

Guidelines on Best Practices for Roadside Weed Management using Herbicides in Mauritius

Prepared by

The Ministry of Environment, Solid Waste Management and Climate Change

in collaboration with

The Ministry of Agro-Industry, Food Security, Blue Economy and Fisheries;

The Ministry of National Infrastructure;

The Ministry of Health and Wellness;

The Ministry of Labour and Industrial Relations;

and

The Ministry of Local Government

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Their contributions have been instrumental in ensuring that these guidelines reflect the key aspects for best environmental practices, safeguard public health, and promote the responsible and sustainable use of herbicides for roadside weed control across Mauritius.

The Ministry looks forward to the continued collaboration of all stakeholders in the successful implementation of these guidelines for the protection of our environment and the well-being of the population.

Disclaimer:

This Guideline is restricted for the purpose for which it is recommended only. The Ministry of Environment, Solid Waste Management and Climate Change shall not be responsible for any act that may arise outside the purview of this guideline.

Definitions

Pesticide

A pesticide refers to any substance or combination of substances intended to prevent, destroy, repel, or mitigate any pest. The term encompasses a wide range of chemical or biological agents including herbicides, insecticides, fungicides, nematocides, and rodenticides, among others.

Herbicide

A herbicide is a chemical, biological, or naturally derived agent specifically formulated to kill or suppress the germination, growth, or reproduction of unwanted plant species referred to as **weeds**. Herbicides are used in selective or non-selective weed control depending on their mode of action and application.

1. Introduction

Spraying of herbicides for weed control involves risks which can range from illness or harm to humans who are exposed as well as damage to wildlife and the environment. Early assessments already flagged concerns that intensive chemical control of weeds using herbicides was contributing to environmental contamination and posed risks to non-target organisms (*Gurib-Fakim, 2002; Facknath, 2006*). Hence, it is essential to adopt good practice when spraying herbicides for better weed control as well as to protect the workers, members of the public and the environment. Moreover, weed control along roadsides is essential for maintaining visibility, road safety, infrastructure integrity and biodiversity. The use of herbicides for managing roadside weeds is a cost-effective tool but must be carried out **judiciously and rationally**.

Effective roadside weed control combines proper herbicide selection, correct application, and strict safety measures. In this context, the Ministry of Environment, Solid Waste Management and Climate Change, in collaboration with relevant stakeholders, has developed guidelines on the best code of practice to be adopted when spraying herbicides for weed control. These guidelines synthesise best practices for Mauritius road maintenance, emphasising worker safety, environmental protection, and legal compliance. They align with international norms (Food and Agriculture Organization (FAO), United States Environmental Protection Agency (USEPA)) while reflecting local conditions (climate, common weeds, and regulations).

This best code of practice will assist its users to reduce the potential adverse effects of herbicide to a minimum by suggesting ways to apply the herbicides in a proper and effective manner.

2. Weed Identification and Herbicide Selection

2.1 Weed Identification and Classification

Accurate identification of roadside weeds is crucial. Weeds are generally classified as broadleaf (dicots), grasses (monocots), or sedges (Cyperaceae), and by life cycle (annual, perennial) (Fig. 1). Broadleaf weeds on Mauritian roadsides include herbaceous species (*Bidens pilosa* “Herbe Villebague”, *Solanum americanum* “Brède Martin”), shrubs/trees (*Litsea monopetala* “Bois d’oiseau Gros Feuille”), and vines (*Ipomoea* spp. “Liane Lastique”) Grass weeds include species like *Cynodon dactylon* (“Chiendent”) and *Panicum maximum* (“Fataque”), while common sedges are *Kyllinga erecta* (“Gros Mota”). For the purpose of weed identification, Annex 1 provides a list of weeds commonly found on roadsides in Mauritius with the appropriate pictures and information on each species.

Knowledge about the growth habit of a weed (annual vs. perennial), and its biology and ecology guides herbicide choice and timing. For example, annual weeds (which germinate and die in one season) are best controlled with pre-emergence (soil-acting) or early post-emergence herbicides, whereas perennial weeds (spreading by rhizomes or stolons) often require systemic treatments. Extension resources and platforms like the WIKTROP Portal (<https://portal.wiktrop.org/>) support local weed identification.

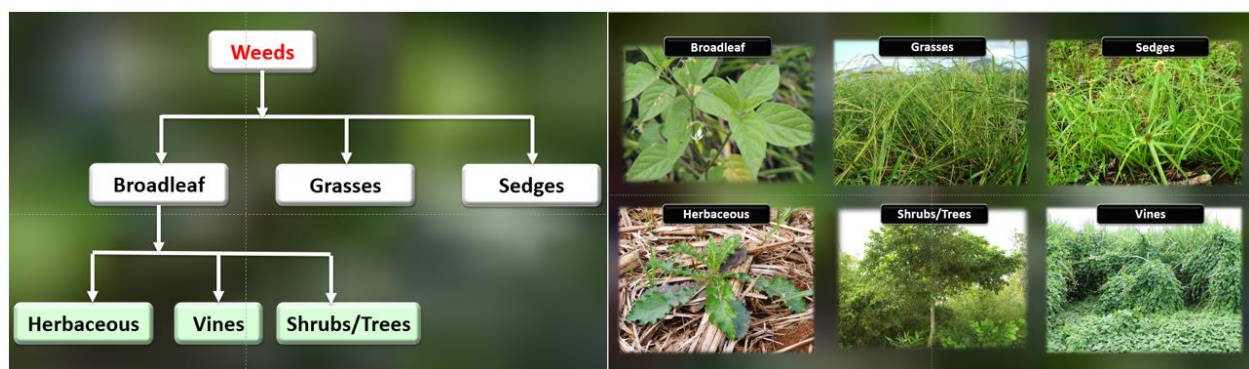


Figure 1. The different classes of weeds based on their biology (Source; MSIRI).

2.2 Herbicides – Classification and Mode of Action

Herbicides are used to control weeds either by being applied to the foliage (Post-emergence) or to the soil (Pre-emergence). According to the type of treatment for which they are used and their mode of action, they can be grouped as follows:

- **Contact herbicides**
 - Those that are applied to the foliage and do not move far from the point of application. They kill only tissues with which they come in contact.
- **Translocated herbicides**
 - Those that are applied to the foliage and can move from the site of application to other parts of the plant. Their action is systemic and their movement is principally through the phloem.
- **Residual herbicides**
 - Those that are applied to the soil and are mainly root-absorbed. They are relatively persistent and move essentially through the xylem.

