BIODIVERSITY

DESCRIPTION

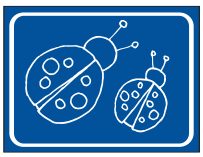
Biodiversity refers to all plants, animals, and microorganisms existing and interacting within an ecosystem.[17] In an agricultural setting, biodiversity can be viewed in layers: microorganisms and worms living in the soil; native plants, crops, and trees growing on top of the soil; and insects, birds, and animals inhabiting the plants, crops, and trees. The greater the number of microorganisms, plants, and animals in an ecosystem, the higher the level of biodiversity is. Humans also live within and alter natural ecosystems.

Biodiversity levels are rapidly declining globally due to increased development by humans. The World Wildlife Fund reports that within the next 30 years, as much as 20% of the world's species will go extinct.[18] Within the United States alone, as of 2003, the Fish and Wildlife Service has classified a total of 1,821 species as threatened or endangered.[19] Other organizations estimate that up to one-third of all plants and animals within the US are at risk.[20] Vermont is also affected by declining biodiversity levels. Vermont has an estimated 2,274 species.[21] Currently, the State of Vermont's Nongame and Natural Heritage Program has identified 28 fish, 19 amphibians and reptiles, 16 mammals, 59 birds, 83 invertebrates (mostly beetles), 20 moths and 12 mollusks as rare and uncommon.[22] The number comprises almost 10% of all species in Vermont. Moreover, eight of these species are listed as threatened or endangered under the Endangered Species Act.[23]

Plant and animal species fulfill a number of important roles in regulating the natural and agricultural environment. Microorganisms and worms in the soil convert nitrogen and other nutrients into a usable form for plants and trees. Plants help to manage water runoff, filter impurities and toxins from water sources, cycle oxygen, and provide habit for animals. Animals, such as bats, spiders, birds and other insects help regulate insect and rodent pests. Insects such as bees help to pollinate crops and wild plant species. Many of these species interact and depend upon one another, making high levels of biodiversity important for the functioning of the entire system.

Agriculture, no matter how small the farm, alters the biodiversity in a landscape through the development of pastureland, crop fields and new structures. Oftentimes, farms are built in floodplains or along rivers and streams, areas typically highest in terms of biodiversity.[24] The implementation of highly managed monoculture systems or development of pastureland displaces native species and reduces the biodiversity upon which the ecological functioning of an ecosystem depends. Genetically modified organisms (GMO) can also displace native species or have adverse impacts on native populations. An example is one strain of Bacillus thuringiensis (Bt) corn, Bt 176. This strain, which is resistant to the European corn borer (a pest which costs US farmers approximately $1 billion in lost crop yields and crop protection costs), led to a severe decline in populations of monarch butterflies.[25] Luckily the effects of the strain were small-scale in that only an estimated 2% of GMO corn was Bt 176 compared to strain MO810, which accounts for almost 95% of planted GMO corn.[26] While this particular strain has since been removed from the marketplace, new GMOs may also have negative, unintended consequences.

Sustainable agricultural processes that foster biodiversity through natural means and low-impact management practices provide an alternative. These processes help restore ecosystem functioning and increase biodiversity levels.[27] Practices such as low-till and no-till farming of feed crops, inter-species plantings, grazing-based management, integrated pest management techniques and other practices allow farmers to decrease use of costly external inputs such as fertilizers, pesticides, and GMO seed and replace these inputs with natural processes.[28]



INCENTIVES FOR CHANGE

- **Decrease in expensive external inputs.** The benefits of increasing biodiversity are most readily seen when the farm is viewed as part of an ecosystem. The key is to "identify and exploit combinations of crops, plants, animals, and practices that increase above- and below-ground diversity and foster proper ecosystem functioning."[29] For example, the use of no or low-till cropping practices maintains soil structure in the top layers of the soil surface, which provides habitat for species which recycle nutrients for plants. One square meter may contain 10,000 species with high population densities.[30] These species assist plants in nutrient uptake and protect plants from disease.[31] If destroyed by tillage practices and the application of certain pesticides, these species must be replaced by costly fertilizers as a means of maintaining production levels.

