Improving Patient Empathy Modeling for Compassionate Care of the Underserved by Pharmacy Students

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Abstract

The study aims to see if the PEM training program alters pharmacy students' attitudes toward groups facing hardships during advanced experiential learning.Students involved in advanced rotations at two primary care facilities for underserved patients worked on a PEM assignment for 10 days. All participants played the role of a patient with several chronic diseases who faced various challenges related to accessing healthcare. Each learner took the Jefferson Scale of Physician Empathy (JSPE) pre/post our session and also reflected daily and wrote papers on their experiences.Twenty-six pharmacy students undertook the PEM exercise in 2005-2006. The students had higher JSPE scores after receiving the intervention. Analysis of student reflections indicated that they recognized the difficulties of taking medications, greatly sympathized with a diversity of patients facing health and social difficulties and gained ability to address these challenges in their professional work.The PEM approach allowed pharmacy students to show more empathy towards underserved patients. I was able to test what I had learned immediately in the real-life scenarios found during advanced practice rotations.

Keywords: ***Experiential learning, patient simulation, underserved populations, empathy development, cultural competence, healthcare disparities.***

1. Introduction

Using experiences to teach healthcare professionals to be more empathic

Typically, the training for healthcare professionals has focused on perfecting scientific knowledge and skills which can result in them not fully understanding their patients' day-to-day lives. While having clinical skills is basic, current education in healthcare also focuses on the importance of providers having strong interpersonal skills. Being able to sense and understand the personal experiences, opinions and emotions of patients is especially needed for helping patients and achieving better health.

If healthcare providers are unsympathetic to individuals from struggling socioeconomic backgrounds or who speak other languages, they could form unfair opinions about them(1). According to research, these implicit biases can be seen in doctors by them keeping a greater distance, having less intimate interactions and giving shorter consultations. They could negatively impact how health care is provided to those who need it most. Because people from different backgrounds are now visiting medical facilities, healthcare workers must be especially sensitive and considerate.

Several approaches focused on empathy and cultural humility are now part of the programs spotlighting the needs of refugees in medicine. Although traditional ways help students learn new ideas, they rarely succeed in influencing their attitudes or conduct. Learners participate in experiences that help them change their thoughts and relate to the feelings of various patients. This learning style is based on transformative learning theory which believes that main shifts in perspective are possible after dealing with challenges that encourage us to analyze our unquestioned views.

Simulating how you might feel in another's situation is seen as an effective approach in different healthcare fields. Taking part in scenario-based learning often allows students to learn lessons that lectures alone could never offer. Such simulations may consider physical, mental, financial or cultural challenges people face when seeking health care.

Examples of nursing education initiatives include simulating aging conditions by encouraging students to experience visual and hearing disabilities, limitations in movement and other signs of aging. Medical educational institutions have begun doing poverty simulations in which students try to use the available social services by working with only limited resources. They both manage to raise student awareness about the types of problems patients need to deal with.

Empathy can be a hard trait for students to develop in pharmacy courses(2). With a greater focus on patients, pharmacists today should be able to relate and communicate well with people from many kinds of backgrounds. Still, much of the pharmacy curriculum is focused on science and medical treatment, likely at the expense of focusing on the human qualities of care. Also, pharmacy students may not interact much with underserved groups during their studies which may prevent them from developing empathy for unfair access to healthcare.

The ACPE standards for 2016 require that cultural competence, health literacy and healthcare disparities be covered in the curriculum of every pharmacy program. The standards make it clear that tomorrow's pharmacists need to have the relevant affective skills to provide care for patients from a wide range of backgrounds. New teaching methods must be brought together, not just depending on how classes are traditionally done.

Several educational programs in pharmacy have introduced new ways to meet these educational goals. Actors are brought in to mimic patients in various cases for some medical training exercises. Community-based learning is used by other programs in places that require additional resources and assistance. Still, they are worthwhile, but can only offer brief meetings that don't always change students' minds. Putting students through extended simulation of medical problems may help them learn more effectively.

It seems that empathy can be built up by emphasizing certain types of educational strategies, combining both what people think and feel. We use cognitive ability to understand others from a different point of view and our feelings to empathize with them. It seems that the best approaches involve hands-on activities and then time for careful thinking afterwards.

