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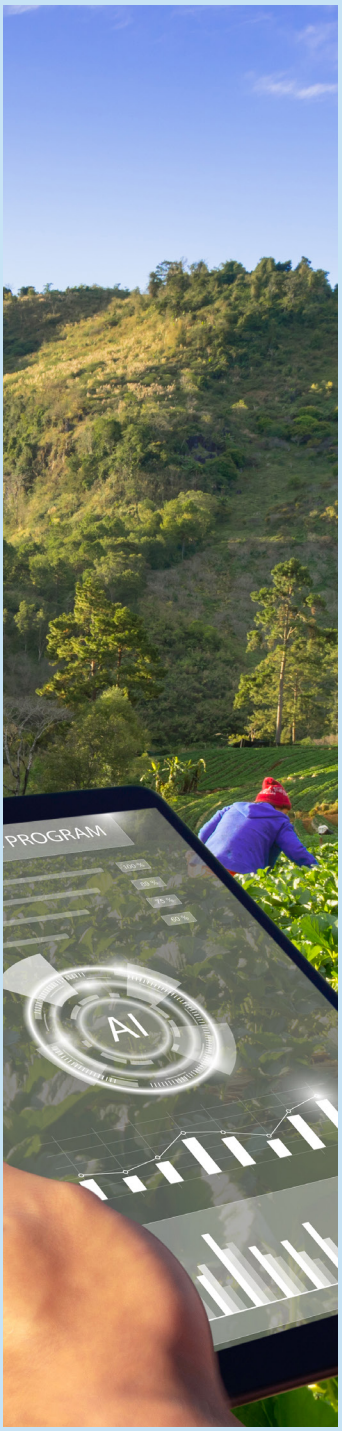

HOW GenAI DRIVES REGENERATIVE AGRICULTURE

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Global greenhouse gas (GHG) emissions from agriculture increased by 18% year-on-year since 1990, reaching 5.87 billion metric tons of carbon dioxide equivalent (CO_2e) in 2020, according to Statista.com.

The largest sources of methane emissions are livestock and rice cultivation. Similarly, agriculture accounts for most of the nitrous oxide (N_2O) emissions. Synthetic / organic nitrogen applied in excess of crop uptake leads to conversion of the fertilizer into N_2O by microbes. In fact, GHG emissions emanating from agriculture is a vicious carbon cycle. The carbon footprint of agriculture adds to global warming, which in turn disrupts crop cycles.

Climate-driven food and water insecurity is expected to escalate with increased global warming, according to a 2023 Intergovernmental Panel on Climate Change report. The IPCC report concludes that "if we act now, we can still secure a livable sustainable future for all."

Regenerative agriculture reverses climate change by rationalizing inputs, restoring soil health, and improving biodiversity. Regenerative farming, ranching and pastoral practices based on the principles of agroecological and conservation agriculture create an ecosystem that fosters a symbiotic relationship between people, land, water bodies, livestock, wildlife, and microbial life.

Data, the catalyst for sustainable agriculture

Generative artificial intelligence (GenAI) enables a climate-first approach to reinforce global food systems. Agribusiness enterprises can combine GenAI models with a cloud-based infrastructure to facilitate regenerative farming.

Prevention of soil erosion and robust fertility management conserve the soil and water table, which in turn supports crop diversity. Efficient water management optimizes utilization and eliminates nutrient runoff, which minimizes resource depletion as well as operational costs. Further, scientific pest and disease management improves nutrient usage efficiency and rationalizes the use of pesticides, which protects the biodiversity of cultivable land.

GenAI models can be trained to learn from historical datasets or generate data by simulating specific conditions. The models use location-specific soil cover, cropping patterns, crop lifecycle data, and pest / disease spread to forecast variables. It calculates key sustainability parameters such as soil composition, nutrients, eco-toxicity, eutrophication potential, and above- and below-ground carbon level.

