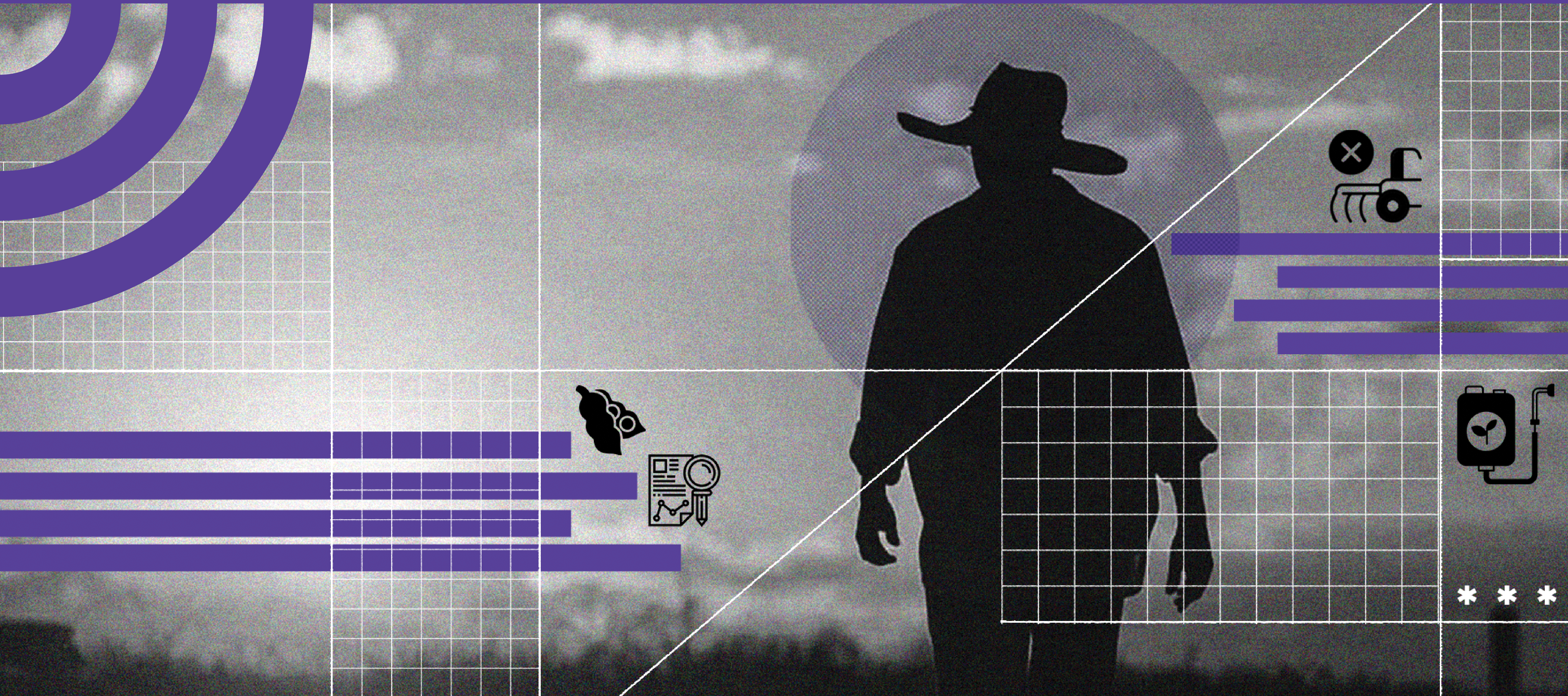
OCTOBER / 2025

HOW CAN SOYBEANS LEAD THE TRANSITION OF BRAZILIAN AGRICULTURE?

INSTITUTO ESCOLHAS



The combination of no-till farming and herbicides

1 Instituto Escolhas. Brazil as a Global Leader in Soy Production: Until When and at What Cost?. São Paulo, 2025. Available at: https://escolhas.org/wp-content/uploads/2025/07/Sum_Brazil-as-world-leader-in-soybean-production.pdf

The study conducted by Instituto Escolhas - "Brazil as a Global Leader in Soy Production: Until When and at What Cost?"[1] - demonstrated that the soybean planted area grew 317% between 1993 and 2023, while the potential use of pesticides (insecticides, fungicides, and herbicides) in grain production increased by 2,019%.

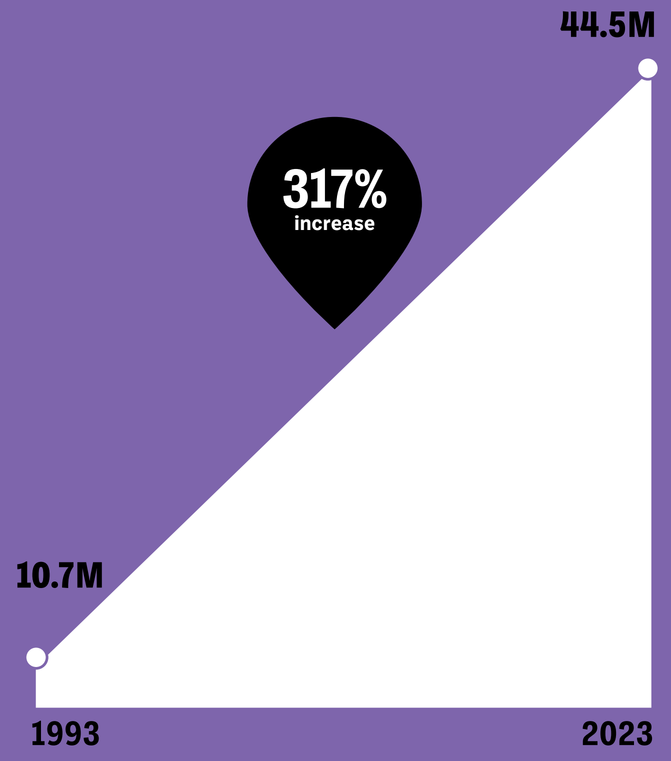
One of the main reasons for this substantial increase in the pesticide use in soybean production, as discussed in this new study, is the widespread adoption of no-till farming dissociated from other sustainable practices and heavily reliant on synthetic herbicides. Throughout the period, herbicides always accounted for more than 50% of all pesticides sold in Brazil. Without biological alternatives, the estimated use of synthetic herbicides in soybean production grew equivalent to the expansion of no-till farming area in Brazil between 1993 and 2023: 11% per year.