- **Marketing opportunity.** Marketing opportunity. Certifications for environmentally and socially responsible agricultural production, awarded by groups such as the Food Alliance program (www.thefoodalliance.org), require that farmers work to enhance biodiversity. This sustainable farming certificate may allow farmers to receive a premium for their practices. Genetic biodiversity is also marketable. Most dairy farmers focus on the genetic lineage of their cows or utilize different cultivars when growing crops. Registering cows to certify genetic lineage may allow a farmer to receive higher prices for heifers sold in the marketplace.

ASSESSMENT QUESTIONS

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance

GENETIC DIVERSITY OF CROPS

❑ 1. I have primarily grown the same crops in my fields for years, and follow manufacturer's recommendations for applications of fertilizers, pesticides, herbicides and fungicides.

❑ 2. I rotate different crops throughout my fields each year, and follow manufacturer's recommendations for applications of fertilizers, pesticides, herbicides and fungicides.

❑ 3. I rotate different crops throughout my fields each year, and regularly use soil tests to decide on the levels of nutrients and fertilizers needed in each field, and limit applications of pesticides, herbicides and fungicides.

❑ 4. I utilize cover crops and include fallow fields within my crop rotation plans to help build soil health. I rotate different crops throughout my fields each year, regularly use soil tests to help determine the levels of nutrients and fertilizers needed in each field, and limit applications of pesticides, herbicides and fungicides through use of Integrated Pest Management practices.

Chromosomes, genes, and DNA "determine the uniqueness" of each individual within a species. Having an array of unique individuals or a genetically diverse number of seed types is important to protect crops from disease and other natural events such as drought that may wipe them out.[32] Increasing the number and types of crops throughout the farm's field also provides habitat for species, which increases biodiversity as well as encourages inhabitation by beneficial species such as spiders and birds.

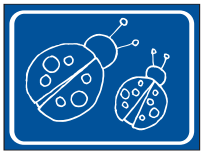
NATURAL AREA CONSERVATION [33]

❑ 1. Few, if any, wild habitat areas exist around fencerows, fields or wooded areas to provide habitat for birds, mammals, or other wildlife.

❑ 2. Fencerows, fields and other areas are managed to provide limited wildlife habitat. Any pastures on the farm are in good health and provide limited wildlife habitat.

❑ 3. Fencerows, fields and other areas are managed to provide wildlife habitat. A percentage of pastures, rest pads, ditches and other wild areas are not grazed or mowed until grassland bird nesting is complete. Pastures and fields are managed to promote for multiple (domestic and wild) species.

❑ 4. Fencerows, fields and other areas are managed to encourage wildlife habitat. Specific actions are planned and have been taken to improve and enhance wildlife habitat on the farm. Wildlife Habitat Improvement Plan (WHIP) has been developed and approved by USDA-NRCS.



Management for natural areas provides habitat for beneficial organisms and other forms of wildlife. While many farmers in the Champlain Valley may already utilize hedgerows and the natural features of the land to provide habitat for biodiversity, farmers in Northern and Southern Vermont may not. Well-structured habitat management plans help ensure higher levels of biodiversity.

MANAGEMENT OF RIPARIAN AREAS [34]

Riparian areas are "the edges of streams, wet weather creeks, ditches, or any other area where water flows at various times of the year."[35] If you have a riparian area on your property, please indicate how you manage your cows:

- ❑ 1. Pastures and confinement areas are less than 50 feet from surface water sources. Cow access to surface water sites is only limitedly restricted.
- ❑ 2. Pastures and confinement areas are at least 50 feet from surface waters. Cow access to surface water sites is restricted by fencing or vegetation.
- ❑ 3. Pastures and confinement areas are at least 50 feet from surface waters. Cow access to water sites is restricted to ensure healthy stream bank vegetation, adequate bank angles, and natural water habitat conditions without visible signs of erosion, sedimentation, and manure deposition in water.
- ❑ 4. Watering sites are developed and located away from stream courses, and cows are not allowed direct access to streams. Cow access to water sites is restricted to ensure healthy stream bank vegetation, adequate bank angles, and natural water habitat conditions without visible signs of erosion, sedimentation, and manure deposition in water.

