NON-CHEMICAL & INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is a science-based decision-making process that combines tools and strategies to identify and manage pests. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

Pests are any organisms (including plants and animals) that pose health, environmental, economic, or aesthetic risks. An organism that is a pest in one environment may be benign or beneficial in others. IPM is relevant in all areas where pests may exist, including agriculture, forests, parks, wildlife refuges, and military bases, as well as residential and public areas, such as schools and public housing.

IPM provides economic, health, and environmental benefits. The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. IPM practitioners use knowledge of pest and host biology in combination with biological and environmental monitoring to respond to pest problems with management tactics designed to: prevent unacceptable levels of pest damage; minimize the risk to people, property, infrastructure, natural resources, and the environment; and reduce the evolution of pest resistance to pesticides and other pest management practices.

- **MULCHING**
- **SOLARIZING**
- **TARPING**
- **FABRIC**
- **MANUAL & MECHANICAL REMOVAL**
- **FLAMING**
- **CONTROL BURNS**
- **SEED TREATMENT**
- **GRAZING**
- **BIOLOGICAL CONTROL**

MULCHING

DEFINITION

A mulch is a layer of material applied to the surface of soil. Reasons for applying mulch include conservation of soil moisture, improving fertility and health of the soil, reducing weed growth, and enhancing the visual appeal of the area. A mulch is usually, but not exclusively, organic in nature.

PURPOSE

To prevent erosion by protecting bare soil from rainfall and wind, reducing runoff velocity, conserving moisture, and fostering plant growth. Mulches can be composed of straw, wood chips, bark, pine needles, recycled paper, wood fibers, cotton, flax, or gravel, and they act to protect soil and enhance seed germination by reducing evaporation and insulating the soil.

PLANNING CRITERIA & IMPLEMENTATION

Applicable to all bare soil surfaces where construction activities will cease for 14 days or more and will not resume within 21 days. Provides a temporary or permanent cover and aids in stabilization measures. Immediately follow temporary and permanent seeding of an area with mulching.

Additional control measures may be necessary for the establishment of vegetation if the area is susceptible to erosion. Straw and wood chip mulch require removal before soil stabilization or permanent seeding is to take place. Straw and wood mulch are prone to removal by runoff and wind if not correctly anchored. Wood fiber hydraulic mulches may be short-lived. Recycled paper lasts longer. A strong potential for introducing weed-seed and unwanted plant material exists with use of pine needles and un-certified straw.

The type of mulch to be applied depends on soil type, site conditions, landscape requirements, and economics. Roughen embankments and fill areas before applying mulch.

MAINTENANCE

- Inspect for failures and loss of mulch during the wet season.
- Reapply immediately if disturbed.

SOLARIZING

DEFINITION

Soil solarization is a nonchemical method for controlling soilborne pests using high temperatures produced by capturing radiant energy from the sun. Solarization leaves no chemical residues and is a simple method appropriate for the home gardener and small- or large-scale farmers.

PURPOSE

Solarization is primarily used as a broad-spectrum pest control technique, but it may also improve soil health by increasing the availability of nitrogen and other nutrients to growing plants and by beneficially altering the soil microbiome.

PLANNING CRITERIA & IMPLEMENTATION

Solarization involves heating the soil by covering it with clear plastic for four to six weeks during a hot period of the year and when the soil will receive the most direct sunlight. Plastic tarps allow the sun's radiant energy to be trapped in soil, heating the top 12 to 18 inches to temperatures lethal to a wide range of soilborne pests; including weeds, plant pathogens, nematodes, and insects. When properly done, the top layers of soil will heat up to as high as 140°F, depending on the geographic location. Soil moisture is important in this process, as wet soil conducts heat better than dry soil. Moisture also makes soil pests, weakened by the heat, more vulnerable to attack by beneficial soil microorganisms during and after treatment.

The effect of solarization is greatest at the surface of the soil and decreases at deeper soil depths. The maximum temperature of soil solarized in the field is usually from 108° to 140°F at a depth of 2 inches and from 90° to 99°F at 18 inches. Control of soil pests is usually best for organisms found in the upper 6 inches of earth. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes, and weed seeds and seedlings.

MAINTENANCE

- Inspect for and immediately repair tarp and covering material failures.