In Mauritius, herbicides that are used for weed management include:

- **Post-emergence herbicides**
 - **Glyphosate (EPSP synthase inhibitor):** A non-selective systemic herbicide absorbed through foliage. Glyphosate inhibits the plant enzyme EPSP synthase, blocking the shikimic acid pathway and preventing synthesis of essential aromatic amino acids. It is widely used for general weed control.
 - **Glufosinate (Glutamine synthetase inhibitor):** A non-selective contact herbicide. Glufosinate inhibits glutamine synthetase, causing toxic ammonia accumulation in plants. It works rapidly on exposed foliage.
 - **Imazapyr (ALS inhibitor):** A systemic herbicide that disrupts an AcetoLactate Synthase enzyme for amino acid synthesis. It controls a wide range of broadleaf, grasses and sedges and has soil activity (residual

effect). Imazapyr may be used on roadsides to maintain bare ground and control shrubs.

- **Fluazifop-p-butyl (ACCase inhibitor):** A selective herbicide for grasses. Fluazifop inhibits Acetyl-CoA Carboxylase (ACCase) enzyme, disrupting fatty acid synthesis in grasses. It is often used to remove grassy weeds without damaging broadleaf plants.
- **Triclopyr and Fluroxypyr (synthetic auxins):** These mimic plant hormones (auxins), causing uncontrolled growth in broadleaf weeds and woody species. Triclopyr and fluroxypyr are used for the control of shrubs and vines, and fluroxypyr for broadleaf weeds and vines.
- **Metsulfuron-methyl (ALS inhibitor):** A systemic herbicide that affects sensitive weeds through inhibition of the ALS enzyme. This results in rapid cessation of cell division and subsequent growth processes in plants. Often tank-mixed with other herbicides (triclopyr, fluroxypyr) for woody plant control; it also targets herbaceous broadleaf weeds.

- **Pre-emergence herbicides**

- **s-metolachlor:** A selective herbicide which inhibits cell division in germinating seeds controls annual grasses and some broadleaf weeds.
- **Mesotrione:** Herbicide is p-Hydroxyphenyl Pyruvate Dioxygenase inhibitor (HPPD), which ultimately affects carotenoid biosynthesis. Uptake is foliar and via the root and symptoms are whitening of leaves, followed by necrosis of the meristematic tissue.
- **Diclosulam:** Inhibits the acetolactate synthase (ALS) enzyme. Taken up by both roots and foliage, and translocated to new growing points. Lethal amounts of diclosulam accumulates in meristems, halting cell division and resulting in plant death. Herbicide is tolerant to weeds from the Solanaceae family.
- **Diuron:** Photosynthetic electron transport inhibitor at the photosystem receptor site (PSII inhibitor). Systemic herbicide, absorbed principally by the roots, with translocation in the xylem.

According to a survey carried out among local authorities, Glufosinate ammonium and Glyphosate are the most commonly herbicides used for weed control on roads.

2.3 Adjuvants

Adjuvants are substances added to herbicide formulations or tank mixes to enhance their effectiveness. In Mauritius, common adjuvants include:

- **Oil-based adjuvants:** For example, *Codacide Oil* (vegetable oil concentrate). These organic oils act as surfactant/stickers: they increase herbicide adhesion and penetration into leaves, and can also help reduce drift by slightly enlarging droplet size.
- **Surfactants:** Nonionic surfactants such as *Complement Super* (an organosilicone surfactant). These improve spreading, wetting, and cuticular penetration of herbicides on foliage. They are essential for herbicides that have poor leaf coverage on their own.

Always use adjuvants as per product labels or official recommendation. Generally, adjuvants are used at the rate of 0.025% v/v. However, some adjuvants, like *Complement Super* is recommended by the MSIRI to be used at the specific dosage of 0.2 L/ha. Proper adjuvant use can improve efficacy and allow lower herbicide application rates.

2.4 Recommended Herbicides

It is highly recommended to use **mechanical means for weed control** along roads and near sensitive areas. However, for management of the weeds or in cases where it is not feasible, the following herbicides can be used.

2.4.1 Imazapyr

Imazapyr is the **only herbicide** registered by the Dangerous Control Chemical Board (DCCB) and recommended by MSIRI for managing weeds along roads. The USEPA also recommends Imazapyr as an effective herbicide for controlling weeds along roadsides.

Imazapyr is an imidazolinone herbicide used to control grasses, broadleaves, vines, brambles, brush, and trees. Imazapyr disrupts an enzyme (found only in plants) necessary for protein synthesis, and interferes with cell growth and DNA synthesis in plants. The isopropyl amine salt of Imazapyr is the only active ingredient (24 % SL) in the herbicide **Arsenal Gen 2**. The generic equivalent of the herbicide is also available in Mauritius.

The USEPA Imazapyr as category III (Low Toxicity). It has low toxicity if individuals get residues on their skin, and very low toxicity if it is eaten or inhaled. Imazapyr is also considered not likely to be a human carcinogen by USEPA.

Note: Imazapyr is not recommended for application on agricultural fields, particularly on vegetable grown lands, as it is highly persistent in the soil.

Additional information on the recommended herbicide Imazapyr is provided in Annex 2.

2.4.2 Bio-herbicides

Bio-herbicides are herbicides that are derived from natural organisms such as bacteria, fungi, and plant extracts. These herbicides are gaining attention as sustainable alternatives to synthetic herbicides. Unlike synthetic herbicides, which can cause environmental contamination and promote weed resistance, bio-herbicides are generally biodegradable, species-specific, and less harmful to non-target organisms and ecosystems (*Charudattan, 2001*). They are especially compatible with organic farming

and integrated weed management practices. However, bio-herbicides often exhibit slower action, limited shelf life, and variable performance under different environmental conditions (*Harding & Raizada, 2015*). Despite these limitations, their ecological safety and potential for reducing chemical inputs make them a valuable tool in sustainable agriculture. Hence, these bio-herbicides can be applied near sensitive areas.