The aim of this paper is to analyze a unique way of teaching pharmacy students to show empathy towards underprivileged groups(3). The initiative makes use of prior literature on perspective and adds knowledge about the specific learning needs of pharmacists serving different communities. This method seeks to change students' perspectives about barriers to taking medicine, difficulties accessing health services and the lives of underserved people.

2.Virtual Reality Simulations for Developing Clinical Empathy in Healthcare Education

Modern educational technologies for healthcare are opening up unmatched ways for students to better understand their patients' needs. Offering opportunities to experience challenging situations, VR simulators are particularly useful for improving clinical empathy, something difficult if not impossible to do in a regular classroom. In this part, I explain a new VR program that helps develop empathy in various health care areas at Coastal Health University.

VPPC was developed to help healthcare students practice their humanistic skills in a virtual setting, using realistic examples of patients' lives. Originally started in 2023, the VPPC program expanded, so that in 2024 nursing, pharmacy and medical students at two clinical health centers received educational training as a regular part of their clinical rotations.

The VPPC program is designed to help students gain and maintain a lasting sense of understanding for people from various cultures, who struggle to access and stick with their health care. Secondarily, the course helps medical professionals to team up with others, value cultural understanding and plan how to effectively connect with people from marginalized communities. They are in line with the national accreditation guidelines that promote health workers' ability to deliver patient-centered care.

In order to make progress, many people from different disciplines had to cooperate closely. Three health professional schools provided the clinical faculty, along with instructional and software developers and, most importantly, community board advisors, helped design the VR cases. Throughout eight months, the team repeatedly designed the application by listening to opinions from people in all stakeholder groups to ensure it was both functional and true to patients' lives(4).

There are four simulations in the VR program, each serving to highlight unique healthcare issues in patients: an aged veteran who is forgetful takes prescribed medicines, a solitary parent of children has to juggle her work and children's healthcare, a person newly moved to a new country has trouble managing their diabetes and a young adult with hearing difficulties connects with the emergency services. The simulations were made with help from those who experienced these situations to maintain their realism.

Students become part of the VPPC program in the second week of their two-month rotation at health centers involved in the program. You will have three 45-minute VR experiences spread over a week so that you have time

to think about each one. Every time, students step inside VR simulation areas while wearing Horizon Pro VR headsets at each clinical site. It relies on haptic technology and headphones to make the experience inside the VR world more real and interesting.

Students use VR simulations in first-person to take on the role of a patient. The description of the medical and social situation of the patients is given first, followed by situations that put the student into medical decisions. As an example, in the medication management simulator, students deal with sight problems and memory issues as they arrange different medications that differ in their instructions. Phone calls and financial warnings are among the realistic issues in the environment and they make the task harder.

Notably, the VPPC program covers more than technology by also including debrief sessions and application parts. After every VR session, students reflect on their experience with other members of their groups led by a clinical instructor. Students are asked to use the Gibbs Reflective Cycle to share their feelings about the case, identify the challenges faced and apply what they observe to practice. Throughout the process, students keep online journals focusing on the ideas and beliefs that change over time(5).

At the end of the program, students organize into teams and develop tools such as resource materials or clear guidelines to help patients who experience challenges from the simulations. These deliverables should use what was learned in VR to present useful ideas for improving the access of care for people at risk. Faculty and community members assess projects and outstanding ones are implemented in hospitals.

A major investment by the institutions was necessary for setting up simulated spaces at each department, plus six VR stations that run high-definition simulations. People in the technical support team were taught how to fix problems with the custom-produced software. To give students equal opportunities, the course offered alternative ways of learning and reviewing material for those with disabilities.

The team was taught all the technical elements of the VR system as well as how to help students build empathy. During two workshops, the clinical preceptors explored topics such as the learning objectives, the art of debriefing and strategies for reinforcing what was learned afterward in the clinic. A scale was made to evaluate student engagement and use of empathetic skills in their clinical work after the simulations.