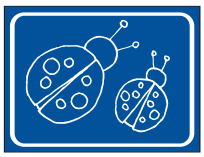
Riparian areas on farms provide unique habitats for a diverse set of plants and organisms and are often the most diverse in a given ecosystem.[36] They are therefore a priority for managing biodiversity on a farm. Cows around water bodies can cause erosion, trample diverse populations of aquatic vegetation, and cause high nutrient levels in streams due to uncontained manure. Management of cows to prevent water body damage increases ecosystem health and biodiversity levels.

PASTURE MANAGEMENT [37]

- ❑ 1. I do not use pasture grazing on my farm.
- ❑ 2. Pastures, if available, are managed as "exercise areas" with limited emphasis on nutritional quality or environmental impact.
- ❑ 3. Beneficial natural plant varieties are established and maintained. Any planted varieties are selected to promote integration in the existing pasture in order to establish a more nutritional pasture base. However, pasture plays only a limited part in overall farm plan.
- ❑ 4. Pasture site and plant varieties are carefully selected and play a significant role in overall farm plan and are designed for optimum nutrition and environmental conservation practices. Animals are regularly rotated to different pastures. Managed Intensive Grazing (MIG) practices are used on a regular basis.

CROP FIELD MANAGEMENT [38]

- ❑ 1. New plantings are established following manufacturer's recommendations for applications of fertilizers, pesticides, herbicides and fungicides with limited regard to environmental impact.
- ❑ 2. Varieties and planting systems are selected that are compatible with current Integrated Crop and Pest Management methods. No-till or minimum tillage planting is often used to reduce soil erosion.
- ❑ 3. Varieties and planting systems are selected and designed as above, with at least some of the acreage in (non-GMO) pest-resistant varieties and/or designed to maximize habitat for beneficial organisms. Chemical pre-plant fumigants or other pesticides, herbicides or fungicides, if used, follow a Integrated Pest Management Plan to reduce their overall impact on the environment, and if used are applied by a certified custom applicator.
- ❑ 4. Above practices are followed to encourage optimum production with minimal agrochemical inputs. Sites are selected or otherwise prepared to avoid harmful nematodes or pre-existing disease conditions. Cover crops, no-till practices and crop rotations incorporated within whole farm plan which does not use genetically engineered seed in the system. The edge of croplands are "buffered" from surface water by a strip of non-cropped vegetation.



Depending upon land management practices, species may be displaced or even lost. Managing pasture and crop field lands in ways that enhance habitat increases production while only minimally impacting biodiversity. Herbicides and fungicides can kill not only pests, but also beneficial plants and fungi that may enhance nutrient uptake and provide disease resistance

ADJACENT AREA MANAGEMENT (LANDS SURROUNDING YOUR CROPLAND) [39]

- ❑ 1. Areas adjacent to cropland or pasture are not included within the farm plan.
- ❑ 2. Wooded and other areas adjacent to cropland or pasture under the control of the farmer are managed in response to known pest problems.
- ❑ 3. In addition to #2, adjacent areas are managed to reduce potential for pest immigration as well as pesticide and fertilizer movement off-site and to encourage wildlife.
- ❑ 4. In addition to # 3, adjacent areas are planted with hedgerows, windbreaks, or other low-maintenance plantings to encourage specific beneficial organisms and/or native wildlife.

While land ownership stops at property lines, ecosystems function across ownership boundaries. Managing what comes into and flows off your property can adversely or beneficially impact biodiversity.

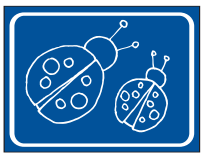
GMOS (Check all that apply.)

- ❑ I do not use rBST.
- ❑ I do not use GMO crops.

Genetically modified organisms (GMOs) are defined as "organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating or natural recombination."[40] The Genomes Project of the US Department of Energy Office of Science cites that some potential benefits associated with GMOs include: improved quality and taste, increased yields due to decreased loss from pests and disease, increased disease resistance (which decreases the need for costly herbicides and insecticides), and new products. While this may be true, the risks associated with GMO use are also large. Some potential risks include production of new allergens, loss of flora and fauna biodiversity, unintended cross-pollination with natural crops, and problems associated with access to intellectual property.