In Mauritius, there are some commercially available bio-herbicides such as:

1. Care against weeds (active ingredient: vegetable oil, silicate phosphate, brine)
2. Beloukha (active ingredient: pelargonic acid)
3. Acetic Acid based products
4. Katoun Gold (active ingredient pelargonic acid)

3. Herbicide Application Best Practices

3.1 Equipment and Calibration

In Mauritius, herbicide application is commonly carried out manually using knapsack sprayers (Fig. 2a & 2b).



Figure 2a: Knapsack Spraying Technique

Common Spraying Equipment

- **Piston Pump Knapsacks** – Suitable for water-based herbicide formulations.
- **Diaphragm Pump Knapsacks** – Ideal for oil-based formulations or where corrosive substances are used.



Figure 2b: Knapsack equipment

Proper maintenance and calibration of these equipment are critical. Before each use, inspect sprayers thoroughly for leaks, clogs, or damage (tank, hoses, nozzles, seals, pressure gauge). Replace worn or faulty parts choose the right nozzles. Ensure filters and screens are clean. If using knapsack sprayers, check that straps and buckles are secure. Always test pressure buildup before filling with chemicals.

Calibration

Always calibrate the sprayer at the start of the season and whenever equipment or conditions change. Calibration (typically done with water for safety) ensures the correct volume per area is applied.

Knapsacks or handheld sprayers:

- time how long and what volume it takes to spray a known small area
- measure output to calculate volume of application in litres/hectare.

Remember: Volume of spray is a function of the flow rate, speed and swath (width of spray) and all spraying operations are carried out at a pressure of 3.0 bars (43.5 psi).

Calibration should yield an accurate volume of application (L/ha) which will ensure that the correct herbicides rates are sprayed. Over-application leads to wasted herbicide and drift damage, while under-application results in poor control and the need for re-treatments. In summary:

“equipment calibration is necessary to ensure you are applying the correct amount of herbicide”.

3.2 Spraying Techniques

- **Nozzle Selection:** Use the appropriate nozzle type for the application.
 - Flat-fan nozzles give uniform coverage for broadcast spraying.
 - Air-inclusion nozzles (Fig. 3) produce larger droplets, greatly reducing drift (Fig. 4) – they are ideal near sensitive areas.
 - Cone nozzles (hollow or full cone) are useful for spot or targeted foliage spray. For example, full-cone nozzles operating at 15–40 psi generate large droplets and are recommended when drift is a major concern. Always match nozzle type and size to the boom width, pressure, and desired output.

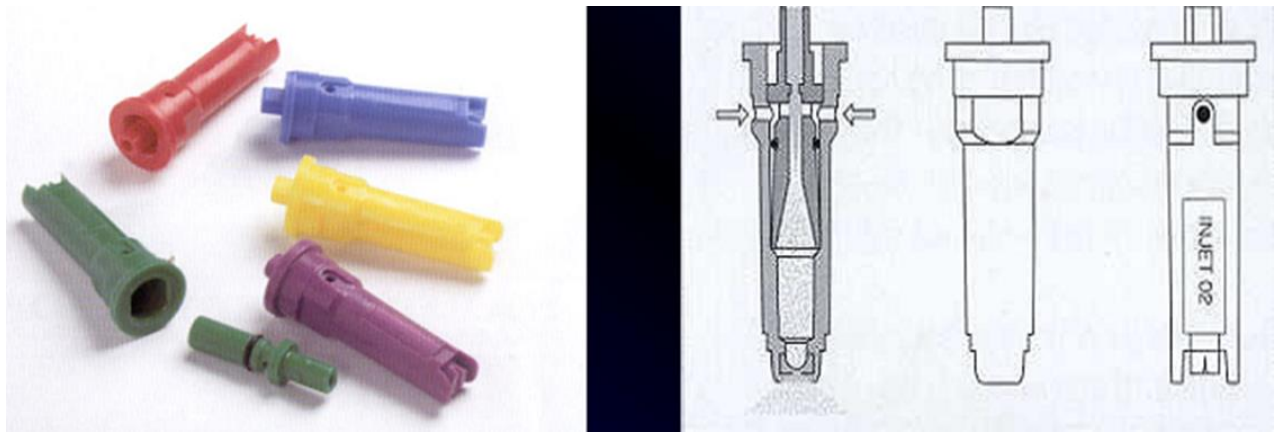


Figure 3. Air-inclusion nozzles



Figure 4. Very few small droplets with air-inclusion nozzle (left) than with conventional flat-fan nozzle (right), greatly reducing drift (Source; MSIRI).

The table below summarises the different types of nozzles and its targeted use.

Nozzle Type	Use Case	Droplet Size	Drift Risk	Ideal For
Flat Fan	Broadcast spraying	Medium	Moderate	Systemic herbicides
Air-Inclusion	Drift-sensitive areas	Coarse	Low	Roadsides, buffer zones
Hollow Cone	Spot foliage or contact action	Fine	High	Shrubs, dense weeds

- Boom and Nozzle Height:** Position nozzles close to the target surface. For boom sprayers, maintain boom height per manufacturer’s guidance (often 40–50 cm above weeds for flat-fan nozzles). Too high a boom increases drift; too low causes uneven coverage. For knapsacks or handguns, spray about 40 cm from the target. Ensure the boom is level across its width.
- Travel Speed:** Maintain a constant walking or driving speed of 6-10 km/h. Consistency is crucial: variations in speed directly affect application rate. A GPS speedometer or regular speed checks can help.
- Overlap and Coverage:** Aim for a minimal but uniform spray overlap to ensure even coverage with minimal streaks. Walk/drive in straight, parallel passes. Keep spray pattern indicators (dyes) if needed to track areas covered.
- Timing and Conditions:** Spray under optimal weather: **avoid high winds, and never spray if wind exceeds ~10–15 km/h.** Spray only when drift will not endanger people, livestock, or sensitive vegetation. Ideal conditions are light wind (1–5 km/h), moderate temperature (below ~30 °C) and moderate humidity. Do not spray in extreme heat or direct mid-afternoon sun to prevent rapid evaporation. Schedule applications so that bystanders are not exposed; warn the public and post signs if appropriate.