No-tillage or no-till (NT) is a recognized soil conservation practice that avoids soil disturbance and prevents erosion, increasing water absorption capacity and nutrient retention. The problem is that the practice has become common across Brazilian soybean area as a standalone technique, rather than integrated with other soil conservation and regeneration measures. As a result, it relies heavily on herbicides for weed management.

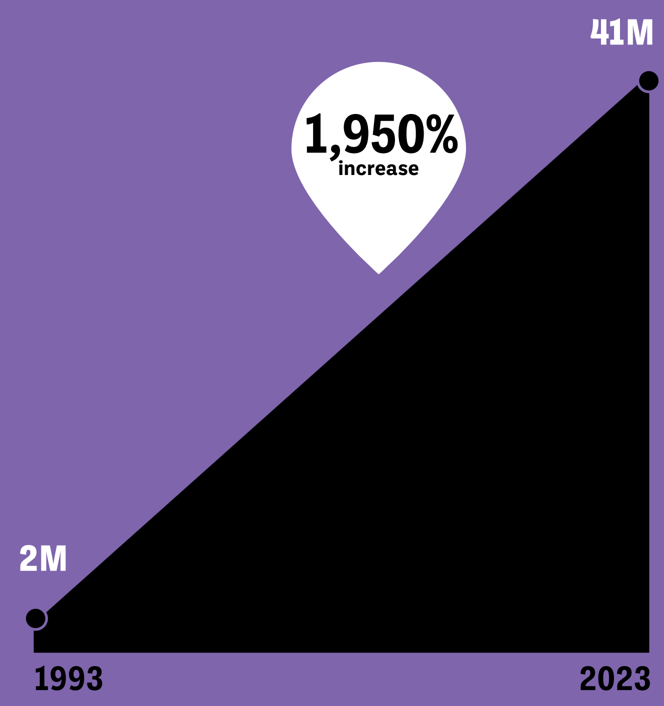
The intensive use of synthetic inputs harms the soil and its microorganisms considerably. Under these circumstances, one negative impact on the soil (soil disturbance) was replaced by another (increased use of synthetic inputs), with worrying side effects for the production model's efficiency and economic and environmental sustainability.

ANNUAL GROWTH OF NO-TILL FARMING AND ESTIMATED HERBICIDE USE FOR SOYBEANS IN BRAZIL 11%

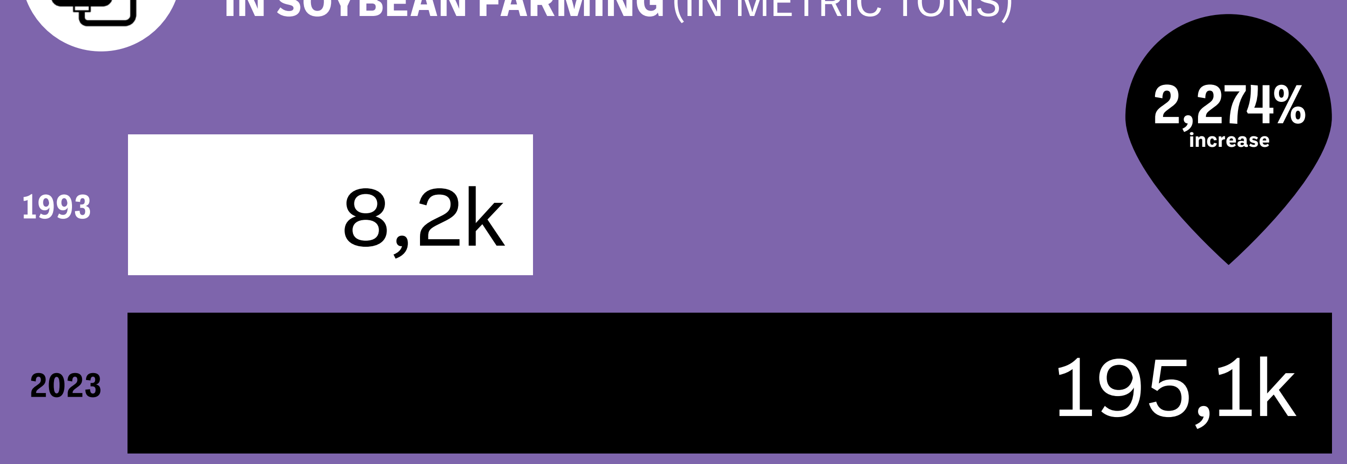
HECTARES OF SOYBEAN PLANTED AREA



HECTARES OF NO-TILL FARMING



SYNTHETIC HERBICIDES POTENTIALLY USED IN SOYBEAN FARMING (IN METRIC TONS)



Introduction

Spraying pesticides in soybean production
Photo: Humeyra/ Adobestock

As shown in the first study of Instituto Escolhas[2], Brazil has been increasingly using synthetic inputs (pesticides and fertilizers) on soybean production, raising production costs to achieve the same yield results. In 1993, 1 kg of pesticide produced 23 soybean bags; in 2023, the same amount produced only 7 bags. Brazil's expenditures on seeds, pesticides, and fertilizers increased 8% annually between 2013 and 2023.

