Guide to Biological Control[28]
	Use compost as a soil amendment to increase biological diversity in soil and plant health and suppress plant disease.	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], & NYS IPM Elements[3]
	CHEMICAL CONTROLS	
	Minimize chemical use. Use in conjunction with accurate pest identification and monitoring, action thresholds, alternative suppression tactics (biological, cultural, etc), and judgments based on previous year's weed map and/or pest scouting records. (Example: Use pheromone traps to monitor for corn earworm in sweet corn.)	New England Vegetable Management Guide[1], Mid-Atlantic Commercial Vegetable Production Recommendations[2], & NYS IPM Elements[3]
	Select pesticides, formulations, and adjuvants based on least negative effects on environment, beneficials (e.g., pollinators, predators, parasites), and human health in addition to efficacy and economics.	See environmental cautions on pesticide label and Environmental Impact of Pesticides (EIQ)[19]
	Use lowest labeled rate that is effective based on label, scouting results, and Extension-recommended action thresholds for target pest.	Contact state NRCS or Extension office for spray record keeping forms.
	Limit applications to partial fields or banding to reduce quantity or impact of pesticide. (Example: Spot treat where pests are found or use banding, seed, edge or field perimeter/border treatments.)	
	Calibrate sprayers or applicators prior to use to verify amount of material applied.	Pesticide Calibration Guide[8]
	Use pesticide-resistance management strategies as appropriate and where required on pesticide label. (Example: Alternate applications of chemicals with different modes of action to avoid development of pest resistance or leave part of crop unsprayed to serve as a refuge for susceptible pests and natural enemies.)	Managing Pest Resistance to Pesticides[20]
	Use specialized pesticide	

	application equipment to increase efficiency and reduce chemical drift. (Examples: Use wiper applicators, digitally controlled adjustable tool bars, direct injection sprayers, double-drop sprayers, laser guided precision sprayers, direct injection, low-drift nozzles, shielded applicators or air induction booms, built-in tank washers, etc.)	
	Use vegetative buffers, setbacks, or filter strips to minimize chemical movement to sensitive areas such as surface waters, schools, residences, and neighboring crops.	
	Use mitigation practices as necessary in accordance with pest monitoring results, pest predictions, action thresholds, and WinPST output.	
	Pesticide applicator must be properly licensed and certified when using restricted use pesticides or when doing custom pesticide applications for hire. Contact state pesticides regulatory agency for license and certification requirements.	
	NOTE: Additional pesticide use requirements from the 595 Practice Standard: • Always follow all pesticide label instructions and environmental cautions. • Store, handle, transport, mix, use, and dispose of pesticides and pesticide containers per state pesticides regulatory agency recommendations and requirements. • Follow state and federal worker protection standards. • When drawing water for pesticide mixing from any surface waters of the state, use anti-siphoning devices and do not use hoses that have been in contact with pesticides. • Do not mix or load pesticides within 50 ft from the high	**NOTE:** See documents listed in the attached resource list for additional guidance. Unless otherwise noted, your regional vegetable IPM guide or vegetable production guides are the best and most comprehensive resource for IPM practices.

	water mark of any surface waters of the state.	

IPM Practices for Vegetable Production Resource List

IPM Guidelines and Elements

1. Howell, J.C., A.R. Bonanno, T.J. Boucher, R.L. Wick, R. Hazzard, & B. Dicklow. New England Vegetable Management Guide 2006-2007. [The 2008-2009 edition of the guide and supplement are bound together. Available from state Cooperative Extensions, UMCE Highmoor Farm: 207-933-2100, or University of Massachusetts Outreach Bookstore: 413-545-2717.] http://www.nevegetable.org/

2. Mid-Atlantic Commercial Vegetable Production Recommendations. 2007. University of Delaware. [This guide is identical for PA, MD, DE, VA, and NJ]. http://ag.udel.edu/extension/vegprogram/pdf/DEvegrecs2007.pdf