- **Special Techniques:** For spot treatments, direct the spray only at the weed foliage (not soil) and consider using marking dyes. Use shielded sprayers or hooded wands (Fig. 5) when working right next to sensitive plants or waterways.



Figure 5. Use of hooded-wand during directed spraying next to sensitive plants or waterways (Source; MSIRI).

3.3 After Application and Clean-up

After spraying, **clean equipment immediately**. Rinse tanks, hoses, and nozzles thoroughly with clean water (triple-rinse containers). Dispose of rinse water onto treated areas away from non-target sites. Contain and clean up any spills promptly using absorbent materials, collecting washings in a sealed container for proper disposal. Never pour rinse water or excess herbicide into drains, ditches, or water bodies.

Dispose of empty pesticide containers according to the label and national regulations. As USEPA stewardship guidelines state, even rinsed containers pose hazards and should never be reused for other purposes. Triple-rinse containers (adding rinse water to the

sprayer tank each time), then puncture or crush if allowed, and dispose of as hazardous waste per local rules. Never burn containers (they can explode or release toxic fumes).

Finally, **recordkeeping** is mandatory. Log each application: product used, active ingredients and rates, date/time, exact location, area sprayed, weather conditions, equipment used, operator name, and any observed efficacy or incidents. Good records help in evaluating effectiveness and demonstrate compliance with regulations.

4. Health and Safety Procedures

Herbicide applicators must follow strict safety and health protocols to protect themselves, public, and the environment from potential hazards associated with herbicide exposure. Key safety measures include












4.1 Reading and Following Label Instructions/Safety Data Sheet

- Always read the herbicide label or Safety Data Sheet before handling any herbicides
- Always follow the instructions for safe dosage and application method.
- Consult the Safety Data Sheet on use of appropriate Protective Equipment to wear and emergency procedures in case of exposure/ingestion or inhalation.

4.2 Personal Protective Equipment (PPE)

Always wear the PPE specified on the herbicide label and Safety Data Sheet. Generally, this includes chemical-resistant coveralls (long sleeves and pants), impervious gloves (nitrile or rubber), chemical-resistant boots, eye protection (goggles or face shield), and a wide-brimmed hat. For some formulations or conditions, a respirator with appropriate cartridge (organic vapor or particulate filter) may be required. Remove PPE carefully after use and wash it separate from other laundry. Decontaminate any equipment or clothing that has contacted concentrate. Employers must provide and maintain PPE, and ensure workers are adequately trained on its use and limitations. Workers should cooperate with employers and comply with all safety procedures and practices.

List of PPEs (Source: International Labour Organisation, ILO)

PPE	Description	Example
Respirator	<p>Protects the mouth, the nose and in some cases the eyes from small particles and vapours. Respirators can be classified into disposable or maintenance-free respirators, respirators with a filter and respirators with air supply.</p> <p>If the respirator is fitted with filters, it should be changed if breathing is difficult, any irritation or odour is detected, if they are broken or if required by the chemical product label or item label.</p> <p>Similarly, filters should be selected according to the type of pesticide or chemical to be used and according to the information in the SDS</p>	 Maintenance-free respirator  Respirator with filter  Respirator with air supply
Gloves	<p>Gloves are the most commonly used items to protect the hands and arms against the possibility of risks from skin contact.</p> <p>Some of the gloves used are made of nitrile, PVC or neoprene material with a long cuff and should be at least 0.4 mm thick, comfortable and flexible enough to be able to grip pesticide containers and other equipment.</p>	 Nitrile gloves  Neoprene
Goggles and masks	<p>Intended to protect the face and eyes against the risks caused by vapours, aerosols, projections of solid particles and liquids.</p>	 Goggles  Mask
Coverall, protective suit, apron, hood	<p>In order to isolate the body from hazardous products and pesticides, it is necessary to use coveralls, as well as protective clothing, aprons and hoods, made of resistant materials such as rubber, PVC and high-density polyethylene.</p> <p>Protective suits are resistant to chemical products under normal conditions of use, while aprons protect against splashes and spills.</p> <p>For tasks such as spraying tall crops, hoods of impermeable material should be worn for neck and head protection.</p>	 Protective suit  Apron  Hood
Boots	<p>Unlined rubber boots protect feet and prevent liquid absorption. Boots protect against spills, splashes and sprays, as well as during walking after application when the substance that has been dispersed is not yet dry.</p>	 Rubber footwear

Order of Taking On & Off PPE (Source: Ministry of Agricultural & Rural Department, Government of Mexico (2019))



According to ILO, the key aspects regarding use and maintenance of PPE during application of herbicides are:

1. PPE must be clean and free of tears, holes or other defects or signs of excessive wear.
2. They should be sized to fit the wearer or be adjustable and comfortable. The service life of each element must be taken into account.
3. They must not impede the wearer's vision, breathing or hearing.
4. They should be inspected periodically and replaced when they are damaged or do not adequately protect the worker

The Guidelines for personal protection when handling and applying pesticides on International Code of Conduct on Pesticide Management can also be consulted

(Guidelines for personal protection when handling and applying pesticides, Food and Agriculture Organization of the United Nations, World Health Organization, 2020)



Figure 6. Protective equipment commonly used during herbicide spraying (Source; MSIRI).

4.3 Proper Handling and Storage

- **Safe Handling:** Mix and load herbicides away from water sources, ideally on a containment pad. As far as possible, use closed mixing/loading systems to minimize spills. Follow label instructions for measurement and mixing. Never eat, drink, or smoke while handling herbicides, and wash hands/face thoroughly before breaks and after work.
- **Storage:** Keep herbicides in original containers with intact labels; never transfer to unmarked containers.