Therefore, there is a pressing need to shift towards more sustainable soybean production models, driven by economic and environmental concerns. The depletion of current production system is jeopardizing farmers' profitability and putting Brazil's global leadership in soybean production at risk. As the country's main crop—occupying 46% of Brazil's total planted area in 2023[3]— and given its importance, soybeans could play a leading role in driving the transition of Brazilian agriculture towards more sustainable practices adapted to the climate crises.

Brazilian soybean farmers are already familiar with the word "adaptation", since they have built their success and prominence by effectively adjusting soybean production to local soil, water, light, temperature, and biodiversity conditions. The expansion of soybean farming, especially from the 1970s onwards, was supported by a robust set of public policies that combined subsidized credit and technical assistance, with major investments in research, development, and innovation to adapt soybean varieties and production practices to Brazilian tropical environment.

2
Refer to footnote 1

3
IBGE. Municipal Agricultural Production (PAM): Table 5457. Available at: https://sidra.ibge.gov.br/tabela/5457. Accessed on July 11, 2025.

NO-TILLAGE (NT) AND NO-TILL SYSTEM (NTS)

No-tillage refers to the practice of planting seeds directly into undisturbed soil covered with crop residues. The "no-till system" is broader and refers to a set of integrated conservation agriculture practices that include minimal soil disturbance, crop diversification, and permanent soil cover.

An example of this adaptation is the widespread adoption of NT as a response to the negative outcomes of using machinery to prepare the soil for planting, as it occurs in conventional tillage. The intensive use of tillage practices compromises soil stability, infiltration capacity, and water and nutrient retention, besides promoting erosion, compaction, and biodiversity loss. Given the low natural fertility of Brazilian soils, these impacts are even more severe. NT emerged as a solution better suited to Brazilian climate and soil conditions. The practice is a benchmark in sustainability, with studies and research validating its implementation and public policies encouraging its adoption.

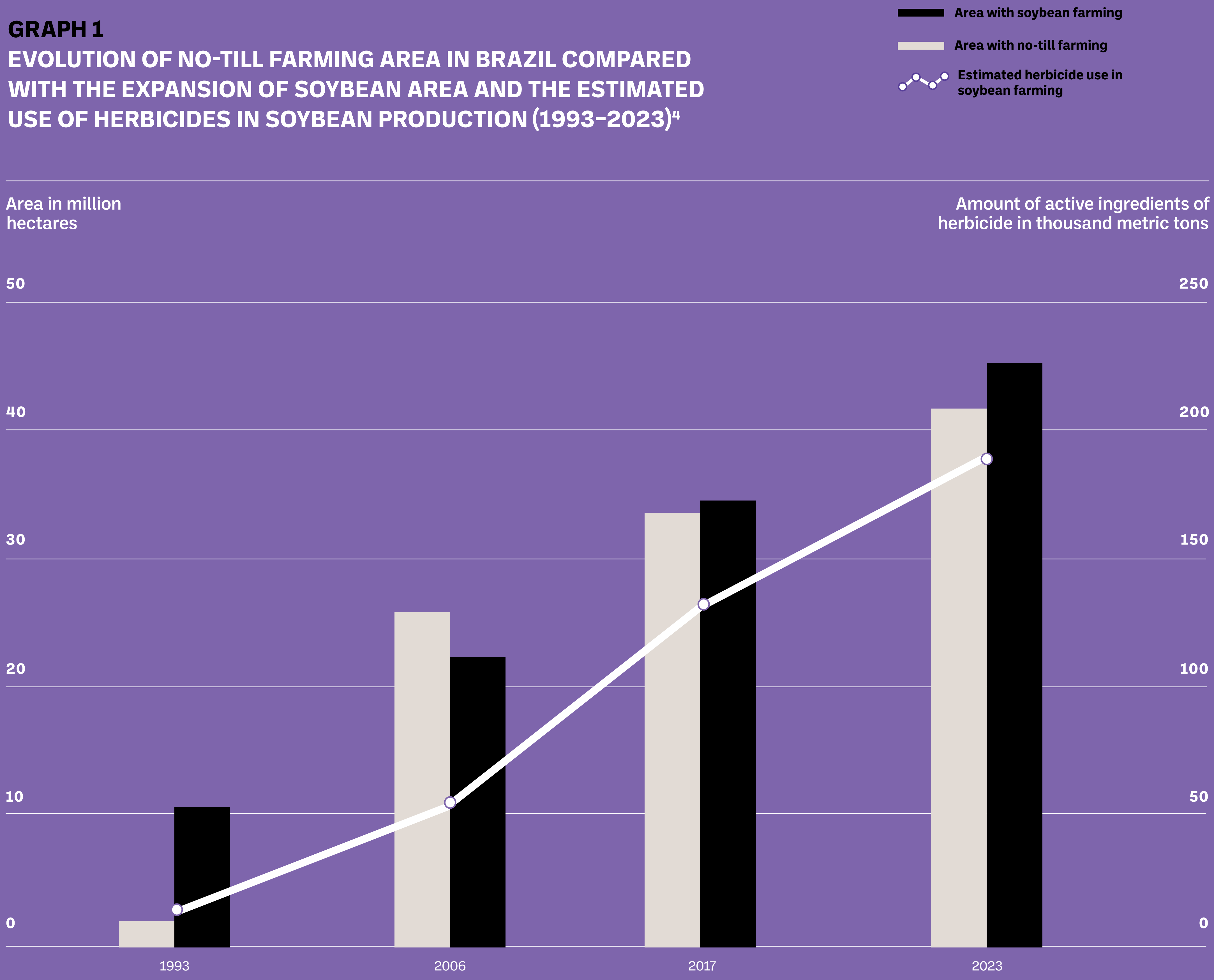
However, the way NT is implemented in Brazil is highly dependent on synthetic inputs, which undermines the long-term sustainability of the grain production model. Unlike NTS, NT is implemented as a standalone practice, lacking integration with crop diversification or strategies to reduce the use of synthetic pesticides. Without soil disturbance, the main challenge for soybean farming became weed control, which was addressed through heavy reliance on synthetic herbicides combined with genetically modified soybean seeds resistant to those same herbicides. In practice, the massive expansion of NT was only feasible due to its association with pesticides (especially herbicides) and genetically modified seeds.

