Decimating The Perpetual Recurrence of Tropical Weeds on Arable Land: A New Population-Based Approach to Sustainable Weed Management

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ABSTRACT

The persistent recurrence of weeds on arable land remains one of the most formidable biological, agronomic and economic constraints to sustainable crop production in tropical agriculture. This phenomenon is often interpreted as a failure of weed-control methods, whereas it is more fundamentally a consequence of the biological resilience of weed populations, the persistence of soil seed banks, continuous seed rain, vegetative regeneration, favourable tropical environmental conditions and repeated agricultural practices that inadvertently replenish weed populations. This paper advances a new conceptual approach, termed the Tropical Weed Recurrence Decimation Approach (TWRDA), which shifts the principal objective of weed management from repeated destruction of emerged weeds to systematic depletion of the biological mechanisms responsible for their recurrence. The approach integrates weed identification and mapping, prevention of weed introduction, soil-seed-bank depletion, stale-seedbed techniques, strategic tillage, competitive crop establishment, crop rotation, cover crops, residue and mulch management, timely mechanical intervention, judicious herbicide use, suppression of reproductive weeds before seed maturation, sanitation and continuous monitoring Contemporary evidence indicates that integrated weed management is more sustainable than dependence on a single control tactic, while excessive dependence on herbicides contributes to the evolution and spread of herbicide-resistant weeds. The paper argues that tropical weed management should therefore transition from a reactive, season-by-season control philosophy to a proactive, population-management system centred on breaking weed life cycles. The approach is particularly relevant to smallholder and resource-constrained farming systems in sub-Saharan Africa, where labour, herbicide costs, environmental concerns and changing climatic conditions complicate conventional weed control. A practical field implementation model and research agenda are proposed for validation under Nigerian and wider tropical agro-ecological conditions.

KEYWORDS

Arable land, crop competition, decimation approach, sustainable agriculture tropical weeds recurrence, integrated weed management.

I. INTRODUCTION

Agricultural production is fundamentally a competition for limited resources among crops, weeds and other organisms occupying the agroecosystem. Weeds compete with crops for sunlight, water, nutrients and space, and may additionally serve as alternative hosts for

pests and pathogens. Weed management can consume a substantial proportion of farmers' labour, particularly in developing countries. The problem is especially pronounced in tropical agricultural environments, where high temperatures, favourable moisture regimes, long growing seasons, intensive cultivation and the extraordinary reproductive capacity of many tropical weed species provide conditions under which weed populations can regenerate rapidly.

The fundamental question therefore becomes: Why do weeds continually return after apparently successful weed-control operations? The answer is more complex than simply saying that weeds are difficult to kill. Weed recurrence is largely a population-dynamics problem. A field contains not only visible weeds but also an often-hidden reservoir of dormant or viable seeds, rhizomes, stolons, tubers, bulbs and other propagules. Annual weeds can replenish the soil seed bank through enormous quantities of seed, while perennial species can regenerate vegetatively following disturbance. Conventional weed management frequently concentrates on the weeds that are visible at the time of intervention. Such an approach is inherently reactive. It addresses the symptom—the emerged weed—rather than the source—the reproductive and ecological system that continuously produces new weeds. This distinction is crucial. If a farmer repeatedly kills weeds after they have emerged but allows surviving weeds to flower and produce seeds, the soil seed bank may remain stable or even increase. Similarly, indiscriminate tillage can redistribute buried seeds into favourable germination zones, while repeated use of the same herbicide mode of action can impose strong selection pressure favouring resistant biotypes.

Integrated Weed Management (IWM) has therefore emerged as an important alternative to single-tactic weed control. IWM combines complementary preventive, cultural, mechanical, biological and chemical approaches rather than relying on one intervention. This paper argues that even the concept of integrated weed management should be taken a step further: the objective should not simply be to manage weeds every season, but to systematically reduce the capacity of the farm ecosystem to generate weeds. The Tropical Weed Recurrence Decimation Approach (TWRDA) is proposed around one central principle: Do not merely kill the weeds that are present; progressively destroy the processes that produce the next generation of weeds.