- **Disposal:** Follow label instructions and local regulations to dispose of empty containers and unused chemicals. Materials contaminated with chemical products, such as used PPE or absorbent material that has been contaminated by chemical spills, should be handed over to hazardous waste managers with environmental permits issued by the competent authorities.
- **Emergency Preparedness:** Keep a spill kit (absorbent material, shovel, neutralizers) on hand. Have eyewash and clean water available in the field for accidental splashes. All workers should know first-aid procedures for exposure (chlorinated water for eye splashes, washing skin with soap and water) and have emergency contact numbers. Consider medical surveillance for workers regularly handling herbicides, as some health effects may be chronic. Any pesticide illness or unusual symptoms should be reported to health authorities.
- **Training and Communication:** Only trained, certified personnel should apply herbicides. Training must cover safe spray techniques, PPE use, label and SDS reading, emergency response, and legal responsibilities. Before each operation, notify the public/pedestrians as needed (signboards, local announcements) and clearly mark the treated zones. Supervision should ensure compliance with safety rules at all times.
- **Regulatory Compliance:** Follow all national regulations on worker safety. For example, Mauritian law mandates protective clothing for pesticide handlers, proper storage/transport of herbicides, and safe disposal of waste. Non-compliance can incur penalties under the Occupational Health & Safety and Pesticides Acts.

For a detailed PPE checklist and safety procedures, see Annex 4. (PPE example: coveralls, gloves, boots, goggles, respirator – see Table in Annex 4)

4.4 Medical Surveillance

Medical surveillance is recommended for all herbicide users and people in close contact with herbicides. The purpose of health surveillance is for the early detection of any harm caused by constant exposure to herbicides. Employers should perform health surveillance for employees. Health surveillance records for users of herbicides and field workers include details of health surveillance performed, clinical information and conclusions of the medical practitioner.

5. Environmental Protection & Safety Hazards

Herbicides can easily migrate into other environmental compartments owing to runoff and leaching. Widespread use and subsequent herbicide disposal by agronomists, the general public, and institutions offer abundant possible bases for spreading herbicides exposures in the environment. The sources of herbicide spread are broad and include dissolution in water, air, and soil.

5.1 Environmental Hazards

1. Water Contamination

- Runoff into surface water (e.g., rivers, lakes, and streams) during rainfall or irrigation can carry herbicides, affecting aquatic life (*Gilliom et al, 2006*).
- Leaching into groundwater may occur if the herbicide is water-soluble and the soil is permeable, potentially contaminating drinking water sources.
- Herbicide application must be avoided near water bodies, drains, or canals, as contamination risks are high.
- To prevent environmental harm, containers should be triple-rinsed after use, and the rinsate should be added to the spray tank. Empty containers must be disposed of following approved protocols, and never discarded in the field.
- Spraying should be suspended during or before heavy rainfall, as the risk of runoff and environmental contamination increases under such conditions.

2. Harm to Non-Target Species

- Herbicide may affect non-target plants along the roadside or nearby fields (Relyea, 2005).
- Insects such as pollinators (e.g., bees and butterflies) can be harmed if they come into contact with treated vegetation. Avoid applications during blooming periods to protect bees and other pollinators.

3. Soil Degradation

Repeated use of certain herbicides can lead to changes in soil microbial communities, reducing soil fertility and ecological balance (*Imfeld & Vuilleumier, 2012, Sanchez-Bayo, 2011*).

4. Development of Herbicide-Resistant Weeds

To protect long-term efficacy and environment, rotate herbicide modes of action yearly. The overuse of a molecule of herbicide can result in the emergence of resistant weed to that particular chemical. In fact, the MSIRI has already established the resistance of *Eleusine indica* (Chiendent patte poule) to glyphosate due to its recurring use for controlling weeds on fallow vegetable fields and roadsides in towns and villages. Thus, this weed has become the predominant weed in these situations making its control problematic. Avoid repeated use of a single herbicide; integrate with mowing/physical control to minimise herbicide reliance. Monitor for signs of resistance (e.g. surviving weeds after treatment) and report any findings to MSIRI or relevant agencies.

5. Air Pollution

Volatile herbicides or those applied by spraying can drift from the target area, potentially affecting nearby vegetation, water bodies, or residential areas.

6. Buffer Zones

- Maintain untreated buffer strips. For water bodies, a buffer of at least 100 feet is recommended as per Rivers and Canals Act 1863, for control of activities near rivers.
- A minimum 10 m untreated buffer is recommended around agricultural zones (FAO, 2016; USEPA, 2022).
- A minimum buffer distance of 50 m should be maintained near Food Vendors, food preparation/operating areas.

5.2 Safety Hazards

1. Human Exposure

- People who can be exposed to herbicides fall into two categories:
- Direct exposure: Herbicide users who directly handle herbicides during preparation and application, supervisors and drivers.
- Indirect exposure: Those who might not be aware that they are being exposed via inhalation or dermal contact to herbicides spray when are being applied to the crop include pedestrians, residents, passer-by, food-vendors among others.

2. Food Safety

Spraying of herbicides near food vendors or food preparation/operating areas may contaminate the food and have several health effects and consequences as follows:

Health Effects on Consumers:

- Chemical contamination of food by settling of herbicide droplets or residues on exposed foods, raw ingredients, utensils or packaging
- People may suffer from acute health effects (short-term), if consume food contaminated by herbicides, such as:
 - Nausea, vomiting, abdominal pain
 - Headache, dizziness
 - Eye, skin, or throat irritation

Health Effects on Food Vendors and Workers:

- Inhalation of spray mist causing respiratory irritation or asthma-like symptoms
- Skin contact leading to rashes, burns or allergic reactions
- Occupational exposure if spraying is carried out during business hours

3. Residue on Adjacent Agricultural Fields

Spray drift can affect nearby crops, potentially causing phytotoxicity or leading to unintentional herbicide residues in food.

4. Fire and Chemical Hazards

Some herbicides are flammable or reactive under high temperatures or when improperly stored, posing risks during transport or application along roads.

5. Accumulation in Wildlife

Herbicides may accumulate in animals such as birds or mammals that frequent roadside environments, affecting reproductive or neurological systems over time.

5.3 Sensitive Areas

Sensitive areas are regions that are particularly vulnerable to the environmental and ecological effects of herbicide application. These areas may include water bodies, health care facilities, agricultural buffer zones, protected conservation areas, public recreational spaces, school yards, Food vendors or food preparation/operating areas and residential areas. Inappropriate or excessive use of herbicides in such locations can lead to contamination of food, water resources, loss of biodiversity, and disruption of ecosystem functions. Therefore, the best recommended practice for sensitive areas are as follows:

- mechanical means to control weeds.
- Use of bioherbicides.