TARPING

DEFINITION

Tarping, or occultation, involves the use of durable black plastic, often sourced as silage covers, that is applied to the soil surface between crops and removed before planting. Tarping differs from solarization in that black plastic is used in tarping, and clear in solarization.

PURPOSE

Tarps have become a multifunctional tool for small-scale and organic vegetable farms. Tarps are reusable over multiple years and adaptable to different applications and planting times over the season. They function as a soil health and weed management tool and serve as a valuable "placeholder" on the farm to hold beds weed-free between plantings. Tarps are working to do many different things - create a stale seed bed for the following crop, kill crops and weeds after harvest, terminate cover crops, and control soil moisture to improve field access in spring.

PLANNING CRITERIA & IMPLEMENTATION

Many of the challenges associated with tarping are logistical, including applying and securing them, moving them across fields, water ponding, and finding time in the rotation to fit them, especially in the middle of the season. Solarization tends to be more effective under suitably warm and sunny conditions, although tarping may be more suitable for some applications. With either practice, the plastic may be removed before planting, allowing for reuse, or left in place with holes cut through it to allow for transplanting.

MAINTENANCE

- Inspect for and immediately repair tarp and covering material failures.

FABRIC

DEFINITION

Pest control fabric or netting is an important (Integrated Pest Management) IPM tool. The fabric is well suited for use on net houses, greenhouses, pollination cages and hoop houses/quonsets.

PURPOSE

These nets block the entry of pests into crop environments and reduce the need to apply pesticides.

PLANNING CRITERIA & IMPLEMENTATION

Insect barriers are made of porous fabric with a mesh sufficiently small to exclude certain insects, preventing them from damaging or otherwise interfering with a crop, without excluding light and rainfall.

MAINTENANCE

- Inspect for and immediately repair fabric and netting material failures.

MANUAL & MECHANICAL REMOVAL

MANUAL WEED REMOVAL:

DEFINITION

Weeds are removed and collected from crop fields or greenhouses by hand.

PURPOSE

- Prevent yield loss due to weed competition.
- Maintain purity and/or quality and market price of harvested product.
- Prevent build-up of weed seeds in soil.
- Prevent weeds that may attract insects or rodents or act as a host for diseases.
- Prevent clogging of field irrigation channels to facilitate water flow.
- Reduce time and cost of land preparation and weeding operations.

PLANNING CRITERIA & IMPLEMENTATION

Weeds need to be controlled from planting until the crop canopy closes. Start hand weeding within two weeks of planting (or when weeds are large enough to grasp). Repeat at regular intervals. Do not allow weeds to flower and set seeds in a crop field. Use good land leveling to reduce weeds.

MAINTENANCE & LIMITATIONS

- Labor-intensive, costly, and time-consuming.
- High drudgery and stress on labor force.
- Difficult if the soil surface is not moist and loose.
- Difficulty in identifying and removing certain grassy weeds at early stages.

MECHANICAL WEED REMOVAL:

DEFINITION

Mechanical weed control generally uses some type of mechanical implement pulled by a tractor to physically slice, chop, or uproot small weeds. Mechanical weed control can also include mowing, hand hoeing, tilling, or hand removal.

PURPOSE

Mechanical weed control involves the use of man-made implements to remove or control weeds, rather than the use of herbicides sprayed on crops or farmland.

PLANNING CRITERIA & IMPLEMENTATION

To ensure a successful growing season, a plan for managing the weeds in a field should be devised, with mechanical weed control as an effective and efficient way to reduce weeds in an operation. The production vegetable or row crop grower growing beyond the hand-scale will see the greatest benefits from mechanization. Designed fields and spaced plantings to accommodate a tractor and tractor mounted tools are the main components and considerations for utilizing mechanical weed control.

MAINTENANCE

As with manual weed removal, growers will need to regularly check their crop for new and missed growth during initial weeding.

FLAMING

DEFINITION

Flaming typically involves sweeping a propane torch flame over very young plants, causing their cells to rupture from the heat.

PURPOSE

Flaming is used to control carpets of seedlings of broadleaf weed species that germinate together in large numbers and are localized in small areas. Flaming is most effective on seedlings from the cotyledon stage to the six true-leaf stage. The ability of this technique to outpace production of propagules is dependent on implementation of technique and timing.