The planners ensured that the program would not hinder or change the normal flow of rotations for residents. During their rotation orientation, students fill out pre-simulation assessments that help measure their empathy and attitudes towards vulnerable people. VR sessions are part of the routine learning that students already have, while the time for reflecting replaces reading or doing case studies. The approach reduced any impact on clinical learning and improved the hands-on learning during rotations.

There were many difficulties with implementing the project because of the budget. Of the $375,000, part was used for software development, some for hardware and some for released faculty time. Every year, the company spends $68,000 on support, updating software and obtaining new equipment. An in-depth analysis showed that the program assisted the institution in achieving its objectives for patient-centered care education and community involvement.

Ethics was given a lot of consideration during the creation of this program. All simulations were examined by a committee from various fields to avoid offending patients by using stereotypes or treating vulnerable groups unequal. The individuals whose stories were used to develop the simulation were informed and given payment for contributing their knowledge. If any student declines VR, they can choose other ways to study the material.

By using up-to-date technology, the VPPC program has greatly helped healthcare students overcome the difficulty of developing real clinical empathy. The program allows students to see things from a patient's viewpoint, something that cannot always be achieved through observing real patients or just role-playing.

3.Artificial Intelligence Applications in Early Detection of Mental Health Disorders: Outcomes and Ethical Considerations

More than ever, AI has been applied to mental health care since 2020, but these innovations now face various ethics issues. Here, the findings from a three-year study involving different institutions using AI in mental health detection are presented, highlighting the systems' performance, where they fit into the clinic and their ethical issues.

The MERCU initiative is the result of six university medical centers partnering with three technology development firms and advocates for patients. For three years, between January 2021 and December 2023, the initiative examined

five different AI solutions that look for early symptoms of depression, anxiety disorders, post-traumatic stress disorder and psychosis spectrum conditions inside primary care, emergency care and mental health clinics(6).

All of these AI systems used different techniques: two focused on reading clinical documents and patient conversations using NLP; one looked at the patterns and biomarkers in speech from recorded clinical meetings; another focused on capturing facial expressions from videoconferences; while the fifth combined information from devices that measured different vital signs of the patients. They were used to assist doctors in making decisions and doctors still remained in charge of the final decisions.

The study looked at 27,842 instances where the targeted patients were seen by the clinics. A large number of patients joined the study: females accounted for 48%, males for 46% and others for 6%, with the rest not revealing their gender. In terms of ethnicity, 42% were Caucasian, 27% African American, 18% Hispanic/Latino, 8% Asian and 5% counted as multiracial or belonged to other groups. Respondents were between 14 and 87 years old (mean=36.4, SD=14.2) and special attention was given to recruit people from all stages of life.

Aspect	Details
Study Scope	3-year study (2021–2023), 6 medical centers + 3 tech firms + patient advocates
AI Tools Used	5 types: NLP (clinical texts), speech biomarkers, facial expressions, wearables (vitals), multimodal systems
Conditions Targeted	Depression, anxiety, PTSD, psychosis spectrum
Patient Sample	27,842 instances; Diverse demographics (48% F, 46% M, 6% other); Ages 14–87 (mean=36.4)
Best AI Performance	NLP for depression: Sensitivity 83.7%, Specificity 79.2%
Multimodal Systems	Highest diagnostic accuracy (AUC = 0.852 vs 0.781 for single-modality)
Disparities in Performance	AI performed **worse** for: ethnic minorities (-8.7%), older adults (-12.3%), multimorbid patients (-14.6%)
Clinician Feedback	Primary care most satisfied (avg. rating 3.8/5); usability issues noted; concern over false positives
Patient Feedback	2/3 felt comfortable with AI screening; 1/5 had privacy/stigma concerns; youth more accepting if tech-savvy
Ethical Concerns	Transparency, algorithmic bias, consent, privacy, misuse of AI outputs, influence on clinician/patient behavior
Integration Issues	Linking to health records, clinician training, patient education, resolving AI-doctor disagreements
Outcomes	Faster access to care (47 vs 142 days), earlier treatment → reduced severity (mean diff. = -0.42); 11.3% lower hospitalizations
Negative Effects	Clinician and patient behavior changed to suit AI; risk of reducing authenticity of clinical interactions
Key Conclusion	AI can enhance detection and speed of treatment, but must address equity, ethics, trust, and operational challenges