5.3.1 Best Practices for Herbicide Application in Sensitive Areas

- To mitigate risks in these areas, the following best practices are recommended:
- **Bioherbicides:** Use of bio-herbicides as safer alternatives in sensitive areas
- **Avoid Application Before Rainfall:** Do not apply herbicides 24–48 hours before forecasted rainfall to prevent runoff.
- **Use Low-Drift Nozzles and Shields:** Employ equipment that minimizes drift, such as low-pressure nozzles and shielded sprayers (*Creech et al., 2015*).
- **Time of Application:** Prefer early morning or late afternoon applications to reduce volatilization and drift. Around school areas, application during school holidays or

weekends are recommended. Near food preparation/operating areas days when vendors are not operating

- **Communication:** People, including vendors, should be informed several days prior application in sensitive areas.

5.4 Communication to Public

Before application of herbicides, the information should be communicated to the people living in the locality and passer-by to take necessary safety precautions. The information could be communicated as follows:

1. Issuance of public communiqué on Billboard or through social media platforms depending on the scale and location of the application.
2. Clear signage in affected area for passerby
3. Implement a public feedback mechanism to allow members of the public to report concerns regarding herbicide application.

5.5 Safety precautions for food vendors

The following precautions should be taken by food vendors to mitigate the risks associated while spraying of herbicides along roadsides:

- **Protect Food and Utensils:** Vendors should cover food and utensils with impermeable covers or remove the food and utensils
- **Suspend Operations:** Food operations should be temporarily suspended, especially during spraying activities
- **Relocate Stalls:** If herbicide spraying in the area is unavoidable, vendors should relocate their stalls.
- **Sanitize Equipment:** All equipment must be thoroughly washed before the vendor resumes operations.

- Report Unsafe Practices: Any unsafe spraying practices should be reported to the local health or environmental authorities.

6.0 Legal and Institutional Framework

Roadside herbicide programs must comply with: the *Use of Pesticides Act* (which enforces label directions), the *Dangerous Chemicals Control Act*, and the *Occupational Safety and Health Act 2005* (As amended). Applicators must hold valid certifications if required. Keep Material Safety Data Sheets (SDS) for all products on-site.

Recordkeeping facilitates audits. Ensure that all herbicides in use are registered for that use in Mauritius. For any questions on legal use, consult the DCCB or MSIRI experts.

6.1 Provision made as per the Dangerous Chemicals Control Act 2004 and OSHA 2005 for handling of herbicides

1. No person shall be employed in the handling of or being exposed to pesticides, unless that person is in possession of a **medical certificate** indicating -
 - (a) his physical fitness to be so employed;
 - (b) the level of cholinesterase in his blood or any other appropriate test result.
2. Employers cultivating 10 or more hectares of land shall keep a **register** of employees working or being exposed with pesticides in the course of employment, and specifying -
 - (a) the names and addresses of all workers employed by him;
 - (b) the number of hours worked by any worker on any particular day;
 - (c) the specified chemical substance with which the worker has worked;
 - (d) the particular operation on which the worker was employed.
3. No worker shall be employed in the handling of or being exposed to pesticides for more than:
 - (a) 6 hours in one day;
 - (b) 36 hours in a period of 14 days

4. No person **under the age of 18** shall be employed in the handling of or being exposed to pesticides.

5. An employer shall not cause or permit any person to work with or being exposed to pesticides unless he is satisfied that the worker has been thoroughly **trained in the precautions** to be observed and is under **adequate supervision**.

6. Every employee working with pesticides shall –

(a) comply with the requirements to be observed for the use of **protective clothing** and **equipment** in relation to pesticides;

(b) comply with any **instructions** given by this employer; and

(c) forthwith notify his employer of **any problem or adverse effect** caused by the pesticide.

7. Every employer shall provide such equipment and facilities as are adequate and appropriate in the circumstances for enabling **first-aid** to be rendered to his employees, including **means of conveyance** to a medical institution, if they are injured or become ill at work and **appoint any number of suitable persons** as is adequate and appropriate for rendering first-aid to his employees.

7. Training and Monitoring

Personnel must be trained in both theory (weed biology, herbicide science) and practice (sprayer operation, PPE, first-aid). Training should be refreshed regularly (annually or when new herbicides/equipment are introduced). Supervisors must monitor applications to enforce best practices. Conduct post-application field checks to assess control effectiveness and refine future strategies

7.1 Training for Roadside Vegetation Managers

Vegetation managers are responsible for planning, supervising, and optimizing herbicide use along roadsides. Their training must emphasize the interaction between herbicides, weed species, and agro-climatic conditions, which influence the timing, choice, and efficacy of weed control strategies.

7.1.1 Training Content for Managers:

- Weed Identification and Biology:
 - Differentiating between annuals, biennials, and perennials.
 - Recognizing invasive and noxious species specific to Mauritius.
- Herbicide Modes of Action (MoA):
 - Understanding systemic vs contact herbicides.
 - Preventing herbicide resistance through MoA rotation.
- Agro-Climatic Considerations:
 - Rainfall patterns, wind conditions, temperature thresholds.
 - Timing treatments relative to the wet and dry seasons.
- Environmental and Regulatory Framework:
 - National pesticide laws and roadside buffer zone rules.
 - Safe disposal, procurement, and transport of chemicals.
- Planning and Monitoring Tools:
 - GIS-based weed mapping.
 - Herbicide efficacy tracking and adaptive management.

7.2 Training for Field Operators and Applicators

Operators are the frontline implementers of weed control plans. Their training must focus on spraying techniques, calibration, health and safety protocols, and routine maintenance of equipment.

7.2.1 Training Content for Operators:

- Sprayer Calibration and Use:
 - Correct nozzle types (flat fan, air-inclusion).
 - Maintaining pressure, nozzle height (30–50 cm), and walking speed.
 - Avoiding overlaps and gaps.
- Application Timing and Weather Readiness:
 - No spraying in wind >10 km/h or before heavy rain.
 - Ideal spraying times: early morning or late afternoon.
- Personal Protective Equipment (PPE):
 - Gloves, masks, goggles, boots, and protective clothing.
 - Correct usage, cleaning, and storage of PPE.
- Safe Handling and Emergency Response:
 - Proper mixing and dilution techniques.
 - First aid for exposure, emergency spill protocols.
- Record-Keeping Basics:
- Filling spray logbooks with dates, locations, and weather conditions.