Graph 1 presents data showing that the expansion of NT areas in Brazil follows the growth of soybean planted area and the estimated use of synthetic herbicides in soybean production. Although other crops have also adopted no-till practices—such as wheat, maize, beans, sorghum, and barley—soybeans remain the predominant and most prominent crop in the country using NT.

Soybean production under mulch cover
Photo: AlfRibeiro/Adobestock

GRAPH 1

EVOLUTION OF NO-TILL FARMING AREA IN BRAZIL COMPARED WITH THE EXPANSION OF SOYBEAN AREA AND THE ESTIMATED USE OF HERBICIDES IN SOYBEAN PRODUCTION (1993–2023)[4]



Source: Instituto Escolhas, based on data from FEBRAPDP, IBGE, FAOSTAT, and IBAMA.

Recently, there has been an emergent trend toward replacing synthetic pesticides with biological inputs, which could make NT as a standalone practice more sustainable. However, commercial biological herbicides are not yet available, and adoption of bio-inputs still lags behind the use of synthetic inputs[5].

Considering that NT as a standalone practice is insufficient to encourage the shift of agriculture toward more sustainable, regenerative, and climate-resilient practices, this study examined the challenges faced by soybean farmers in adopting other sustainable practices and recommends the adoption of five ambitious commitments to accelerate the transition of our agriculture.

4
FEBRAPDP: data on no-till farming area. For 1993, 2006, and 2017, data is available at: https://plantiodireto.org.br/area-de-pd. For 2023, data is available at: https://plantiodireto.org.br/spd-praticado-no-brasil-e-destaque-em-conceituada-revista-cientifica-internacional.
IBGE – PAM: data on soybean planted area. Data for the corresponding period is available at: https://sidra.ibge.gov.br/tabela/5457.
IBGE-PAM, IBAMA, FAOSTAT: as no specific data on herbicide sales for soybean are available, the estimated value was obtained by multiplying the total volume of herbicide active ingredients sold in Brazil with the percentage of soybean in the country's total planted area. For more details on this methodology, please see details in the previous study (Instituto Escolhas, *Ibid.*).

5
Based on Ministry of Agriculture (MAPA)'s input data, synthetic pesticides represent 87% of all registered products.

How is soybean production transitioning to more sustainable practices?

Crop residues for soil cover
Foto: Geza Farkas/ Adobestock

The study included interviews with 34 soybean farmers from the country's leading soybean-producing states (Mato Grosso, Goiás, and Paraná) and visits to their properties. The goal of the investigation was to identify which production practices farmers implement or fail to implement, and why.

We spoke with soybean farmers certified as organic (under Brazilian legislation), regenerative (in accordance with private protocols), and conventional (without any certification), to capture different farm management systems. The study opted to distinguish farmers by the certification as it indicates the farmer's decision to adopt a package of practices established by a third party that generates an implementation cost, even without a legal obligation.

As summarized below, we asked farmers about 45 practices for soil conservation and regeneration and reduction of synthetic inputs (pesticides and fertilizers).

TABLE 1 – CHARACTERISTICS OF THE SOYBEAN FARMERS INTERVIEWED IN THE STUDY

TYPES OF FARM MANAGEMENT	CONVENTIONAL	ORGANIC	REGENERATIVE
Average age of farmers (min.-max.)	44 (~26-62)	48 (~34-68)	48 (~32-69)
Average farm size in hectares (min.-max.)	2240 (~16-19,300)	328 (~20-990)	5060 (~43-16,500)
Average number of products marketed	3.1	6	4.5
Nº of farmers in Mato Grosso	5	0	5
Nº of farmers in Paraná	4	7	3
Nº of farmers in Goiás	4	3	3
Total farmers	**13**	**10**	**11**

Source: Instituto Escolhas, 2025

CHALLENGES TO ADOPT SOIL CONSERVATION AND REGENERATION PRACTICES

I don't have the infrastructure to raise cattle

I'm afraid of falling into debt

Erosion is a problem. I produce without poison, but I damage the soil

The soil conservation and regeneration practices considered in the study correspond to those aligned with the core principles of conservation agriculture, such as minimum soil disturbance, diversification of species in the planted area, and maintenance of permanent soil cover.

The farmers interviewed tend to implement well-established practices such as soil correction (97%), soil mulching (91%), and no-tillage (76%), which do not threaten yields and require only short-term investments. Practices that promote various ecosystem benefits are less commonly adopted, as they occupy land otherwise used for the main crop (such as ecological corridors and intercropping), demand additional investment and technical training (as in the case of integrated crop-livestock-forest system), and/or are proposed for long-term returns (such as the use of compost).

All conventional farmers interviewed adopt no-tillage; however, only 31% implement crop rotation, 23% maintain diversity of living roots, 15% use green manure, and 15% adopt cover cropping. The consolidated production model shows no signs of progress towards implementing a complete no-till system, resulting in a trade-off between soil conservation (by not disturbing the soil) and soil degradation (by increasing the use of pesticides).