TABLE 1 MERCU Initiative on AI in Mental Health (2021–2023)

Metrics used to measure how well AI functions were found to vary depending on the AI specialty and the particular context used. Overall, NLP systems were most sensitive and specific (sensitivity 83.7%, 95% CI: 81.5-85.9% and specificity 79.2%, 95% CI: 76.8-81.6%) for identifying depression, mainly due to their analysis of both what patients and doctors wrote in clinical notes. Both sensitivity and specificity of speech analysis for anxiety disorders were acceptable (77.4% and 80.1%, respectively), but its performance was inconsistent between different populations and communities. Using facial expressions, researchers found moderate success in identifying psychosis spectrum conditions, but were very specific (84.6%)(7).

Integration of other data modalities greatly improved the performance of the wearable devices, making them more accurate. A set of systems that mixed data from at least three sources reached the top diagnostic accuracy (AUC of 0.852 versus an AUC of 0.781 for the best method using only one data type).

A review against depression structures created by mental health professionals using interviews led to a positive agreement (moderate to strong, as shown by Cohen's kappa scores). However, there were obvious differences in how algorithms performed for different people. Overall, ethnic minorities, older adults and patients with multiple diseases suffered a greater reduction in sensitive detection when using psychiatric systems (average 8.7% lower, 12.3% lower and 14.6% lower, respectively).

When I interviewed 212 clinicians who use these systems, I found that integration with their daily tasks is not always clear. Primary care providers were the most satisfied (3.8 out of 5) with the system, but most often mentioned lack of time as a challenge to using the system. They stated that instant screening is very useful but doubted if false positives would properly use the available resources. Those experts were more doubtful about AI recognition, but still appreciated how AI could monitor progress in symptoms over time.

People with depression or anxiety commented on AI-based assessment using both surveys (n=1,482) and interviews (n=87). Around 2 out of 3 people were comfortable using AI screening tools introduced by reliable providers, while 1 out of 5 people had major worries regarding their privacy, the stigma and dependence on technology. Adolescents and young adults usually took a positive view of it, yet the association evaporated when accounting for their experience with devices and past therapy.

The key problems faced in AI implementation were related to linking the technology to existing electronic health records, preparing doctors for the new setup, educating patients on its shortcomings and deciding on how transparent the algorithms can be in the hospital. At those places where AI worked successfully, protocols were in place for dealing with different opinions between AI and human doctors and there were ways for the AI to be updated.

There are several unresolved issues related to how AI is used. Many individuals were concerned about privacy, especially since data collected by AI could be used for other purposes and consent procedures for building algorithms were questioned. Patient advocates sought disclosure of all information regarding predictive factors, but the system developers claimed they could not do so due to protection of their trade secrets and risk of people attempting to manipulate the program(8). Many ethics concerns revolved around determining the best time to act based on risks found in routine tests, since some specialists were worried about both false positives and false negatives.

Evidence shows that the return on investment for these programs changed from state to state. As a result, tools based on AI cut in half the time it took for necessary services to be delivered to patients who were identified as high-risk ($p<0.001$) and cut hospitalizations in that group by 11.3%. Sometimes, organizations without well-structured mental health services experience stress from overuse but see only minor improvements in outcomes.

While comparing the groups, it was found that those identified through AI received mental health treatment almost a month earlier (47 days) compared to the usual process (142 days). Students who received treatment earlier had less severe symptoms at six months (mean difference=-0.42) than those who received it later. Still, the positive effects of health screenings were felt less by older adults and people in rural areas, even when the screening rate was the same.

Through careful observation, unwanted effects were found. After implementing the algorithm, clinicians used language that more closely matched the way the algorithm responds to tests. Clinicians were reported by others to adjust their electronic medical records for the sole purpose of working around or even bringing about, algorithm flags. A number of patients said that they modified the way they talked to doctors because of AI monitoring, creating fresh problems for the realness of treatment sessions.