7.3 Ongoing Monitoring and Capacity Building

Both managers and operators should engage in annual refresher courses to stay updated with the latest herbicide technologies, regulatory updates, and best practices. Routine monitoring of weed populations and herbicide effectiveness must be institutionalized, with data feeding into an annual review of herbicide plans. This approach promotes continuous improvement and proactive resistance management.

Institutions like **MSIRI** and **FAREI** can be contacted for training of trainers and operators.

8.0 References

- 1 Charudattan, R. (2001). Biological control of weeds by means of plant pathogens: Significance for integrated weed management in modern agro-ecology. *Biocontrol*, 46(2), 229–260.
- 2 Creech, C. F., et al. (2015). Reducing Herbicide Drift with Application Technology. Texas A&M AgriLife Extension Service.
- 3 Harding, D. P., & Raizada, M. N. (2015). Controlling weeds with fungi, bacteria and viruses: A review. *Frontiers in Plant Science*, 6, 659. <https://doi.org/10.3389/fpls.2015.00659>
- 4 Facknath, S. (2006). Environmental effects of pesticide use in Mauritius. *Applied Ecology and Environmental Research*, 4(1), 111–118.
- 5 Food and Agriculture Organization of the United Nations (FAO). (2001). *Guidelines on Good Practice for Ground Application of Pesticides*. Rome.
- 6 Food and Agriculture Organization of the United Nations (FAO). (2016). *International Code of Conduct on Pesticide Management: Guidelines on Highly Hazardous Pesticides*. Rome.
- 7 Gilliom, R. J., et al. (2006). The Quality of Our Nation's Waters—Pesticides in the Nation's Streams and Ground Water, 1992–2001. *USGS Circular 1291*. <https://pubs.usgs.gov/circ/2005/1291>
- 8 Gurib-Fakim, A. (2002). The status of pesticides management in Mauritius. *Ambio*, 31(7–8), 430–433.
- 9 Imfeld, G., & Vuilleumier, S. (2012). Measuring the effects of pesticides on bacterial communities in soil: a critical review. *European Journal of Soil Biology*, 49, 22–30
- 10 International Labour Organization. (2022).
- 11 Relyea, R. A. (2005). The impact of insecticides and herbicides on biodiversity and productivity of aquatic communities. *Ecological Applications*, 15(2), 618–627
- 12 Rivers & Canal Act, cap 421- 21 Nov 1863.
- 13 Sánchez-Bayo, F. (2011). Impacts of Agricultural Pesticides on Terrestrial Ecosystems. In: Sánchez-Bayo, F., van den Brink, P.J., Mann, R.M. (Eds). *Ecological Impacts of Toxic Chemicals*. Bentham Science Publishers.
- 14 United States Environmental Protection Agency (USEPA). (2022). Pesticide Environmental Stewardship. <https://www.epa.gov/peps>
- 15 World Health Organization & Food and Agriculture Organization of the United Nations. (2020). *Guidelines for personal protection when handling and applying pesticide*. International Code of Conduct on Pesticide Management. Rome.

Annex 1: Weed Identification Guide

This annex provides details on common roadside weeds in Mauritius (botanical/common names, growth habit, distinguishing features).

Table A1 Lists of key species by category:

Botanical Name	Common Name	Category	Growth Habit	Notes
<i>Clidemia hirta</i>	Watook	Broadleaf shrub	Perennial	Opposite leaves; small pink-white flowers. Invasive.
<i>Clibadium surinamense</i>	Eupatorium	Broadleaf shrub	Perennial	White plume flowers; spreads by seed.
<i>Schinus terebinthifolius</i>	Poivrier marron	Broadleaf tree	Perennial	Compound pinnate leaves; red berries.
<i>Ipomoea alba</i>	Morning glory, Liane Lastique	Broadleaf vine	Annual	Twining vines; large heart-shaped leaves; showy white flowers.
<i>Cynodon dactylon</i>	Chiendent (Bermuda grass)	Grass	Perennial	Fine wiry stolons; rough seedheads; very drought-tolerant.
<i>Panicum maximum</i>	Fataque	Grass	Perennial	Tall coarse grass with broad blades; spreads by seed and stolons.
<i>Eleusine indica</i>	Chiendent Patte poule	Grass	Annual	Flat seedhead (like rooster foot); prolific seeder.
<i>Cyperus rotundus</i>	Herbe à oignon	Sedge	Perennial	Triangular stems; tubers (nuts) underground; summer emergence.
<i>Litsea monopetala</i>	Bois d'oiseau gros feuille	Broadleaf tree	Perennial	Aromatic leaves; small dioecious flowers; common in gullies.

<i>Ipomoea cairica</i>	Morning glory	Broadleaf vine	Perennial	Similar to <i>I. alba</i> ; hardy, invasive vine.
<i>Digitaria horizontalis</i>	Gros Meinki	Grass	Annual	Flat, spreading seedheads; occurs in open disturbed ground.

The ecology and distribution of weeds are mostly dependent upon the rainfall patterns that characterize the three climatic zones of Mauritius, namely, subhumid (< 1500 mm/year), humid (> 1500 and < 2500 mm/year) and superhumid (> 2500 mm/year) (Fig. 7).

Climatic Zones of Mauritius



Figure 7. Chart showing the three climatic zones of Mauritius with isoyets indicating the amount (mm) of annual rainfall.

The occurrence of some of the roadside weeds listed below refer to the climatic zones illustrated in Figure 7.