Simulation models combine real-time weather data, such as rainfall, temperature, relative humidity, and wind speed, with seasonal forecasts and historical weather patterns and variations. Similarly, smart tools simulate crop growth, yield and potential loss due to diverse factors. Further, GenAI models identify farmlands with soil degradation, water stress and pest infestation, which enables targeted interventions for crop rotation, fertilization and pest control. A data-driven ecosystem empowers agrochemical manufacturers, R&D organizations, and seed and input suppliers to offer comprehensive soil, water and crop management solutions to farmers.

Regenerative agriculture supports resource conservation

Virtual environments help enterprises analyze the impact of irrigation and fertilization schedules (frequency and quantity) on crop growth and yield. GenAI models assess water and nutrition requirements accurately by combining historical data and real-time weather conditions, soil quality data, GPS maps, IoT sensor data, drone imagery, and crop life stage data. AI-generated insights help develop customized strategies to restore soil health, build soil structure, and improve water retention.

Farmers can combine drone footage with smartphone functionality to relay field data to farm service providers via chatbots and mobile apps. Machine learning algorithms identify disease and pest attacks by analyzing sensor data and images of affected plants. They also accurately predict potential outbreaks by evaluating pest population, weather conditions and early symptoms. The ability to identify nutrient deficiencies and infestations in the formative stage facilitates prompt response or preventive measures to mitigate crop loss.

Crop scouting through remote sensing and AI-driven site management augment agricultural practices, be it for pest control, weed suppression or precision farming. For instance, in the event of a decrease in water holding capacity or the outbreak of disease in an area within a plantation, robotic sprayers can be calibrated for targeted application. Precise application of fertilizers, pesticides and water ensures healthy growth and improves crop yield, while minimizing wastage and boosting resource efficiency.

Regenerative agriculture personalizes product and service

Customized recommendations throughout the crop lifecycle enables growers to boost farm productivity and profitability. Generative AI tools allow agribusiness enterprises to offer contextual advice, address queries and resolve issues, be it crop management techniques or sale of produce.

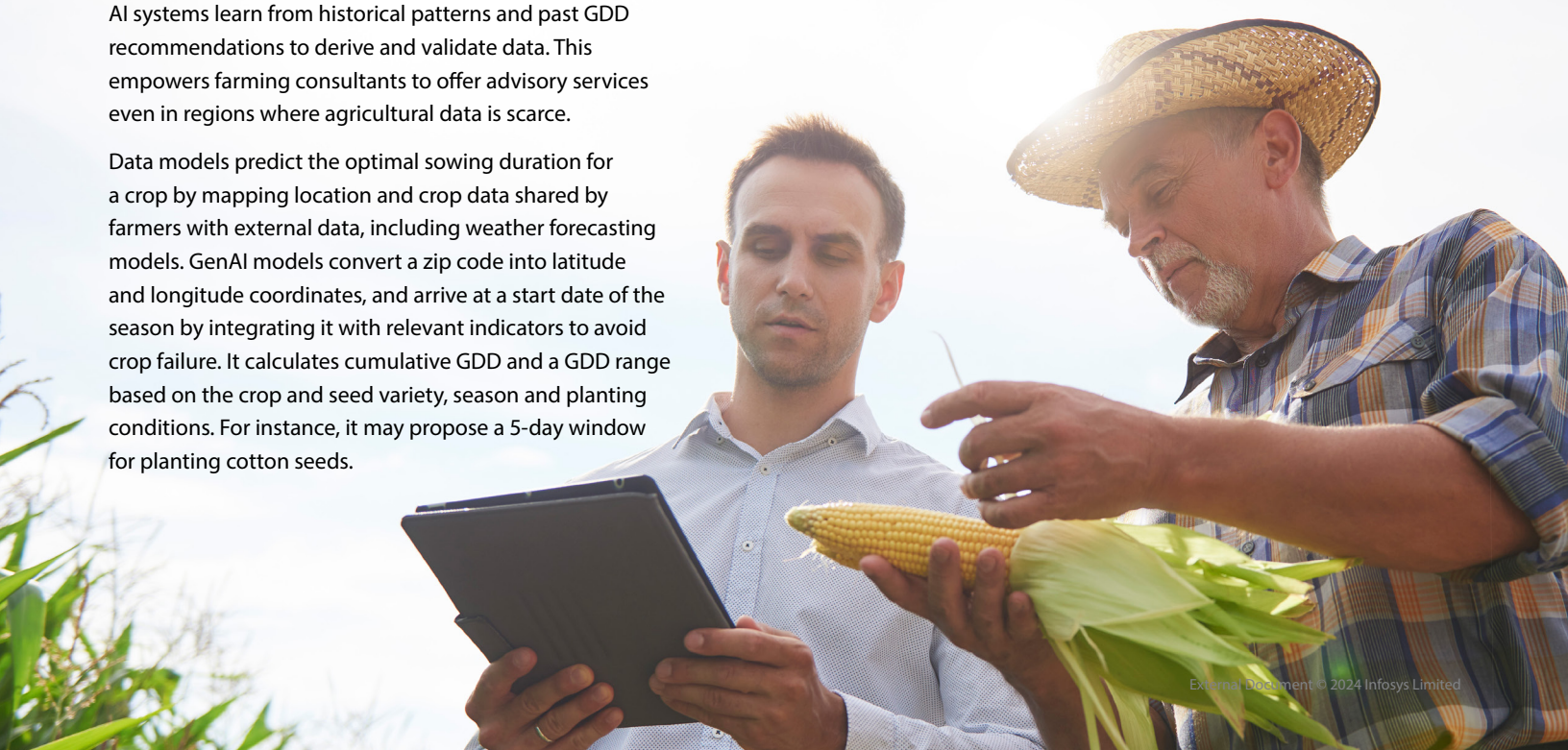
AI algorithms leverage large databases of genetic crop data, growth traits and disease resistance to recommend crop varieties best suited for the local ecosystem. It also simulates yield for different genetic combinations or variations and forecasts market demand for each, enabling farming communities to make informed decisions for a bountiful harvest.