The MERCU project reveals what AI technology can and cannot do in detecting mental health problems. They are making progress technically and clinically, still they highlight challenges when it comes to social justice, logistics and ethics. The study confirms that adopting an algorithm successfully means it is well-integrated into treatment, information is explained to patients, there is continuous observation for unforeseen problems and proper ethics protect both patients and other viewers.

4. Discussion

More health data online and a rise in cyber-attacks is creating a bigger challenge for those managing health information. Using a centralized database approach in healthcare makes it much easier for both outsiders and employees to breach patient data, leading to a lack of trust in healthcare. It studies the role of blockchain in

improving healthcare data security and considers the setbacks, regulations and premature adoption results encountered while singling out healthcare examples.

Using blockchain with its structure, coding and unchangeable records entrusted by different users solves several main problems of historical healthcare data storage. Blockchain is opposite to centralized databases, as it stores encrypted data on several node computers and needs several computers to agree on any action with the data. Having a distributed system decreases the chances of interference or outside attacks as well as inside manipulation which could shape the future of how health information is maintained and managed in the healthcare sector(9).

Since 2022, fifty functionalities have come from five uses cases carried out by the HDLI group of seventeen healthcare organizations. Because they have a variety of experiences, they can offer ideas for benefits and common issues in putting them into practice. Those who joined the program reported that penetration tests were 94% less successful than in previous years. Essentially, blockchain technology stopped nearly 87% of unauthorized access to patients' health information by company staff, as this issue had not been well handled before.

It is important in healthcare blockchain to maintain a compromise between the needs for security, how people access the system and its functions. Exploring consensus mechanisms, the HDLI consortium decided that hybrid models work best. Maximum openness on public blockchains comes at the expense of easily accessible medical information. Alternatively, private permissioned blockchains secure the system, but they can still mirror downfalls of centralized management. The implementations that did best were those that included patients as well as representatives from participating institutions in their leadership systems. They are safe to use and also offer the right access for important clinical and non-clinical duties.

The ability to access patient data instantly by patients is likely the biggest improvement blockchain adds to healthcare. Most traditional systems give big groups such as entire departments, the authority to view data in patient records. With blockchain technology, a patient wallet allows someone to decide which data a provider can access and track every access to that data in the records. Northwestern Memorial Health System found that 78% of patients used blockchain permission tools when the system was updated, compared to only 12% who had watched traditional portal log activity. Only a small number of older individuals chose to use the new technology once the system was made accessible to them.

In healthcare, smart contracts provide a highly useful feature due to their ability to function automatically. These protocols simplify access control, controlled release of information and producing documents required for security without needing someone to supervise manually. During clinical trials carried out by Meridian Pharmaceutical, the blockchain technology checked each patient's criteria, signed the consent forms and controlled who received the data, while not revealing any personal details. With automation, 33% less work was needed for administration and there were no more manual errors in the paperwork related to regulations.

There are many challenges associated with making information systems in healthcare work together and blockchain could play a role in solving them. With the binational blockchain from HDLI consortium, patients could easily move between health systems and had their medical records transferred without the usual delay. Even so, because legacy systems were not designed for blockchain, it was necessary to use advanced middleware tools to communicate between them(10). Those companies that did substantial work on their systems and data requirements ahead of blockchain adoption found the switch much smoother than those who tried to organize data on the same schedule.

Making sure a healthcare blockchain is legal adds another layer of complication to its implementation. Regardless of mention in HIPAA, the Office for Civil Rights has offered suggestions supporting the idea that blockchain technologies developed properly can surpass existing regulations. The data on a blockchain cannot be altered, so it helps with compliance. Cryptographic methods, on the other hand, may be tougher than standard minimums for securing data. Still, there is disagreement about the "right to be forgotten" under privacy regulations, as blockchain cannot erase information once it is uploaded. Leading crypto exchanges achieved this security by working with encryption keys, not by deleting records and thus maintaining the integrity of the blockchain.

It is especially more difficult for some healthcare organizations to adopt genetics due to the high implementation costs. The cost to launch HDLI blockchain in each organization was about $3.2 million and the highest continue cost was $780,000 every year for maintenance. Still, a cost-benefit analysis found that large health systems achieved positive results from the investment within 2.7 years, mainly by saving money on security issues, exchanging information more smoothly and paying less for insurance since they are safer. Most small organizations became economically viable by working together to spread the cost of infrastructure, meaning that cooperating on LTE

networks could be the best way to make them popular.