PLANNING CRITERIA & IMPLEMENTATION

This method has a narrow range of conditions under which it can be applied effectively, including high site moisture (too wet to support fire), small spatial scale, accessibility to roads, and early phenological stage of plants. Despite this narrow range, it is a helpful tool to incorporate into an IPM program because it lengthens the weed treatment season by effectively targeting seedlings early in the season that would otherwise take more time to control manually. Flaming also has the advantages of not leaving plant debris behind and leaving soil surfaces intact. Flaming may have the added benefit of forcing germination of seeds in the soil. With follow-up treatment, this technique can shorten the longevity of the seedbank.

Flaming is intended to wilt a plant, not burn it. Burning with a propane torch takes significantly more time per plant than flaming, is not any more effective, and poses a greater risk of fire. Seedlings that have their growing tips above-ground and have poorly developed roots are the most susceptible. Grasses and other monocotyledonous plants with their growing tips at or below-ground or at ground level are likely to regrow after flaming unless they are very young seedlings. Older plants with well-established root systems cannot be effectively controlled with this technique unless they have no capacity to regrow after being damaged. Plants that reproduce vegetatively cannot be controlled with flaming unless repeated treatments are used to deplete carbohydrates stored in roots below ground.

MAINTENANCE & SAFETY CONSIDERATIONS

Flaming can have non-target effects such as killing desirable plants in its path that are unable to regrow. Recruitment of desirable competitive species may be an important consideration in your long term weed management plan and should be considered. Alternatively, there may be very little desirables in the seed bank if the weed infestation is old enough to have exhausted other species. In this instance there may be very little desirable species that can immediately recruit. Additionally, flaming has the potential to kill any ground-dwelling organisms immediately in the path of the flame.

This technique is most effective when followed up by manual removal of plants that emerged after treatment or that did not die as a result of flaming. Where additional weed seed is stimulated to germinate, follow-up flaming can further reduce the seed bank. Mowing, raking, or brush removal prior to flaming will reduce flammable thatch and increase surface area for seedlings to germinate. Flaming should not be conducted in dry conditions or with excessive thatch that might catch fire. Fire extinguishing equipment (water and fire rakes) should always be on hand in the event that vegetation catches fire. Flaming is not generally recommended for seed bank control because of the high heat required to kill seeds. It is most efficient for small areas because it is both very labor- and fuel-intensive at larger scales.

CONTROL BURNS

DEFINITION

A prescribed fire or controlled burn is the carefully planned and controlled application of fire to an area.

PURPOSE

The purpose of a controlled burn is to accomplish land management goals, including fuels reduction, invasive species removal, and habitat restoration.

PLANNING CRITERIA & IMPLEMENTATION

Controlled burning is recommended only when:

- The weed is an annual plant, such as yellow starthistle, that reproduces by seed.
- The infested area has a large amount of decadent material or thatch.
- The infested area does not have many desired species that could be negatively impacted by the fire.
- There must be intensive planning to ensure the burn is safe and contained.

MAINTENANCE & SAFETY CONSIDERATIONS

- There must be a plan for restoration or reseeding after the burn on the newly disturbed area.
- Seedbanks of noxious weeds can still remain after fire.
- Specific noxious weed species respond with increased growth after fire and this method can be counter productive.

SEED TREATMENT

DEFINITION

Seed treatment is the application of substances to seeds before sowing.

PURPOSE

The goal of seed treatment is to protect the seeds and future seedlings from pests and pathogens. Seeds are treated with a physical, chemical or biological agent before sowing. Agents include products such as insecticides, fungicides, nematicides, but also biocontrol agents. Opting for natural seed treatment substances like biopesticides can effectively protect crops in their most vulnerable state and enhance plant health while improving agricultural sustainability.

PLANNING CRITERIA & IMPLEMENTATION

The applied treatment coats seeds, which forms a barrier on their surface. This barrier will deter foreign pests and pathogens. It targets organisms that might attack stored or germinating seeds or young crops during emergence or early growth.

Seed treatment is beneficial against pests and diseases that are seed and soil-borne. It works also against pest and diseases that attack crops early in the season. These harmful organisms are usually very destructive when not managed in time. Crops are the most susceptible to attacks in their early growth as their immune system has not fully developed yet.

Treating seeds can encourage crops to grow healthy and become robust, which will help them overcome future pest attacks.