II. THE PROBLEM OF PERPETUAL WEED RECURRENCE

A. Weed Control versus Weed Population Management

There is an important distinction between weed control and weed population management. Weed control asks how the weeds currently present in the field can be removed. Weed population management asks how the number of weeds emerging in the field can be progressively reduced from one production cycle to the next. The second question is more appropriate for sustainable tropical agriculture. A field may appear weed-free immediately after hoeing, herbicide application or mechanical cultivation. Yet the apparent success can be temporary if thousands of viable seeds remain in the soil. Similarly, a perennial weed may be cut at the soil surface while its underground organs remain alive. The persistence of weeds is therefore partly a consequence of their biological strategy. Many weed species are highly effective colonizers and prolific seed producers.

B. The Soil Seed Bank: The Hidden Enemy

The soil seed bank represents one of the most important components of weed recurrence. It consists of viable weed seeds present in the soil at different depths and stages of dormancy. Some seeds germinate immediately when environmental conditions become favourable, while others remain dormant and constitute a reserve for future generations. Thus, visible weeds do not represent the total weed population. A more realistic conceptual equation is: Total weed pressure = emerged weeds + dormant seed bank + vegetative propagules + incoming propagules. This means that destroying emerged weeds without addressing the seed bank is analogous to repeatedly removing leaves from a plant while leaving its root system intact. The strategic implication is that weed management should target both present weeds and future weeds.

III. WHY CONVENTIONAL WEED CONTROL OFTEN FAILS

A. Dependence on Hand Weeding

Hand weeding is widely used in tropical agriculture because it requires relatively little purchased input. However, it is labour-intensive and frequently performed after weeds have already established. Where labour is insufficient, farmers may weed late, allowing weeds to compete with crops during critical growth stages and sometimes reach reproductive maturity. The result is a cycle of late weeding, surviving weeds, flowering, seed production, increased seed bank and more weeds in the following season.

B. Repeated Tillage

Tillage can effectively destroy existing weeds, particularly annual weeds. However, its long-term effects depend on timing, depth, frequency and the biology of the target species. Repeated soil disturbance can expose dormant seeds to light, oxygen and favourable temperature conditions and may distribute seeds vertically through the soil profile. Consequently, tillage should not automatically be regarded as a permanent solution.

C. Overdependence on Herbicides

Herbicides have transformed modern agriculture by providing rapid and effective weed control. Nevertheless, dependence on herbicides as the principal or exclusive management strategy creates several problems. Repeated use of herbicides with similar modes of action can select resistant weed populations. Herbicide resistance is not merely a chemical problem; it is an evolutionary response to repeated selection. Therefore, the combination of the same weed, the same herbicide, repeated application and survival of susceptible individuals creates increased selection pressure for resistance. Global evidence has demonstrated that herbicide resistance has become a major agricultural challenge.

IV. A NEW CONCEPTUAL FRAMEWORK: TROPICAL WEED RECURRENCE DECIMATION APPROACH (TWRDA)

This paper proposes TWRDA as a strategic extension of integrated weed management. TWRDA is based on seven principles: (1) know the weed population; (2) prevent new weed introduction; (3) exhaust the soil seed bank; (4) prevent seed production; (5) make the crop more competitive; (6) attack surviving weeds using diversified tactics; and (7) monitor recurrence continuously and adapt management. The central objective is to change the direction of weed population dynamics. Under conventional management, the cycle is weed emergence, control, regrowth or emergence, seed production, replenishment and repeated control. Under TWRDA, the cycle becomes weed identification, seed-bank stimulation and depletion, crop competition, targeted control, prevention of seed rain, seed-bank decline and reduced emergence.

V. THE SEVEN PILLARS OF TWRDA

A. Pillar I: Weed Reconnaissance and Mapping

The first intervention should occur before the major weed-control operation. Farmers should identify dominant weed species; annual versus perennial weeds; broadleaf weeds; grasses; sedges; parasitic weeds; areas of concentrated infestation; pathways through which weeds enter the field; areas where perennial weeds persist; and weed emergence periods. A simple field map can divide the farm into low infestation, moderate infestation, high infestation and perennial hotspot zones. This transforms weed management from a uniform field operation into a targeted ecological intervention.

B. Pillar II: Preventing New Weed Introduction

The cheapest weed is the weed that never enters the field. Preventive measures should include the use of clean crop seed, cleaning farm machinery between fields, preventing weed seeds from entering with manure, preventing weed-infested fodder from contaminating farms, controlling weeds along field boundaries, managing irrigation and drainage channels, controlling weeds along access roads, preventing livestock from transporting viable seeds, avoiding movement of contaminated soil between farms, and cleaning harvesting and processing equipment.