Species : *Litsea monopetala*
Family : Lauraceae
C/Name : Bois d'oiseau gros feuille
Ecology : Non crop land; Cold humid and superhumid areas



Species : *Clibadium surinamense*
Family : Asteraceae
C/Name : Eupathorium
Ecology : Agricultural and Non crop land; Cold humid and superhumid areas



Species : *Clidemia hirta*
Family : Melastomataceae
C/Name : Watook
Ecology : Agricultural & non-crop lands; very common in cold and humid to superhumid areas



Species : *Lantana camara*
Family : Verbenaceae
C/Name : Vieille Fille
Ecology : Agricultural & non-crop lands; common in humid & subhumid areas



Species : *Ipomoea alba*
Family : Convolvulaceae
C/Name : Liane Lastique
Ecology : Non-crop lands; common at all altitudes



Species : *Solanum americanum*

Family : Solanaceae

C/Name : Brède Martin

Ecology : Agricultural and non-crop land; Common in all climatic zones



Species : *Bidens pilosa*

Family : Asteraceae

C/Name : Herbe Villebague

Ecology : Agricultural and non-crop land; Common in all climatic zones



Species : *Eleusine indica*

Family : Poaceae

C/Name : Chenopodium patte poule

Ecology : Agricultural and non-crop land; Common in all climatic zones

Annex 2: Recommended Herbicide Summary Table

Table A2. Additional Information on Imazapyr

Active Ingredient (Trade Name)	MoA Group (HRAC/WSSA)	Primary Action	Dosage rate– L or kg/ha	Target Weeds/Use
Imazapyr (e.g. Arsenal)	Group B / WSSA 2 (ALS)	Systemic, nonselective	3.0-4.5	Woody and brush species, many broadleaves and grasses. Bare-ground maintenance.

Note: This recommendation can evolve over time depending on latest research findings.

Imazapyr is being recommended for weed management on roadside, sugar-cane field roads and non-crop lands. It is not recommended for use near sensitive areas

Table A3. Common adjuvants in Mauritius.

Adjuvant	Type	Function
Codacide Oil	Vegetable oil ester	Sticker/penetrant; reduces drift; improves adhesion and uptake.
Complement Super	Organosilicone surfactant	Spreader/sticker; ultra-low surface tension improves leaf penetration.

Note: These are additives for spray mixes.

Always follow tank-mix compatibility rules. Do not mix incompatible products. Use only labeled tank-mixes or those recommended by MSIRI

Annex 3: Spraying Technique Guidance

This annex provides practical checklists for equipment, calibration, and application timing:

Equipment Checklist:

- Inspect sprayer tank for cracks and leaks.
- Check pump seals and diaphragms (for knapsacks).
- Ensure hoses, couplings, and valves are intact.
- Clean/replace filters and nozzles; verify nozzle orifice size.
- Verify boom sections (if any) actuate properly.
- Replace any nozzle with >10% flow variance from new output.

Calibration Procedure:

- Handheld (knapsack) calibration:
 - Flush and prepare: Fill cleaned sprayer with water.
 - Spray a measured area at normal speed.
 - Time the spray.
 - Then spray into a graduated bucket for the same time.
 - The amount in Litres collected is then converted to the volume of application in Litres per hectare (L/ha).
- Compute spray volume per area and adjust pump pressure or driving speed to achieve the labeled application rate.
- Record calibration data (nozzle size, pressure, output, speed, calculated Total Flow Rates). Re-check calibration after changing or cleaning nozzles or pumps.

Application Timing:

- **Season:** Apply pre-emergent herbicides just before the main rainy season (early wet season) to intercept germinating weeds. Post-emergent treatments work best in mid-to-late wet season when weeds are actively growing. For perennials, target them when they are green and actively transporting (often before flowering).

- **Time of Day:** Early morning or late afternoon tends to give better uptake (higher humidity, lower heat) and reduced volatilization. Avoid midday heat (>30°C).
- **Weather:** As noted, spray only in calm conditions. Postpone spraying if rain is forecast within 24 hours. Do not apply if winds are gusty or over ~10–15 km/h.
- **Spot Spraying:** Use a low-volume, low-pressure spray directed precisely at each target plant's foliage. Use wand or backpack with a narrow nozzle. Consider a protective shield or card to block drift from the target. Keep track of spots treated (e.g. marker flags or dye) to avoid overlaps or misses.

Annex 4: Health and Safety Procedures

PPE Checklist: Wear the following whenever mixing or applying herbicides:

- **Coveralls or full-body suit** (preferably chemical-resistant).
- **Long-sleeved shirt and long pants** (cotton under coveralls).
- **Chemical-resistant gloves** (nitrile, neoprene or rubber).
- **Chemical-resistant boots** (ankle-high or higher).
- **Eye protection** (goggles or face shield).
- **Hat** (brimmed hat or hood).
- **Respirator** (if label requires it, e.g. for fine aerosols or if products have inhalation hazards) with the correct filters (organic vapor cartridge or P2 particulate).

Maintain PPE: inspect for tears/holes, wash after each use, and replace according to manufacturer guidelines. Do not wear protective clothing home.

Mixing/Loading Safety: Always prepare solutions in a designated, well-ventilated area away from people and open water. Use only clean, calibrated measuring tools. Add herbicides to water (not vice versa) when mixing. Fill partially with water first to allow room for agitation. Rinse measuring containers immediately.

Storage and Transport: Store herbicides in a locked, ventilated storage with secondary containment (e.g. on plastic trays). Follow label for storage conditions (usually cool, dry). Do not transport herbicides in passenger compartments; use secure, leak-proof crates.

First Aid and Emergency: Keep a first-aid kit accessible. Know first-aid measures for exposure: in case of skin/eye contact, rinse with plenty of water for 15+ minutes; if inhaled, move to fresh air; if ingested, do NOT induce vomiting – seek medical help. Keep emergency contact numbers (Poison Control, doctor) posted at worksite. Workers should be informed of the nearest medical facility.

Disposal of Waste: Rinse spray equipment onto target area as per label. Triple-rinse empty containers and add rinsate to sprayer (spray out). Discard rinsed containers according to local hazardous waste protocols. Contain and label any surplus spray or contaminated materials and hand over to authorized waste disposal services. Never pour unused herbicides or rinsate into drains or onto bare ground.

Training Topics: All applicators should be trained in: herbicide labeling, PPE use, safe spraying techniques, spill cleanup, environmental precautions, and health monitoring. Employers should provide refresher training annually and whenever procedures change. Records of training and certifications should be kept on file.

Worker Hygiene: After handling herbicides, wash hands and exposed skin thoroughly with soap and water. Do not eat, drink or smoke during work. Launder contaminated clothing separately from other laundry.

Importance of Label: Remember that following the product label is mandatory by law. Any use not specified on the label (off-label use) is illegal. The label provides critical safety and application instructions. Compliance protects health, the environment, and ensures legal operation.