MAINTENANCE

Seed treatment can prevent growers from resorting to harsher, less environmentally-friendly, and more expensive control methods once a pest or disease is detected. Through seed treatment, growers can provide their crops with an immediate defense against potential threats. This doesn’t guarantee that pests will be kept under control. However, along with other IPM measures such as crop rotation, biological control, and cultural practices, seed treatment helps maintain a balance between pest control and environmental sustainability.

GRAZING

DEFINITION

A livestock/wildlife grazing system in which two or more grazing units are alternately deferred or rested from grazing in a planned sequence over a period of years. The rest period may vary in duration given the specifics of the grazing area (i.e. season, year, etc.).

PURPOSE

1. To maintain or improve plant cover, plant composition and forage production while properly using the forage on all grazing units.

2. To improve efficiency of grazing by uniform use of all parts of each grazing unit.

3. To provide a supply of forage throughout the grazing season.

4. To improve the quality of forage available to animals during specific seasons.

5. To protect watersheds, reduce runoff and sedimentation for the improvement of surface and ground water quality.

6. To improve wildlife habitat.

APPLICABILITY

Applies to native grazing lands, including those treated by spraying, seeding, etc., grazable woodlands and grazed wildlife lands. Grazing management may be applied to a single grazing unit and may be adequate to meet water quality objectives where proper grazing use and uniform distribution can be obtained.

PLANNING CRITERIA

The grazing system plan should:

1. Consider the climate, soils, range sites, present vegetative conditions, topography and other ecological conditions.

2. Allow forage use allocation for livestock and wildlife.

3. Be coordinated among all effected interests and natural resources. A "watershed" view should be established to identify all of the resources and interests. The coordinated approach should include federal land management agencies, state agencies, private land owners, other grazing users and applicable special interest groups. A variety of Resource Management and/or grazing systems are available given the specifics of the site including Holistic Resource Management, Coordinated Resource Management, and Savory Grazing Systems, to mention a few.

4. Consider specific management measures to alleviate livestock distribution problems such as concentrated use of riparian areas or other critical areas.

5. Should consider the kinds of livestock and the operator's objectives in conjunction with the federal land management objectives if the plan involves public lands.

6. Allow for practical application of the system and be flexible enough to meet the needs of key plant species and communities in relation to climatic fluctuations.

7. Consider the facilities needed for proper distribution and uniform use of grazing units such as fences, stock water developments, stock trails, access roads, salt, and supplemental feeding stations.

8. Provide for prolonged drought or other unusual circumstances. A monitoring plan should be included which monitors plant species use and condition with respect to the desired condition.

9. Consider economic costs in relation to the benefits expected from the entire system.

METHODS AND MATERIALS

1. **Grazing Management Systems** - Appropriate grazing management systems ensure proper grazing use by adjusting grazing intensity and duration to reflect the availability of forage and feed designated for livestock uses, and by controlling animal movement through the operating unit of range or pasture. Practices that accomplish this include:

   A. Deferred grazing - usually is defined as the postponing or resting of livestock grazing on an area for a prescribed period to provide for plant reproduction, establishment of new plants, or restoration of vigor to existing plants.

   B. Deferred-rotation grazing - Provides for a systematic rotation of deferment among two or more units.

   C. Rest-rotation grazing - Provides for adequate rest to restore and maintain plant vigor, reduced trampling of mature seeds after plant maturity, and establishment of seedlings. Grazing and rest are systematically rotated until all pastures within the system have received treatment. Rest periods may be throughout the year, during the growing season of key plant species or may include one full year of rest.

2. **Livestock Distribution** - Proper distribution of livestock is needed for the efficient and uniform use of each grazing unit. A livestock operator can implement the management practice of herding or moving livestock when the desired plant use has been attained in a given area:

A. Fencing - Fences are usually required for livestock control and to divide ranges into grazing units of near equal capacity. Fences are also needed to exclude livestock from sensitive or critical areas. (See Appendix G-5 for fencing guidelines and specifications)

B. Stockwater Developments - It is essential to provide adequate water for livestock within reasonable distance of the grazing areas. Implementation of an improved grazing system often concentrates livestock requiring development of new or higher capacity watering facilities. In some applications water alone can be controlled to move livestock from one area to another.