C. Pillar III: Soil Seed-Bank Depletion

This represents the heart of the proposed approach. Instead of regarding the soil as a passive medium, TWRDA treats it as a dynamic weed reservoir. The objective is to reduce seed-bank size, seedling recruitment and mature weed population while preventing seed rain. A stale seedbed involves preparing the soil sufficiently early to encourage weed seeds near the soil surface to germinate. The newly emerged weeds are then destroyed before planting the crop. The sequence is soil preparation, moisture availability, weed emergence, shallow destruction and crop planting. In heavily infested fields, sequential depletion may be considered where ergonomically feasible, with repeated stimulation and destruction of weed flushes before crop establishment.

D. Pillar IV: The Zero-Seed-Rain Principle

One of the most important innovations proposed in this paper is the Zero-Seed-Rain Principle. The objective is simple: no weed should be allowed to mature and replenish the soil seed bank unnecessarily. This principle changes how effectiveness is evaluated. A herbicide application that produces high visual weed control may appear excellent, but if the surviving weeds produce thousands of seeds, the long-term outcome may be poor. Weed management evaluation should therefore consider weed density, weed biomass, percentage control, weed fecundity, number of reproductive weeds, seed production, seed viability and subsequent soil seed-bank density.

E. Pillar V: Making the Crop the Stronger Competitor

An agricultural field should not be designed merely to kill weeds. It should also be designed to allow the crop to outcompete weeds. Crop competitiveness can be enhanced through timely planting, vigorous crop varieties, appropriate plant population, suitable spacing, narrow row spacing where agronomically suitable, good seed quality, adequate soil fertility, balanced nutrition, efficient water management, appropriate planting depth and rapid canopy development. A vigorous crop is itself a weed-management tool. However, nutrient management requires care because some fertility interventions can also stimulate weed growth. Fertilizer should therefore be placed and timed to maximize crop benefit rather than indiscriminately stimulating the entire plant community.

F. Pillar VI: Cover Crops, Mulches and Residue Management

Cover crops can suppress weeds through competition for resources, shading, modification of soil temperature and light, and in some cases allopathic effects. Suitable tropical cover crops may include carefully selected legumes, grasses, forage crops, green-manure species and locally adapted mixtures. A productive sequence may involve cover crop establishment, high biomass production, strategic termination, residue retention, cash-crop establishment and canopy closure. Cover crops should nevertheless be incorporated into an integrated program rather than treated as a universal stand-alone solution.

G. Pillar VII: Diversified and Precision Chemical Control

TWRDA does not reject herbicides; rather, it rejects herbicide dependency. Where herbicides are necessary, they should be integrated with cultural, mechanical and preventive approaches. Important principles include correct weed identification, selection of an appropriate registered herbicide, correct application timing, use of label-approved rates, rotation of modes of action where appropriate, appropriate mixtures where scientifically and legally justified, avoidance of unnecessary repeated applications, targeted treatment of high-density patches, prevention of surviving weeds from producing seed, and monitoring fields after application.

VI. MANAGEMENT OF PERENNIAL TROPICAL WEEDS

Perennial weeds require special attention because simply cutting their above-ground shoots may not eliminate them. Examples of important tropical perennial or persistent weeds

include Imperata cylindrica, Cyperus rotundus, Sorghum halepense, Chromolaena odorata and other rhizomatous, stoloniferous or tuber-producing weeds. The management objective should be to exhaust underground reserves while preventing reproduction. A suitable strategy may involve identification, repeated suppression, prevention of photosynthetic recovery, strategic cultivation, competitive cropping, targeted chemical treatment where appropriate and continued monitoring.

A. Crop Rotation as a Weed-Disruption Mechanism

Continuous mono-cropping creates ecological predictability. The same crop creates similar soil conditions, receives similar management, is planted at similar times and creates similar canopy architecture. Consequently, weed species adapted to the system can become increasingly dominant. Crop rotation changes these ecological conditions. A rotation involving cereals, legumes, root crops and appropriate cover crops can alter planting dates, crop architecture, nutrient demand, soil disturbance, canopy development, herbicide selection pressure and weed emergence patterns.