Regarding soil conservation and regeneration practices, the organic farmers interviewed face the dilemma of having to plough the soil due to the lack of machinery and inputs to control weed growth without violating the requirements of their production model.

Regenerative farmers, in turn, adopt a wide variety of practices to increase soil health, maintain the resilience of their production models, and reduce costs with synthetic inputs.

CHALLENGES TO IMPLEMENT PRACTICES FOR REDUCING SYNTHETIC PESTICIDE USE[7]

[7] Since no synthetic pesticides are permitted in the organic production model, the responses help to understand which practices are implemented to a greater or lesser extent by organic farmers to control pests, diseases, and weeds without relying on these prohibited inputs.

I don't like spraying insecticides, but I do because I can't fix it otherwise

I started using biologicals to reduce the cost of chemicals, but the companies tell us to combine them [synthetic and biological products].

Among the practices to reduce the use of synthetic pesticide examined in the study are the systemic approaches such as integrated pest, disease, and weed management (MIP, MID, and MIPD in Portuguese), which aim to prevent, control, and address these problems as efficiently and sustainably as possible. Proper management strategies involve implementing a set of preventive and corrective practices, always based in integrated approaches. Chemical control is understood as a last resort, used only to avoid economic losses in crop production.

Most of the farmers interviewed responded positively to the adoption of integrated management practices, especially for pests (97%) and diseases (88%), and, to a lesser extent, for weeds (76%). However, it was common for those integrated management systems (MID, MIP, and MIPD) to be identified as equivalent as field monitoring for rapid detection and action on the problem. Although monitoring is an important step within integrated management, it does not represent it as a standalone practice, as MIP, MIP, and MIPD involve a comprehensive approach and the integration of multiple strategies. In fact, many of the conventional and regenerative producers interviewed reported an increase, rather than a reduction, in the use of synthetic inputs, emphasizing the growth in herbicides.

The increased use in pesticide becomes even more evident when examining the group of conventional farmers interviewed, who seldom use crop rotation and biological control practices (except for commercial bioinsecticides, as shown in the table).

It should also be noted that both conventional and regenerative production models follow a logic of combining synthetic and biological inputs, a practice not allowed for organic farmers, who rely extensively on biological inputs and other preventive control measures.

Finally, given the lack of bioherbicides available on the market, organic farmers, who cannot use chemical control, resort to other practices, such as manual weeding (100%), which significantly increase production costs, especially in large-scale areas. In the case of regenerative farmers, who are concerned about using synthetic inputs, the adoption of localized herbicide application (55%) was also noted.

CHALLENGES TO IMPLEMENT PRACTICES FOR REDUCING SYNTHETIC FERTILIZERS USE [9]

Alongside soil correction with agricultural gypsum and limestone (97%), a practice already consolidated in Brazilian soybean production, most of interviewed farmers reported adopting inoculation practices with *Azospirillum* (94%) and *Bradyrhizobium* (91%). Practices such as the use of biochar (0%), the application of compost (26% commercial and 35% on-farm), and rock dust (38%) were the least adopted among interviewees, which is related to challenges such as the limited availability of certain inputs in the market as well as logistical constraints.

With low adoption of practices to reduce synthetic fertilizers, conventional farmers tend to prioritize high-solubility fertilizers due to their immediate absorption of nutrients by roots and plants. However, these fertilizers present losses due to leaching and lower absorption than low-solubility fertilizers, such as rock dust or manure.

On the other hand, organic and regenerative farmers showed widespread adoption of these practices. The low adoption of certain inputs across all production models is correlated with infrastructure and logistical bottlenecks, as occurs with compost, and slow advance in research and development, as occurs with biochar.

I can't use a lower dosage of fertilizers

Since I don't raise pigs or chickens, I have to move heaven and earth to get it [biofertilizer]

9 Since no chemically synthesized fertilizers (such as urea, MAP, KCl, and granular NPK) is permitted under the organic production model (that permits only mineral fertilizers with low solubility or obtained through physical processes), the responses described help to understand which practices are more or less implemented by organic farmers to use fertilizers without relying on these prohibited inputs.

Process of preparing compost
Photo: DORA/Adobestock

TABLE 2
Percentage, average, and number of soil conservation/regeneration practices implemented by the interviewed farmers, according to farm management type[6]

