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An assessment of conventional farming practices in Punjab's agricultural sector

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Abstract

Agriculture sits at the heart of Punjab's economy—and let's be honest, it's a big piece of India's food security puzzle too. But the region's deep reliance on just rice and wheat has created a whole host of problems: groundwater is vanishing, soil nutrients are all out of whack, and costs keep climbing. In this study, we took a closer look at what's really happening on the ground. We spent time in five villages—Barauli, Fatehpur Jattan, Doom Cheri, Dhollan Majra, and Tole Majra—talking to 80 farmers with land of all sizes. We asked about how they grow their crops, use fertilizers and pesticides, manage water, check their soil, and deal with leftover crop residue.

When we dug into the numbers, some patterns stood out. Most farmers stick with rice, wheat, maize, and sugarcane. Nearly all of them use way more chemical fertilizers and pesticides than the Punjab Agricultural University recommends—only 40% follow the guidelines, and nobody checks their soil. Chemical pest control is everywhere, but hardly anyone uses cultural or biological alternatives. The water table is dropping under the feet of 83% of these farmers, and 70% say they can't get enough urea. On average, farmers here have about 25 years of experience, and both small and large landholders make up the majority. Sure, there's some use of machines, but new technology hasn't really caught on. All in all, most farmers are stuck in traditional, chemical-heavy mono-cropping, and there's not much crop variety. If we want to make farming sustainable here, we need to push for more crop diversity, better soil care, and a bigger focus on integrated, precision-based approaches.

Keywords: Punjab, agronomical practices, rice-wheat system, fertilizer use, groundwater depletion, sustainable agriculture

Introduction

Agriculture isn't just about growing food—it's how millions of people around the world make a living and escape poverty. In India, farming is still the backbone of the economy, making up about 20% of the country's GDP [1]. A lot of countries have brought in new technology, but many farming communities still struggle with things like worn-out resources, unpredictable weather, and rising costs. That's pushed a lot of people to rethink how they farm, and start looking for more sustainable ways to do things. The Green Revolution turned India from a country that couldn't feed itself into one with more than enough food. But it came with a price: now we're dealing with tired soils, shrinking water sources, and small farmers who just can't seem to get ahead [2].

Punjab—often called the "Granary of India"—was ground zero for the Green Revolution back in the late 1960s. Even though it's a tiny state (just 1.53% of India's land), Punjab produced nearly 28% of the country's rice and wheat in 2014 and 2015. That's huge for India's food security [3]. But this success story has a dark side. The relentless focus on rice and wheat drained the soil, sucked up way too much groundwater, and left farmers exposed to wild swings in both the market and the weather [4]. Punjab's rich soil, big irrigation projects, and hardworking farmers made it a food powerhouse. Still, the rice-wheat system, along with heavy use of chemicals and water, has raised real questions about how long this can last.

Groundwater keeps life going—it gives water to nearly half the world's people and is the backbone of many farm economies. It's helped feed more people, boost economies, and cut rural poverty. But people have been pulling too much out of the ground, and aquifers are drying up all over [5]. In Punjab, farmers' choices— what they plant, which chemicals they use, how they water their crops, and what they do with crop leftovers— all shape whether farming here can keep going. When aquifers run dry, irrigation gets more expensive and water quality drops, putting the entire future of farming at risk. And Punjab, with only 4% of India.

Groundwater keeps life going on this planet. Nearly half the world—about 1.5 to 2.8 billion people—get their water from underground sources. Farmers depend on it too. It's what keeps crops, livestock, and, really, the whole agricultural economy alive. You see the impact everywhere: more food, stronger economies, and fewer people stuck in poverty out in the countryside. But there's a problem. People have been pumping out water faster than nature can put it back, so aquifers are running dry in a lot of places [5]. That hits rural communities the hardest.

In Punjab, it's critical to look at what farmers are actually doing—their agrochemical habits, what crops they choose, how they water, and what they do with leftover plant stuff. If you really dig into these patterns, you start to see why things are done a certain way and what's stopping folks from switching to more sustainable methods. When aquifers

dry up, farmers have to spend more on energy to get what water's left, and the water quality drops. That's a serious threat to the future of farming there. And here's another kicker: Punjab only has about 4% of India's farmland yet uses 11% of all the pesticides in the country. That just makes the pollution problem worse—both for the soil and the water [6].

Materials and Methods

We ran this research in five villages across Punjab: Barauli, Fatehpur Jattan, Doom Cheri, Dholan Majra, and Tole Majra. We picked around 80 farmers at random—making sure to get a mix of small, medium, and big landholders—so our sample really covered the range. Out in the field, we used a structured questionnaire and did face-to-face interviews. We asked about all sorts of things: what crops they grow, how much fertilizer and pesticide they use, how they irrigate, whether they get their soil tested, how they treat seeds, and what they do with crop leftovers. Farmers also told us what gets in the way when they try to follow best practices. To make sense of it all, we ran the numbers using basic stats—just percentages and averages—to spot the most common practices and the biggest challenges.

Results and Discussion

Experience in farming

Farmers in the village have been working the land for about 26 years, on average. Most of the people still farming is older. Young folks usually move away for school or better opportunities, so you don't see many of them sticking around. This gap leaves the next generation with less hands-on experience. Some might have a tough time if they try to farm later on, but honestly, a lot just won't come back to it. They're more likely to hire workers to manage the fields, or maybe just step away from farming altogether.