B. The Critical Period of Weed Competition

Not every weed emerging in a field produces the same level of yield loss. The timing of weed emergence relative to crop development is crucial. The critical period of weed control concept provides an important basis for deciding when weed management is most important. The objective should be to maintain the crop sufficiently weed-free during the period when weed competition is most damaging, while simultaneously preventing surviving weeds from producing seed.

VII. A PROPOSED TWRDA FIELD PROTOCOL

- Phase 1: Pre-season diagnosis—walk the farm systematically; identify major weeds; record perennial weed hotspots; estimate infestation levels; identify field boundaries and weed entry points; and examine previous crop and weed history.
- Phase 2: Preventive sanitation—clean farm equipment; remove weeds around field boundaries; use clean planting materials; prevent contaminated manure from entering fields; and control weeds along roads and irrigation channels.
- Phase 3: Seed-bank stimulation—prepare the seedbed early enough to encourage the first flush of weeds. Where appropriate, allow weed emergence and destroy it shallowly.
- Phase 4: Seed-bank depletion—where weed pressure is exceptionally high, repeat the process when agronomically feasible.
- Phase 5: Competitive crop establishment—plant vigorous seed at the correct time, population and spacing under adequate fertility and moisture.
- Phase 6: Early-season monitoring—scout regularly and record weed species, density, emergence time, distribution, crop growth and reproductive weeds.
- Phase 7: Targeted intervention—use the least disruptive effective method, including hand removal, hoeing, mechanical cultivation, mulching, targeted herbicide or integrated combinations.
- Phase 8: Zero seed rain—remove or suppress surviving weeds before flowering and seed maturation.

- Phase 9: Post-harvest assessment—record weed density, dominant species, weed biomass, reproductive weeds and changes in weed hotspots.
- Phase 10: Next-season adjustment—base the following season's strategy on the previous season's weed map. This creates a learning farm system rather than a repetitive weed-control routine.

VIII. THE TWRDA CONCEPTUAL MODEL

The proposed model can be represented as follows:

WEED ENTRY → WEED SEED BANK → WEED EMERGENCE → CROP–WEED COMPETITION → SURVIVING WEEDS → FLOWERING AND SEED PRODUCTION → SEED RAIN → REPLENISHED SEED BANK.

Under conventional management:
Control emerged weeds → incomplete control → reproduction → seed-bank replenishment → recurrence.

Under the proposed TWRDA cycle:
Prevent entry → stimulate and exhaust seed bank → suppress emergence → strengthen crop competition → eliminate reproductive survivors → prevent seed rain → monitor → repeat.

The fundamental difference is that TWRDA attempts to make every production cycle contribute to a negative weed population balance.

A. Weed Population Balance Concept

The long-term objective can be expressed conceptually as: Change in weed population = weed recruitment – weed mortality. Weed recruitment includes seed production, seed dispersal, germination, vegetative propagation and immigration. Mortality includes natural seed decay, predation, microbial decomposition, mechanical destruction, competitive suppression, biological control and appropriately applied chemical control. The ultimate objective is recruitment less than mortality for successive production cycles. This is the fundamental ecological basis of decimating recurrent weed populations.

B. Biological Control and Agroecological Suppression

Biological weed control deserves greater consideration in tropical agriculture. Potential biological mechanisms include weed seed predation, pathogenic microorganisms, herbivorous insects, competitive cover vegetation, livestock grazing where appropriate and ecological enhancement of natural enemies. Biological control should be approached scientifically because introducing organisms against weeds can have unintended ecological consequences. The emphasis should therefore be on conservation and enhancement of naturally occurring biological suppression mechanisms wherever feasible.

C. Weed Management Under Climate Change

Climate change introduces additional complexity. Changes in temperature, rainfall patterns, atmospheric carbon dioxide, growing-season duration, drought frequency and extreme weather can influence weed emergence, growth, flowering and seed production. A resilient tropical weed-management system should therefore be flexible. A strategy that works under one rainfall regime may become less effective under another. TWRDA consequently incorporates continuous monitoring and adaptive management rather than fixed prescriptions.

D. Precision Agriculture and Digital Weed Management

Although sophisticated agricultural technologies are often associated with large-scale farming, simplified versions may increasingly benefit smallholders. Potential tools include smartphone photography, GPS-based weed mapping, drone imagery, remote sensing, artificial intelligence for weed identification, geographic information systems, digital farm records, variable-rate application and predictive weed-emergence models. The future of weed management is likely to move from asking where weeds are to asking where weeds will emerge, which species will emerge, and which intervention will provide the greatest long-term reduction in weed population.