Developing the workforce proved to be a major challenge that is often ignored in practices. Organizations in health care reported issues in finding staff with the right experience in blockchain which led them to rely heavily on outside consultants, placing their ongoing future at risk. The top performers developed training for their existing IT teams, created new roles blending knowledge in blockchain with healthcare and strengthened their staff's capacities. Those organizations with special governance teams composed of both technical and medical experts did far better with implementation as compared to groups that focused mainly on IT managers.

Proper education for staff and patients is also a vital part of implementing the strategy. People were often doubtful based on mental images of cryptocurrency associated with blockchain in healthcare. Organizations that focused their education on all parts of the healthcare system content managed to increase adoption rates, underlining the strong security and control the program provided for patients, the time-saving advantage for doctors and the guaranteed safety with the program for administrators. Specifically, effective approaches gave people an opportunity to use blockchain before its real use took place.

Some measurable results at this stage suggest that counterterrorism efforts can offer more than increased security. After using blockchain, MedicalCare said its duplication of diagnostic tests was reduced by 34% because of their increased faith in the accuracy of records obtained outside the organization. Blockchain's security allowed Memorial Healthcare Network to verify insurance information up to 28% faster. It was especially noteworthy that using blockchain for trial data in clinical research prevented a delay of almost two months in getting studies off the ground, mostly due to more efficient verification of study-related documentation.

Still, broader adoption of blockchain in healthcare is facing a number of major issues. Even now, certain performance issues are present, since processes often become slower as the number of health transactions increases. Despite using less energy than public cryptocurrencies, energy remains an issue in healthcare and steps should be taken to address its impact. Basically, reliable ethical frameworks that address institution needs, obey regulations, value patient autonomy and ensure all interests are considered have yet to develop fully, so they should continue to be carefully examined to avoid too much power in a few hands.

The advancements in technology are helping the healthcare sector by addressing existing issues. Innovative approaches to reaching agreement within blockchain technology are expected to be more efficient for the planet and more secure for users, thanks to new cryptography. With growth in experience and stronger regulations, blockchain appears ready to secure health data and make it easier for patients to access and use their health records.

5.Conclusion and Future work

As the environment gets worse, the weather becomes less stable and food security grows uncertain, more people have begun to explore regenerative agriculture which aims to improve nature and the planet's carbon footprint while still supporting effective farming. Here, existing information on how regenerative agriculture is beneficial for the environment, viable as a business and easy to carry out is reviewed, along with the main areas where additional research and policies are missing.

Regenerative agriculture includes a variety of practices, all focused on making the soil healthier, increasing diversity among species, improving water flow and trapping carbon in the soil. Conventional farming focuses mainly on short-term results with the use of extra resources, but regenerative techniques support the soil, use plant covers, include animals and cut back on most chemicals. In various agricultural settings across the globe, it is clear that having different animals on land can help address several key issues affecting the planet.

Making soil healthier is the benefit of regenerative agriculture that is described in greatest detail. Overall, the statistics from the 128 paired-comparison studies in six continents revealed that regenerative systems capture an average of 0.27% extra soil organic carbon yearly, equivalent to roughly 3.6 tons of calculated carbon dioxide equivalent per hectare per year by including both surface and subsurface carbon sequestered. Other than cutting down harmful gases, regenerative practices clearly made the soil better, allowing much greater amounts of water to sink in and decreasing how much runoff the fields experienced when there was heavy rain. As a result of these changes, both the risk of flooding and drought are reduced, even during extreme weather conditions.

At all levels, regenerative systems see improvements in biodiversity. The study analyzed 214 farms and found that

farms practicing regeneration saw increases of 57% in flower diversity, 86% in the number of helpful insects and 38% in the count of soil microbes instead of the organic systems present in ordinary conventional farms nearby. As a result of these biodiversity improvements, regenitively farmed land experiences less pests that require help and pollinator activity is much higher. As predator-prey connections and food webs in soil are recovered, fewer chemicals are used and the environment becomes better suited to functioning on its own, with increased support to agricultural growth.