3. NYS IPM elements. n.d. New York State IPM Program. Cornell University. http://www.nysipm.cornell.edu/elements/default.asp

4. Umass Amherst. IPM Guidelines. 2007. http://www.umass.edu/umext/ipm/guidelines/index.html

Crop Specific Guides, Pest Fact Sheets, and Other Resources

5. Bachman, J. 2005. Season extension techniques for market gardeners. National Sustainable Agriculture Information Service. ATTRA Publication #IP035. [Information on floating row covers, mulches and other techniques for pest management, and season-extension.] http://attra.ncat.org/attra-pub/seasonext.html PDF version available at http://attra.ncat.org/attra-pub/PDF/seasonext.pdf

6. Boucher, T.J. and R. Durgy. 2003. Perimeter trap cropping works. University of Connecticut Integrated Pest Management. http://www.hort.uconn.edu/IPM/veg/htms/ptcworks.htm

7. Clark, A. (Ed.). Managing Cover Crops Profitably 3rd ed. 2007. Sustainable Agriculture Network. Beltsville, MD. Handbook Series Book 9. http://www.sare.org/publications/covercrops/covercrops.pdf

8. Dill, J. & G. Koehler (Eds.). 2005. Agricultural pocket pesticide calibration guide. University of Maine Cooperative Extension & USDA. http://pronewengland.org/INFO/PROpubs/CalibrationGuide-small.pdf

9. Diver, S. 2002. Flame weeding for vegetable crops. National Sustainable Agriculture. Information Service. ATTRA Publication #CT165. http://www.attra.ncat.org/attra-pub/flameweedveg.html

10. DuFour, R. 2001. BioIntensive integrated pest management. National Sustainable Agriculture Information Service. ATTRA Publication #IP049. http://www.attra.org/attra-

pub/ipm.html PDF version available online at http://www.attra.ncat.org/attrapub/PDF/flameweedveg.pdf

11. Everts, K., S. Sardanelli, R. Kratochvil, and L.B. Gallagher. 2005. Agricultural innovations fact sheet: Cultural practices for root-knot and root-lesion nematode suppression in vegetable crop rotations. Sustainable Agriculture Research and Education. SARE Publication #06AGI2005. http://www.sare.org/publications/factsheet/0605.htm

12. Flint, M.L. and P. Gouveia. 2001. IPM in Practice: Principles and Methods of Integrated Pest Management. University of California. Publication 3418.

13. Gugino, B.K., O.J. Idowu, R.R. Schindelbeck, H.M. van Es, D.W. Wolfe, J.E. Thies, and G.S. Abawi. Cornell soil health assessment training manual. ed.1.2. 2007. http://soilhealth.cals.cornell.edu/Soil Health Manual Edition 1.2.pdf

14. Hazzard, R., A. Brown, and P. Westgate. 2008. Using IPM in the field: Sweet corn insect management field scouting guide (draft). University of Massachusetts Extension Vegetable Program.

15. Hazzard, R., A. Brown, and P. Westgate. 2008. Using IPM in the field: Sweet corn insect management record keeping book (draft). University of Massachusetts Extension Vegetable Program.

16. Hendrickson, J. 2003. Cover crops on the intensive market farm. http://www.hort.wisc.edu/FreshVeg/Publications/Cover crops on the intensive market farm.pdf

17. Invasive plant atlas of New England. 2004. University of Connecticut. http://nbii-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do

18. Kersbergen, R. Cover crops for soil health. 2005. http://www.newenglandvfc.org/2005_conference/sessions/soil_health/cover_crops_soil_health.pdf

19. Kovatch, J., C. Petzoldt, & J. Tette. n.d. A method to measure the environmental impact of pesticides. New York State Integrated Pest Management. Cornell University. [Environmental impact quotients of pesticides]. http://nysipm.cornell.edu/publications/eiq/default.asp