There are several methods of developing stock water, including:

(1) Spring developments - Improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities.

(2) Wells - Constructed or improved to meet the needs of livestock and wildlife.

(3) Stockwater ponds and dugouts - A water impoundment made by constructing a dam or an embankment, or by excavation of a pit or dugout.

(4) Pipelines, trough or tank - Pipeline to convey water to areas with no water source and a trough or tank for storage.

(5) Photovoltaic pumping systems.

(6) Ram pumps.

(7) Windmills.

C. Stock Trails - May be needed where natural or man-made barriers limit access and movement of grazing animals. (See Appendix G-4 for guidelines and specifications for stock trails)

D. Salt, Mineral and Feed Supplement Locations - These need to be properly placed for good distribution of grazing animals throughout each grazing unit. They may be placed in light use areas away from water.

3. **Access** - It is necessary to have good access to all grazing areas for livestock management and to service and maintain facilities. Refer to NRS.535.010 on permit requirements for stock watering ponds and dams.

MAINTENANCE

Proper grazing use will maintain enough live vegetation and litter cover to protect the soil from erosion; will achieve riparian and other resource objectives; and will maintain or improve the quality, quantity and age distribution of desirable vegetation. Maintain fences and other facilities for efficient operations. Follow proper grazing use, that is, grazing at an intensity that will maintain plant cover and maintain or improve the quantity and quality of desirable vegetation. Adjust system plans based on inspection and records of utilization.

EFFECTIVENESS

A properly operated grazing system provides for efficient use of forage and is an effective means of maintaining a plant cover that will reduce runoff and sediment delivery. How effective grazing management will be is dependent upon both the quality of the design in relation to the land and the skill utilized to implement, monitor and adjust management to meet objectives.

BIOLOGICAL CONTROL

DEFINITION

Biological control involves the reduction of pest populations through the use of natural enemies such as parasitoids, predators, pathogens, antagonists, or competitors to suppress pest populations.

PURPOSE

Natural enemies of insects play an important role in limiting the densities of potential pests. These natural enemies include predators, parasitoids, and pathogens. Biological control of potential pest insects can be increased by: 1) conservation of existing natural enemies, 2) introducing new natural enemies and establishing a permanent population, and 3) mass rearing and periodic release of natural enemies, either on a seasonal basis or inundatively.

PLANNING CRITERIA & IMPLEMENTATION

Biological control can be classified into three basic categories namely conservation, classical and augmentation. First, conservation biological control involves the deliberate practice aimed at promoting the survival and activity of natural enemies at the expense of pest populations. For example, ecological strips consisting of selected non-crop plants can be deliberately created to provide food sources and overwintering shelters as well as protect local natural enemies from pesticide disturbances thereby enhancing classical biological control as successfully shown in cereals, cabbages, and fruit orchards.

Second, classical biological control involves collection of natural enemies from their area of origin and releasing them in the new area where their host was introduced accidentally. This is of particular importance when the introduced pest species has no known alternative parasitoids indigenous to the area. However, the efficacy of a classical biological will depend on the newly released parasitoids to successfully establish populations that can compete in the new environment.

Last, augmentative biological control is the periodic release of large numbers of mass-reared natural enemies with the aim of supplementing natural enemy populations or flooding (i.e., inundating) pest populations with natural enemies. It is commercially deployed in various cropping systems worldwide and two forms of control are distinguished namely the inundative approach and the seasonal inoculative method. In the inundative release method, the biological control agent is collected, mass-reared and released periodically in large numbers as for example a biotic insecticide to achieve immediate pest control in crops where viable breeding populations of the natural enemy are not possible.

The seasonal inoculative approach differs from inundative method in that it is deployed in short-term crops, the production season of which is not longer than one year and where multiple pest generations occur. The aim of the method is to obtain both immediate pest control as well as a build-up of the biological control agent population over the entire duration of the same production season.

MAINTENANCE & CONSIDERATIONS

Biological control is a practical option for suppressing pest populations because:

- It is easy and safe to use.
- It is a very cost effective and environmentally sound method of pest control, especially compared to the broad-spectrum pesticides often used.
- It reduces the use of conventional pesticides.
- It can be implemented as part of an Integrated Pest Management (IPM) program.
- Once established, populations are typically self-sustaining.
- It is target specific.