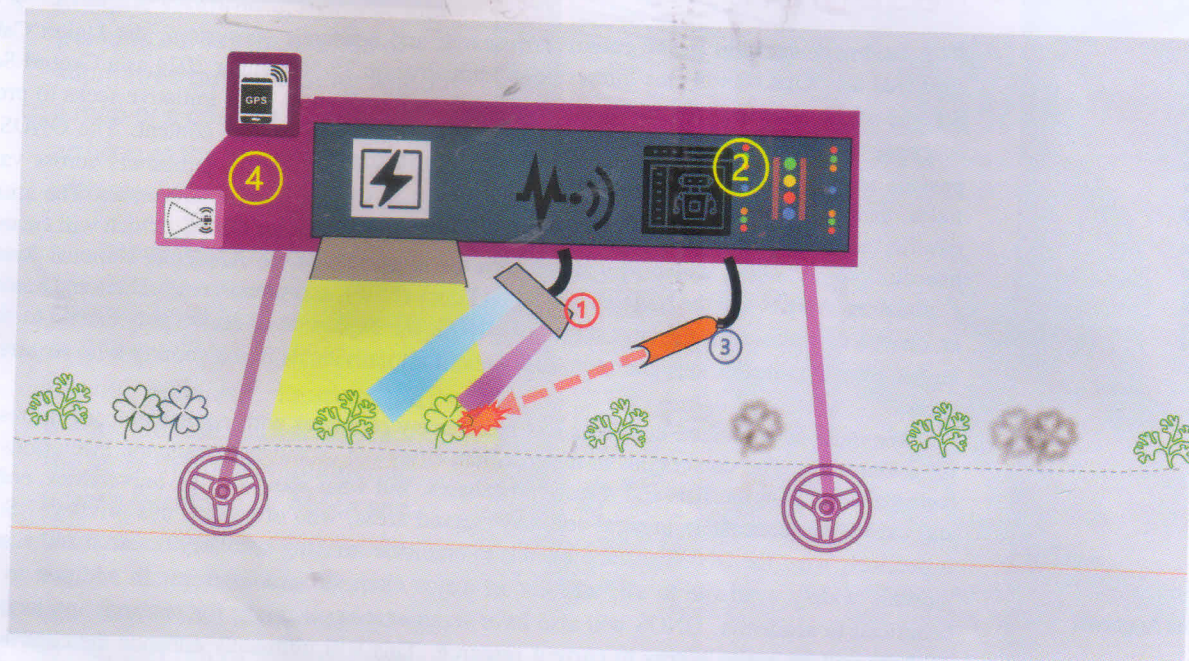


# Robotics and AI Reshape Weed Management



**W**EEDS have been a challenge for cultivators throughout history. Some 15,000 years ago, our ancestors foraged for grains and fruits in the wild among weedy growth. When they began cultivating crops on beds, weeds naturally came along, competing for vital resources like nutrients, water, and sunlight. These early farmers had to resort to labour-intensive hand weeding, followed by introducing mechanical tools to make the process more efficient. The use of target-specific herbicides starting in the 1940s was a significant breakthrough. These miracle chemicals selectively killed unwanted plants, reducing the need for manual labour and boosting crop yields. However, weeds developed resistance to these herbicides over time, which became a major concern by the 2010s.

Today, the International Herbicide-Resistant Weed Database reports a staggering 521 unique cases of herbicide resistance worldwide. This resistance spans 23 out of 26 known herbicide sites of action and involves 164 different herbicides. The current weed control scenario is messy, as cocktails of herbicides and genetically engineered herbicide-resistant crops are being used as options.

The recent advent of artificial intelligence and deep learning, and its prudent fusion with already existing technologies of robotics and lasers, has given rise to innovative solutions in the form of modern laser weeders.

These sophisticated machines, equipped with sensors and cameras, meticulously scan the fields. Upon detecting a weed, a laser, fine-tuned to the task, quickly zaps it, leaving the surrounding crops intact. This technology operates at an impressive speed and holds enormous potential for a sustainable agricultural future.

A modern laser weeder has four key components: i) a high-resolution camera, ii) a deep learning system, iii) a robotic actuator with a laser gun, and iv) a haulage vehicle. The weeding process begins with the camera capturing real-time images of a designated area in a field. These images are then analysed by the Deep Learning System (DLS), which acts as the brain of the weeder. For this brain to work, it must first be 'trained' for the crop-weed system it must deal with. The trained DLS system comprehends the exact location of the weeds in the captured field of view. Subsequently, it commands the robotic actuator to aim the laser gun and fire a precise beam, selectively targeting and destroying each weed without harming the surrounding crop plants. The entire weeder system can be hitched to a tractor, drawing power from its PTO (Power Take-off). Alternatively, the weeder may be an AHS (Autonomous Haulage System) vehicle that drives itself with computer vision, positions itself with GPS, and searches for obstacles with LIDAR (Light Detection and Ranging).