20. Managing pest resistance to pesticides. 2008. Gemplers. http://www.gemplers.com/pages/tech/ipmresistance.aspx

21. May, H.L. and M.B. Ryan. IPM and wildlife. 2004. NRCS. Fish and Wildlife Management Leaflet. No. 24. [Good introduction to IPM. Illustrated with specific examples.]. ftp://ftp-fc.sc.egov.usda.gov/NHQ/ecs/Wild/IPM_Wildlife.pdf

22. NYS IPM fact sheets for vegetables. n.d. New York State IPM Program. Cornell University. http://www.nysipm.cornell.edu/factsheets/vegetables/

23. Organic weed management. n.d. National Sustainable Agriculture Information Service. http://attra.ncat.org/attra-pub/PDF/IPM/weed.pdf

24. Pest management. 1998. National Association of Soil Conservation Districts. [Tip sheet]. http://www.ma.nrcs.usda.gov/news/publications/pestmgt.pdf

25. Vaughn, M., M. Shepherd, C. Kremen, and S.H. Black. Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. 2nd ed. 2007. Xerces Society for Invertebrate Conservation. Portland, OR. http://www.xerces.org/Pollinator_Insect_Conservation/Farming_for_Bees_2nd_edition.pdf

26. Sullivan, P. 2003. Overview of cover crops and green manure. National Sustainable Agriculture Information Service. ATTRA Publication #IP024. http://attra.ncat.org/attra-pub/covercrop.html

27. Sullivan, P. 2003. Principles of sustainable weed management for cropland. http://www.attra.org/attra-pub/PDF/weed.pdf

28. Weeden, C.R., A.M. Shelton, and M.P. Hoffmann (Eds.). n.d. Guide to biological control: A guide to natural enemies in North America. Cornell University. http://www.nysaes.cornell.edu/ent/biocontrol/

29. Windows pesticide screening tool Win-PST 3.0. n.d. Natural Resources Conservation Service. http://www.wsi.nrcs.usda.gov/products/W2Q/pest/winpst.html

30. Weed Assessment List. n.d. New York State Integrated Pest Management Program. Cornell University. http://nysipm.cornell.edu/scouting/weed_assmt.pdf

Forecasting Service Websites

31. Cucurbit downy mildew forecast homepage. 2008. http://www.ces.ncsu.edu/depts/pp/cucurbit/

32. PestWatch. n.d. Penn State University. [A free internet-based insect and disease forecasting service for sweet corn and other crops. Based on in-season data from Maine and other NE states.]. http://www.pestwatch.psu.edu/

33. Skybit.com. n.d. [Commercial weather service]. http://www.skybit.com/

34. University of Maine Cooperative Extension Maine apple IPM program forecast. 2007. [Includes current and long-range weather forecasts.] http://pmo.umext.maine.edu/apple/forecast.htm

IPM Websites

35. Database of IPM resources (DIR). n.d. http://ipmnet.org/cicp/Vegetable/veg.htm

36. National Sustainable Agriculture Information Service. 2007. [Source for IPM and organic guidelines for many pests and practices]. http://www.attra.ncat.org/pest.html

37. Northeast IPM Center. 2008. [Searchable database of IPM resources]. http://www.northeastipm.org/vege_all.cfm

38. ProNewEngland. [Links to web resources for New England IPM]. http://www.pronewengland.org/INFO/PROInfoCropLivestock.htm

39. UMassAmherst Vegetable Program. 2007. http://www.umassvegetable.org/index.html

40. University of Delaware Cooperative Extension IPM - Vegetables. http://ag.udel.edu/extension/IPM/info/ipmveg.html

41. University of Maine Cooperative Extension Integrated Pest Management. http://www.umext.maine.edu/topics/pest.htm

42. University of Maine Cooperative Extension Potato Program. 2008. http://www.umaine.edu/umext/potatoprogram/