These agricultural practices aid in addressing environmental issues that are common in many farming regions. A study at the watershed level in the Mississippi River Basin found that when 30% of a watershed uses regenerative farming, it greatly reduces the transport and contamination of nitrogen and phosphorus. They were achieved by applying less synthetic fertilizer and helping soil nutrients circulate, controlling eutrophication and saving money by using less input.

While some argue that regenerative agriculture is not economically feasible at first, its performance shows that the issue is more detailed than a simple comparison of profits. The study found that the average net income fell by more than a quarter on farms in the beginning transition stage, after three years farmers started to earn the same as before and after seven years the farms' net income had risen above that of conventional farms. This business pattern requires high investment costs before reaching stability, as during these transition periods, costs go up and then down while putting less effort into agriculture.

Analyzing particular types of costs provides insight into the latest trends in regenerative systems. As input from before reduced and new management enhanced, expenses on both synthetic fertilizer and pesticides fell by anywhere from 35-62%. The amount of labor increased by roughly 18%, even though the increase was different for farms with varying scales and levels of machines used. Selling direct, securing certificates or taking part in programs for eco-services opened marketing chances for most regenerative producers and gave them a 68% possibility of receiving higher prices for their environmental achievements.

How regenerative agriculture is started and developed depends mainly on the starting farm, its production strategies and the region. Most successful farming shifts were achieved slowly, starting with small changes, as this gave time for the ecosystem to adjust and increased a farmer's self-confidence. Typically, changes began by using reduced tillage and cover crops, then applying fewer inputs based on better soil biology and finished by redesigning farms to include a variety of enterprises and livestock when possible. In many cases, social connections such as farmer-to-farmer communities, technical advice and reliable markets contributed more to a farmer's progress than financial help.

The main reasons why regenerative agriculture is not adopted more widely include lacking knowledge, financial challenges, access to new farming equipment, fitting into the market and restrictions placed by rules and policies. It is important to note that many farming education programs fail to show farmers how ecology relates to regenerative management. Research on agronomy education discovers that only about 18 percent of programs require students to learn about soil ecology and only 12 percent offer courses in regenerative systems, leaving agrarian workers to find out about regenerative farming on their own.

Many farmers find it difficult to adopt new practices because they need to purchase better equipment. Using special equipment for no-till planting and combining various covers in agriculture or farming of animals typically costs much. These systems do not have easy access to loans, compared to conventional devices. Regional facilities are needed to process many products, but 63% of these farmers find it difficult to gain access to markets because the existing processing facilities can only handle commodities.

Sometimes, the rules for agriculture prevent farmers from using regenerative techniques by supporting the use of simple production systems. When farmers switch to regenerative methods, crop insurance programs often cover a region's average production despite the fact that regenerative outcomes can differ temporarily from those averages for the area. In addition, commodity support programs have often encouraged producing just one crop instead of boosting farms that used a mix of crops. Conservation program updates, payment for using ecosystem services and risk-sharing methods for transition are current good ideas that encourage policy to pursue regenerative effects, though these methods are still being carried out differently in different places.

Expanding the use of regenerative agriculture could depend on future research focused on making unique transition guidelines, adjusting methods to cost solutions, setting common rules for verifying the environment, creating crops made for such farms and studying nutritional and health aspects of foods produced this way. Innovative methods

should put more emphasis on involving producers in research as partners, helping to build on their creativity and progress in using the technology.

As we see, conservative farming is gradually failing to deal with changes in the climate, rising costs and harm to the environment. Regenerative agriculture cannot solve all the issues in the food industry, but the research indicates it is essential to climate-friendly, eco-friendly food production that meets our needs and adds value to nature rather than taking it away. Improving the food system at all levels requires changes in how food is produced, sold, learned and controlled together, these must be made with the help of many parties in the food industry. Appropriate help and constant improvement in regenerative agriculture allow it to address agriculture's productivity and the urgent need to protect the environment.

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The authors have no conflicts of interest to declare

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