Controversies over the use of GMOs have been especially strong in Europe where strict regulations have been instituted for approval of GMOs.[41] [42] The newest directive, Directive 2001/18/EC, requires in-depth environmental assessments and public comment on the approval and release of any new GMOs. Public backlash against GMOs has caused concern both in the US and Europe. As early as 1999, Archer-Daniels-Midland asked US producers to separate GMO and non-GMO stock due to increasing demands for non-GMO products in Europe and Asia.[43] This trend against the use of GMO-altered crops and animal products may indicate a growing social backlash and financial risk to farmers using GMOs. Vermont itself has a number of active pieces of legislation trying to limit the use of GMO seed.[44] Given these developments and potential negative consequences, a better alternative may be the implementation of an integrated pest management plan, which utilizes natural pest management methods and limited pesticide use instead of GMOs.

rBST is one controversial GMO also known as bovine growth hormone (BGH), or bovine somatotropin (BST), is produced by the pituitary gland in cows and affects milk production. Genetically engineered microorganisms have been developed to produce an almost identical hormone [recombinant bovine growth hormone (rBGH)] that when injected into dairy cattle, can increase milk production by 10% to 15%.[45] Other potential negative effects of rBST include excess milk production and probable udder pain for cows, increased udder infections, bacteria, pus, and antibiotic resistance.[46] These impacts in cows can be passed on to humans with links to increased risk of cancer and antibiotic resistance.[47] Due to controversy surrounding the hormone, rBST has been banned in Europe and rejected by a number of companies including Ben & Jerry's.



LINKAGES TO OTHER MODULES

Water quality issues are tied to Soil, Animal Husbandry, and Pest Management. The table below identifies where you can find more information on some of the topics mentioned in this module.

BIODIVERSITY TOPIC	OTHER MODULE(S)
Cover Crops	Soil Health
Pasturing	Animal Husbandry
Crop/Pasture Insect Pests	Pest Management
Weeds	Animal Husbandry

FURTHER INFORMATION

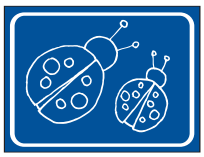
Additional details and information on the above can be obtained through the following programs or sources.

- Altieri, Miguel. "The ecological role of biodiversity in agroecosystems." Agriculture, Ecosystems and Environment 74 (1999) 19-31. This article details how biodiversity is essential to a healthy and naturally-functioning agricultural system. It also describes management practices for enhancing biodiversity and restoring ecosystem function to farm lands.

- Appropriate Technology Transfer for Rural Areas (ATTRA) "Sustainable Agriculture: An Introduction." http://attra.ncat.org. ATTRA specializes in developing sustainable agricultural information and tools. For a summary of the practices they advocate regarding biodiversity, see "Sustainable Agriculture: An Introduction" at http://attra.ncat.org/attra-pub/PDF/sustagintro.pdf.

- The Food Alliance. http://www.thefoodalliance.org/. This organization certifies producers, which use socially and environmentally responsible farming practices. The certification process includes sections on natural area management, watershed management, crop management, pest management, pastureland management, and animal welfare. Details on biodiversity are included under wildlife habitat.

- Center for Sustainable Agriculture, University of Vermont. http://www.uvm.edu/sustainableagriculture. The Center for Sustainable Agriculture was established in 1994 as a unit within the University of Vermont to integrate university and community expertise to promote sustainable farming systems throughout Vermont and the region.



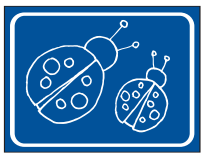
SUMMARY RESULTS FOR BIODIVERSITY

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Genetic Diversity of Crops	
2. Natural Area Conservation	
3. Management of Riparian Areas (If you don't have any riparian areas on your property, give yourself 4 points)	
4. Pasture Management	
5. Crop Field Management	
6. Adjacent Area Management	
7. GMOs (Add 1 for each box checked)	
Total Score (Out of Possible 25)	

Interpretation: The next step in understanding your farm's performance in the category of Biodiversity is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	Interpretation
Green	21 – 25	Best practices regarding Biodiversity are currently being employed on this farm.
Yellow	16 – 20	Farm is using some good practices regarding Biodiversity; however there are some key areas that should be improved upon.
Red	6 – 15	Biodiversity management practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.



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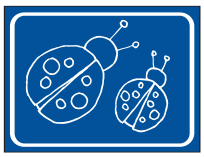

Footnotes

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38 Ibid.

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47 Ibid.