Table Caption

CONVENTIONAL
>50%
≤ 50%

ORGANIC
>50%
≤ 50%

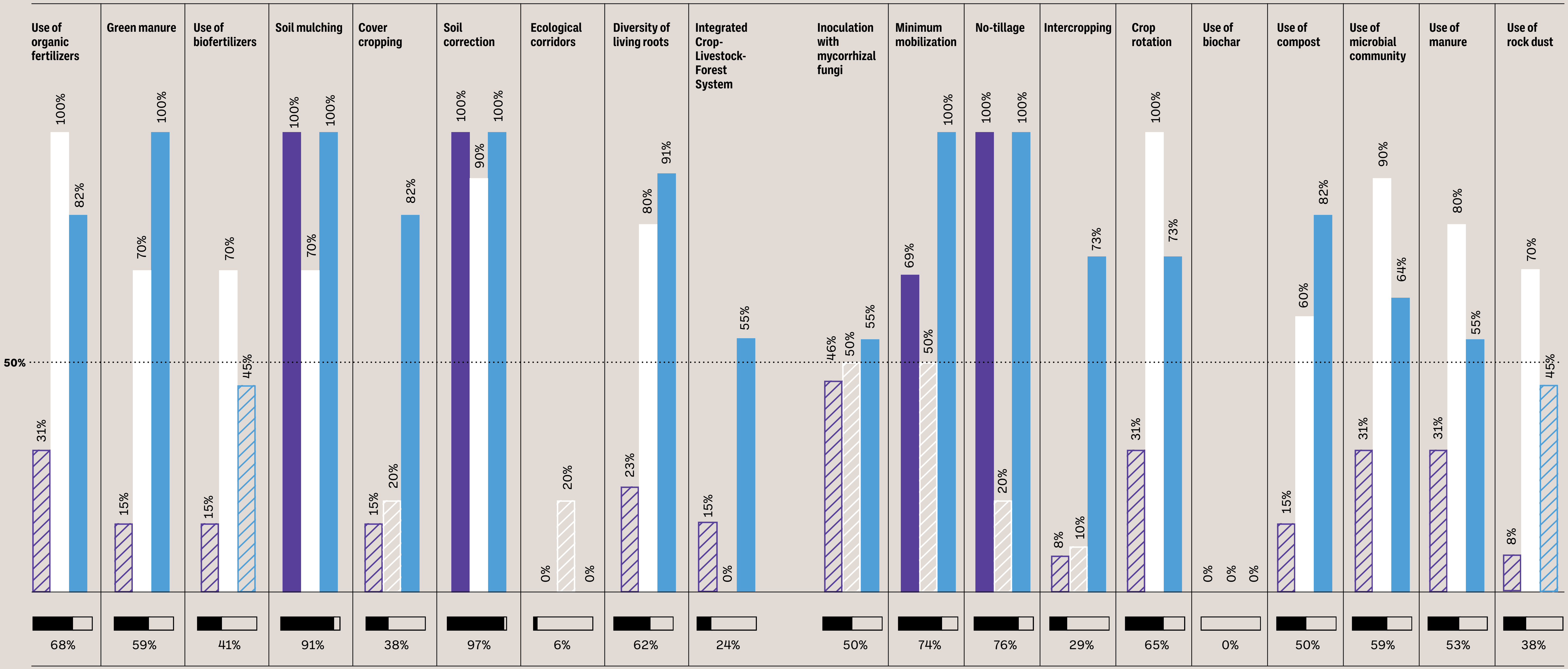
REGENERATIVE
>50%
≤ 50%

TOTAL

50%

Average of practices implemented per producer

Conventional 6,5
Organc 10,6
Regenerative 13



Source: Instituto Escolhas, 2025, based on data collected in the field.

6 The definitions of each practice can be found in the glossary of the Technical Report of this study: Instituto Escolhas. *How can soybean lead the transition of Brazilian agriculture?* Technical Report. São Paulo, 2025 (available in Portuguese only).

TABLE 3
Percentage, average, and number of practices implemented by the interviewed farmers to reduce synthetic pesticide use, according to farm management type [8]