E. Socioeconomic Relevance to Nigeria and Sub-Saharan Africa

The proposed approach has particular relevance to Nigeria. Many Nigerian farmers operate under constraints involving high labour costs, seasonal labour shortages, limited access to machinery, increasing herbicide costs, inadequate technical knowledge, small farm sizes, unreliable extension services, changing rainfall patterns and fragmented farms. A weed-management system for Nigeria must therefore be scientifically sound, affordable, labour-conscious, locally adaptable and environmentally responsible. TWRDA can be implemented at different technological levels. Low-input TWRDA may involve field scouting, sanitation, timely hand weeding, crop rotation, stale seedbeds, mulching, cover crops and prevention of seed production. Intermediate-input TWRDA may involve mechanical weeders, improved seed, herbicide rotation, GPS-supported mapping and residue management. Advanced TWRDA may involve drone mapping, AI weed identification, precision spraying, soil seed-bank modelling, remote sensing and predictive weed-management systems.

F. Environmental Benefits

An effective recurrence-reduction strategy could provide environmental benefits by reducing unnecessary dependence on repeated chemical applications. Potential benefits include reduced pesticide exposure, reduced herbicide resistance selection, improved soil biological activity, improved soil cover, reduced erosion, enhanced biodiversity, improved water quality, reduced farm chemical expenditure and improved long-term soil productivity. However, environmental claims should be tested experimentally rather than assumed.

G. Economic Implications

The economic objective should not be zero weeds at any cost. Rather, it should be maximum economic crop production with the minimum sustainable weed-management expenditure. A useful economic framework is: Net benefit = crop value – production cost – weed-management cost – weed-induced yield loss. A TWRDA system may initially require greater planning and labour investment than conventional weed control. However, if it successfully reduces weed pressure over successive seasons, farmers may experience declining expenditure on herbicides, repeated hoeing, emergency weeding, labour, crop replanting and yield-loss compensation. Long-term economic studies should therefore compare not only one-season weed-control cost, but also multi-season weed-population trajectories.

IX. PROPOSED INDICATORS FOR EVALUATING TWRDA

A major contribution of this paper is the proposal that weed-management success should be assessed using both immediate and long-term indicators. Immediate indicators include weed density, weed biomass, percentage control, crop height, crop canopy development and crop yield. Reproductive indicators include number of flowering weeds, number of seed-producing weeds, seed production per weed and viable seed production. Population indicators include soil seed-bank density, weed emergence frequency, recurrence rate and perennial hotspot size. Economic indicators include cost of weed management, labour requirement, herbicide expenditure, gross margin and cost-benefit ratio. Environmental indicators include herbicide-use intensity, soil cover, erosion indicators, biodiversity indicators and pesticide-risk indicators.

A. Proposed Research Agenda

The TWRDA framework should be subjected to rigorous field experimentation. A suitable research programme could compare: T1—conventional farmer weed-management practice;

T2—chemical weed management; T3—mechanical/cultural weed management; T4—Integrated Weed Management; and T5—TWRDA.

The most important innovation would be multi-season measurement. Researchers should measure initial soil seed bank, weed emergence, weed density, weed biomass, crop growth, weed reproductive output, post-harvest seed bank, crop yield, cost of production and economic return. A multi-year experiment would be considerably more informative than a single-season weed-control trial because the central hypothesis of TWRDA concerns weed population decline over time.

B. Hypotheses for Future Experimental Testing

- H01: There is no significant difference in weed density between conventional weed management and the TWRDA system.
- H02: There is no significant difference in soil weed-seed-bank density between conventional weed management and TWRDA.
- H03: There is no significant difference in weed seed production between conventional weed management and TWRDA.

- H04: There is no significant difference in crop yield between conventional weed management and TWRDA.
- H05: There is no significant difference in the economic returns of conventional weed management and TWRDA.
- H06: TWRDA does not significantly reduce weed recurrence over successive cropping seasons.

X. DISCUSSION

The central argument of this paper is that perpetual weed recurrence is primarily a population-management problem rather than simply a weed-killing problem. This perspective is consistent with the evolution of contemporary weed science. Modern integrated weed management increasingly integrates weed biology, crop competition, seed-bank dynamics, crop rotation, herbicide resistance and ecological processes.