Recommend planting and harvesting period

Farmers often determine the sowing date based on experiential knowledge, weather conditions, and historical demand for produce. GenAI-based growing degree days (GDD) tools eliminate human judgement by calculating plant development rate and predicting maturity date based on location data and weather forecasts. Generative AI systems learn from historical patterns and past GDD recommendations to derive and validate data. This empowers farming consultants to offer advisory services even in regions where agricultural data is scarce.

Data models predict the optimal sowing duration for a crop by mapping location and crop data shared by farmers with external data, including weather forecasting models. GenAI models convert a zip code into latitude and longitude coordinates, and arrive at a start date of the season by integrating it with relevant indicators to avoid crop failure. It calculates cumulative GDD and a GDD range based on the crop and seed variety, season and planting conditions. For instance, it may propose a 5-day window for planting cotton seeds.

Similarly, GenAI models derive the optimal harvesting period for specific crop varieties. Models integrate cumulative GDD with seeding date, weather data, and data across growth stages to predict maturity. This enables agro-consultancy enterprises to help growers maximize revenue by aligning the crop harvest window with supply chain factors.



Optimize logistics

The application of GenAI in agriculture transcends field services. Analytical models predict market demand, plantation-specific surplus inventory based on harvest data and sales contracts, and supply chain bottlenecks. Such predictive insights enable mitigation strategies. Further, analytical tools recommend storage locations to rationalize truck rolls, minimize transportation costs, and reduce food waste.

GenAI-based supply chain management drives demand fulfillment by improving inventory planning and optimizing routes for distribution. Notably, data-driven operations ensure seamless movement of produce from farms to consumers.

Smart technologies deliver multi-dimensional outcomes – higher yield, better nutrition, and sustainable land management. It creates climate-first agriculture systems for food security, while conserving resources and protecting natural habitats.

Infosys Topaz cultivates agro-ecosystems

Infosys Topaz, an AI-first set of services and platforms, combines generative AI with cloud and data analytics to build connected ecosystems for regenerative agriculture. It adopts a 'responsible by design' approach to ensure compliance with industry regulations and cybersecurity standards. Notably, Infosys Topaz builds an AI-first core that empowers agriculture enterprises to deliver cognitive solutions for sustainable farming.

About the Author

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