Table Caption

CONVENTIONAL
>50%
≤ 50%

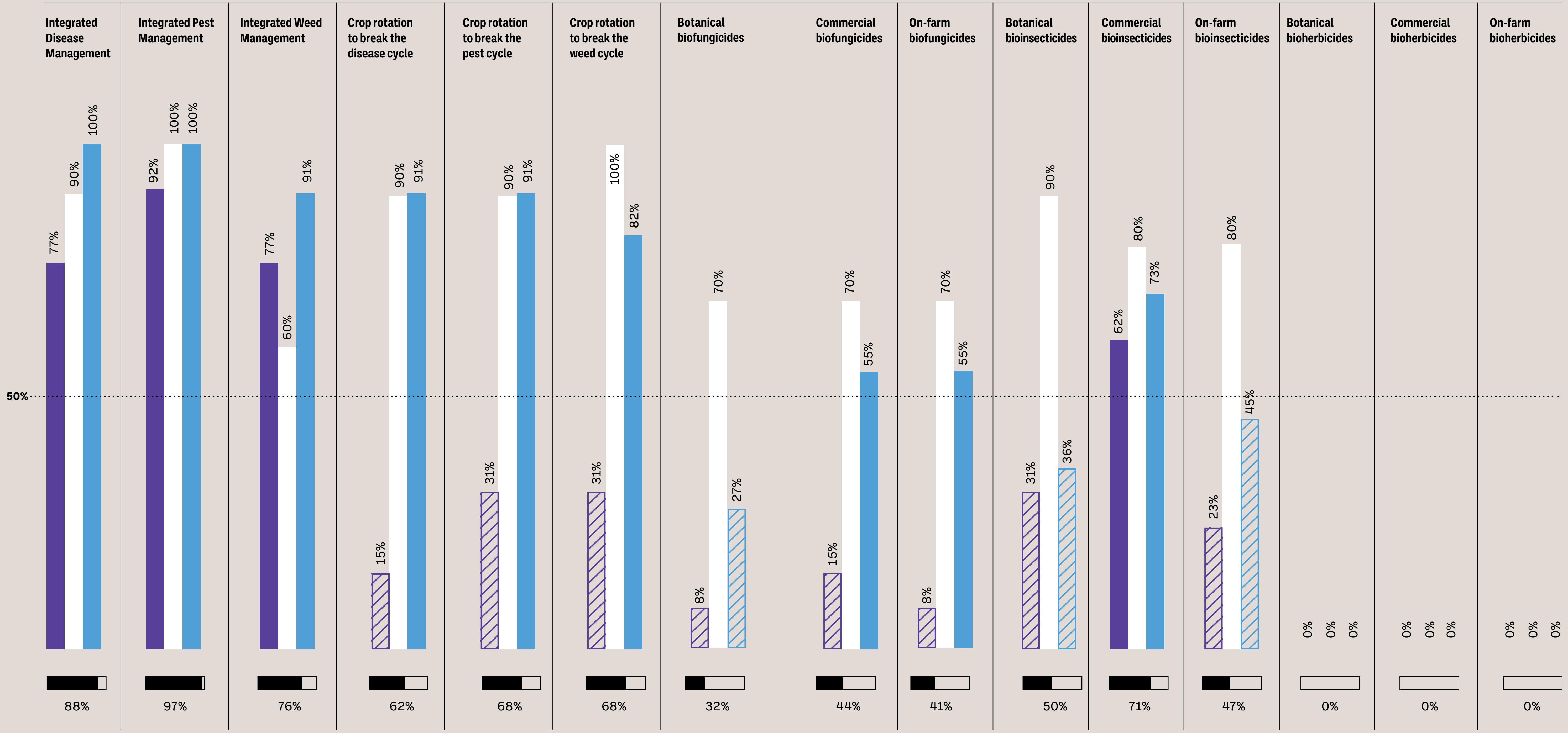
ORGANIC
>50%
≤ 50%

REGENERATIVE
>50%
≤ 50%

TOTAL
50%

Average of practices implemented per producer

Conventional 4,7
Organc 9,9
Regenerative 8,5

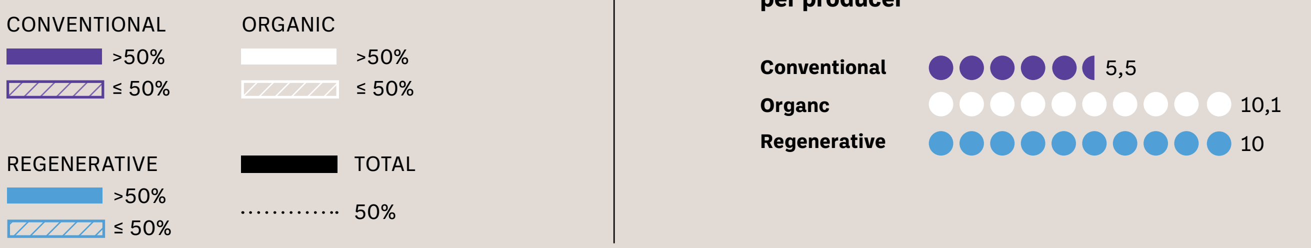


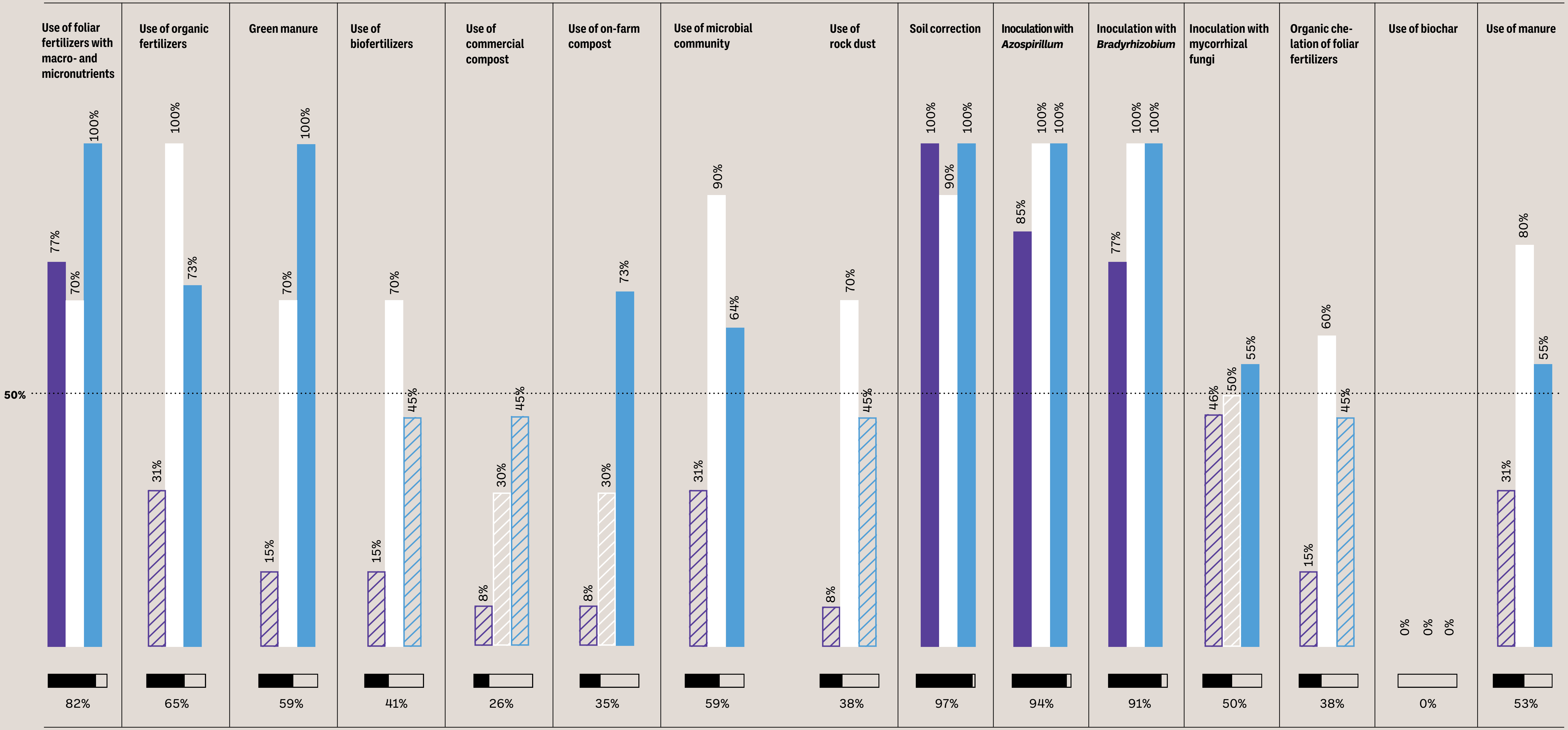
Source: Instituto Escolhas, 2025, based on data collected in the field.