The proposed TWRDA framework extends this thinking by placing recurrence prevention at the centre of management. The key conceptual transition is therefore from killing weeds to reducing weed populations; from focusing on visible weeds to focusing on visible weeds plus the seed bank; from seasonal management to multi-season management; from herbicide-centred control to diversified control; from controlling emergence to preventing recurrence; from measuring weed mortality to measuring mortality plus reproduction; from short-term success to long-term population decline; and from reactive management to preventive and predictive management. This shift is particularly important because herbicide resistance demonstrates the limitations of relying heavily on one control mechanism. Similarly, cover-crop research demonstrates that weed suppression can operate through multiple ecological mechanisms, but no single method should be assumed to work uniformly across all environments. Several individually imperfect tactics can become powerful when deliberately combined around a common population-level objective.

A. Limitations of the Proposed Approach

TWRDA is a conceptual framework and should not yet be presented as a scientifically validated technology. Several limitations require investigation. Tropical weed communities differ considerably among ecological zones, and a strategy effective in the Southern Guinea Savanna may not have the same outcome in humid rainforest or Sudan Savanna systems. Seed-bank responses vary among weed species. Cover crops may compete with crops for water under certain conditions. Repeated mechanical operations may increase soil disturbance and erosion if poorly managed. Herbicide selection and rotation must conform to registered products and local regulatory requirements. Labour availability may constrain intensive monitoring. Some components may initially increase management costs. Therefore, TWRDA should be considered a testable framework rather than a universal prescription.

B. Policy and Extension Implications

Agricultural extension systems should shift from teaching farmers only how to kill weeds to teaching them how weeds reproduce and how weed populations can be progressively depleted. Extension messages should emphasize: Identify → Prevent → Deplete → Compete → Control → Prevent seed → Monitor. Farmer field schools could establish demonstration

plots comparing conventional weed management with recurrence-oriented management. At institutional level, agricultural research organizations should prioritize multi-season weed population studies, local weed-seed-bank characterization, low-cost mechanical weed control, tropical cover crops, herbicide resistance surveillance, farmer-friendly weed identification tools, digital weed mapping, integrated weed-management economics and climate-resilient weed-management systems.

C. Conclusion

It is established that tropical weeds are stubborn and adamant recurring after every effort to keep them off. Unlike the weeds in the temperate regions of the world that would not surface again once removed. The perpetual recurrence of weeds on tropical arable land cannot be sustainably solved by repeatedly killing the weeds that appear above the soil surface. The underlying problem is the continuous biological renewal of weed populations through soil seed banks, seed rain, vegetative regeneration, weed immigration and ecological adaptation. This paper proposes the Tropical Weed Recurrence Decimation Approach (TWRDA) as a new conceptual framework for addressing this challenge. The approach is founded on seven interconnected principles: know the weed population; prevent new weed introduction; deplete the soil seed bank; prevent weed seed production; increase crop competitiveness; diversify control tactics; and monitor and adapt continuously. Its most important conceptual contribution is the Zero-Seed-Rain Principle: weeds that survive control operations should not be allowed to mature and replenish the soil seed bank wherever practical. Consequently, successful weed management should no longer be measured solely by the number of weeds killed today. It should also be measured by the number of weeds prevented from emerging tomorrow. The ultimate objective is therefore not simply, "How do we kill today's weeds?" but, "How do we make tomorrow's weeds fewer than today's weeds?" This change in perspective could provide a powerful foundation for sustainable weed management in Nigeria and other tropical agricultural regions. Nevertheless, the proposed TWRDA framework requires multi-season, multi-location empirical testing before claims of efficacy can be established scientifically.

Table 1. Conventional Weed Management Compared with the Proposed TWRDA Framework

Dimension	**Conventional Approach**	**TWRDA Approach**
Primary objective	Kill emerged weeds	Reduce weed population and recurrence
Main target	Visible weeds	Visible weeds, seed bank and reproductive processes
Time horizon	Usually one season	Multi-season
Management philosophy	Reactive	Preventive, proactive and adaptive
Herbicide role	Often central	One component of diversified management
Seed production	Often secondary consideration	Explicitly prevented through zero-seed-rain principle
Soil seed bank	Often overlooked	Core management target
Crop competition	Variable	Deliberately strengthened
Monitoring	Often periodic	Continuous and mapped

Success indicator	Visual weed control/yield	Weed control + reproduction + seed bank + yield + economics

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