8 The definitions of each practice can be found in the glossary of the Technical Report of this study: Instituto Escolhas. *How can soybean lead the transition of Brazilian agriculture?* Technical Report. São Paulo, 2025 (available in Portuguese only).

TABLE 4
Percentage, average, and number of practices implemented by the interviewed farmers to reduce synthetic fertilizer use, according to farm management type[10]

Table Caption





Source: Instituto Escolhas, 2025, based on data collected in the field.

10 The definitions of each practice can be found in the glossary of the Technical Report of this study: Instituto Escolhas. *How can soybean lead the transition of Brazilian agriculture?* Technical Report. São Paulo, 2025 (available in Portuguese only).

More ambitious public policies for the transition

Soybean producer monitors his crop
Photo: Zoran Zeremski/Adobestock

All soybean farmers interviewed for the study, even those who adopt few sustainable practices, expressed concern about the resilience of their crops in the medium and long term, particularly due to the evolution of input prices and climate variations. Since soybean production is the main economic activity of the establishments visited (regardless of size, location, and farm management model), farmers are the ones most interested in constantly seeking ways to ensure the maintenance and resilience of their production, preferably with positive and increasing yields.

I don't want to be a productivity champion; I want to be a profitability champion

In this context of soybean production model leading to depletion and of farmers increasingly inclined towards change, the role of the State is fundamental, not only to encourage the adoption of sustainable practices, but also to promote access to and availability of inputs aligned with these practices. The problem is that existing public policies fall far short of the urgency to encourage the transition.

The system is in the Intensive Care. Small-size producers will disappear; the medium ones will disappear... The big ones, who can scale up production, will reinvent themselves

The main public policy instrument currently dedicated to promoting sustainable agriculture (fostering both mitigation and adaptation practices to face the climate crisis) is the Sectoral Plan for Adaptation to Climate Change and Low Carbon Emission in Agriculture (ABC+ Plan). The Plan includes actions that encourage the implementation and expansion of practices which are highly aligned with the transition in soybean production, such as no-till system, integrated crop-livestock-forest system, and the use of bio-inputs.

One of the goals established by the plan for 2020–2030 is to increase area with no-till farming by 12.5 million hectares. However, the target is divided into two targets: an increase of 4.5 million hectares under NTS and 8 million hectares under NT by 2030[11]. The first problem with this goal is to prioritize NT as standalone practice, as it lacks an integrated approach and does not advance in reducing the use of synthetic inputs.

The second problem is that it is a target that does not

11 According to data from the *Sectoral Plan for Climate Change Adaptation and Low Carbon Emission in Agriculture 2020–2030: Operational Plan, 2021.*

encourage the sector to do more than it is already doing. Between 2020 and 2023, the growth rate of the soybean planted area was 6% per year, representing an increase of more than 7.2 million hectares. Considering that NT is already a hegemonic practice among soybean farmers, the target of an 8-million-hectare increase in NT under the ABC+ Plan represents not only natural growth for the sector, but also a potentially unsustainable choice, given the potential rise in herbicide use driven by the adoption of NT as a standalone practice.

The ABC+ Plan also sets a target to increase the area using bio-inputs by 13 million hectares[12]. The problem is that, in this case, the target for bio-inputs is limited to plant nutrition actions, disregarding more assertive measures for plant defense. In other words, the plan does not set goals for reducing the use of pesticides. If we also consider that soybean production already widely adopts inoculants to promote biological nitrogen fixation in the soil, it is reasonable to question the ambition of the target established for plant nutrition.

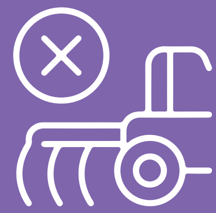
Beyond the important ABC+ Plan, we can also address the inadequacy of the National Fertilizer Plan. While focusing on reducing the country's external dependency on inputs, the plan fails to address the need to reduce the use of synthetic fertilizers. With a planned investment of R$ 24.41 billion, most all of the resources are directed towards producing nitrogen, phosphate, and potash fertilizer, which complies with the traditional chemical/synthetic model (92% of the total). For emerging sectors (such as organomineral and organic fertilizers), the planned investment is only 0.11% of the total[13]. In other words, we are channeling resources into an industry of the past, which puts the country at a competitive disadvantage in the transition to a new model of sustainable tropical agriculture.

An important step toward achieving meaningful and urgent changes in Brazilian agriculture is acknowledging past efforts, but also recognizing that they are currently insufficient, so we need to go further. The government, together with the sector and the input industry, need to set more ambitious targets, commitments and comprehensive policies that fully support all necessary agricultural changes, not only part of them. In the case of soybean production, this means going beyond the implementation of no-till farming as a standalone practice and addressing the urgent need to reduce the use of synthetic inputs.

12
Refer to footnote 11.

13
According to data made available by the project portfolio of the National Council for Fertilizers and Plant Nutrition (Confert in Portuguese).

5 AMBITIOUS COMMITMENTS TO DRIVE AGRICULTURE'S TRANSITION



1. **Make the increase of area of No-Till System (NTS) the main goal of the ABC+ Plan;**

2. **Include plant defense in the ABC+ Plan's goal of increasing the area that uses bio-inputs;**

3. **Substantially increase investments by the National Fertilizer Plan in the industry and market for organo-mineral and organic fertilizers;**

4. **Invest in research, development, and structuring of the biodefense industry and market;**

5. **Invest in research, training, and the provision of technical assistance to support farmers in implementing more sustainable production practices.**

Study idealized by Instituto Escolhas and Instituto Folio

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