Table 1: experience in farming

Farming experience	Barauli n=15	Fatehpur jattan n=13	Tole majra n=26	Doomcheri n =16	Dhollan majra n=10	Total N=80
Below 10 years	3	2	5	3	2	15
10 -15 years	5	5	9	7	3	29
More than 15 years	7	6	12	6	5	36

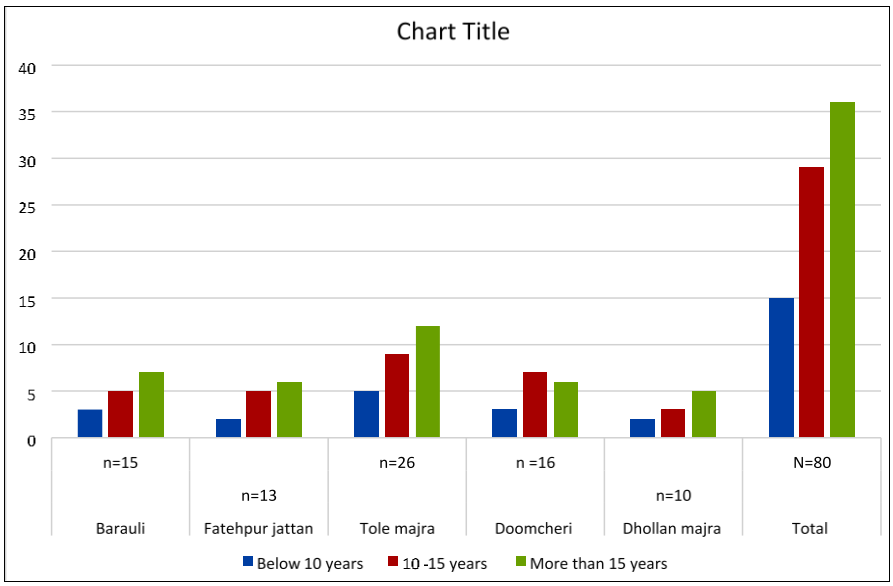

Fig 1: farming experience

Crops and their yield

Agriculture sits at the heart of Punjab's economy. It pumps almost 17% into India's national GDP and gives work to more than 60% of the people there. Still, most farmers are working with small, scattered patches of land. So, they end up chasing higher yields, sometimes at the cost of everything else. Things like soil pH, sunlight, or rainfall get pushed aside. Chaudhary and his team pointed this out back in 2022—they said today's farmers aren't always sure when or where to plant. They're so focused on squeezing out bigger harvests that they forget about things like soil health or how much sunlight the crops actually get. You can see why there's a real need for better information and practical tools. Small farmers could get so much more out of their land if they knew how to manage it smarter.

Table 2: Crops and their yield

Crop	Minimum Yield (q/acre)	Maximum Yield (q/acre)	Average Yield (q/acre)
Rice (Jiri)	30	35	32.5
Wheat	20	22	21
Maize	30	35	32.5
Sugarcane	250	300	275

Let's look at the numbers. Rice (Jiri) and maize both brought in about 32.5 quintals per acre. Wheat didn't do as well—just 21 quintals per acre. Sugarcane really stood out, though. It topped the charts with 275 quintals per acre, which says a lot about how well it grows here, especially when farmers manage it closely. So, while staples like rice, wheat, and maize still lead the way, sugarcane's huge yield

makes it a strong choice for anyone looking to earn more or shake up their crop rotation. You can see all this laid out in Table 1 and Figure 1.

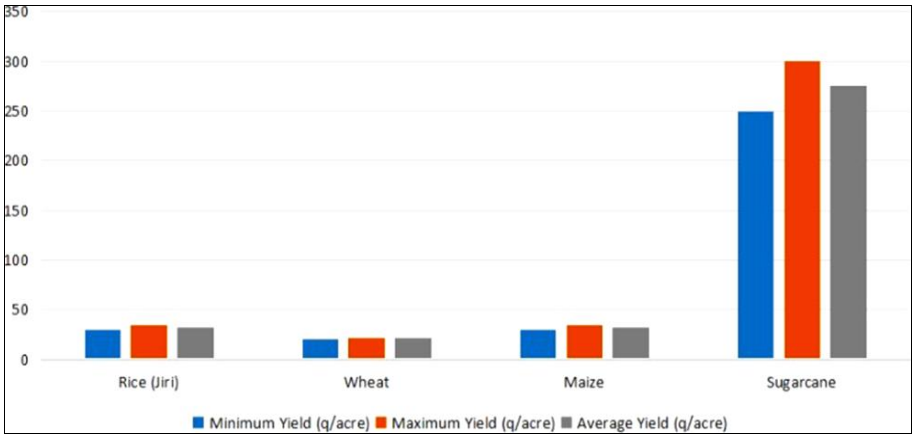

Fig 2: Graphical representation of crop yield

Land Holding Distribution

Land means everything in an agrarian society. It's not just about making money or finding work—owning land shapes your status, your influence, and pretty much your whole place in rural India. The more land you have, the more power you hold. But here's the thing: land isn't shared out evenly at all. Some folks have a ton, and most have just a little.

If you look at the numbers, the story's pretty clear. Small farmers make up the vast majority, about 83% of all holdings. Medium-sized farms? Around 16%. And big landowners? Less than 1%—they're rare. That's from the 2005-06 Agricultural Census. The size of land people actually work on also varies a lot between these groups.

Governments—both central and state—have tried to help small and marginal farmers hang onto their land. Still, these inequalities haven't gone away. You see it everywhere, but Punjab stands out. The land there tells a big part of this story.

Table 3: Land Holding of different villages

S. no	Village	Barauli [n=15]	Doom Cheri [n= 16]	Tole majra [n=26]	Fatehpur Jattan [n=13]	Dhollan majra [n=10]	Total [N=80]%
1	Marginal (below1 hectare)	6	8	12	4	6	36 (45%)
2	Small (1-2 hectare)	6	3	6	7	4	26 (32.5%)
3	Large (4-10 hectare)	3	5	8	2	-	18 (22.5%)

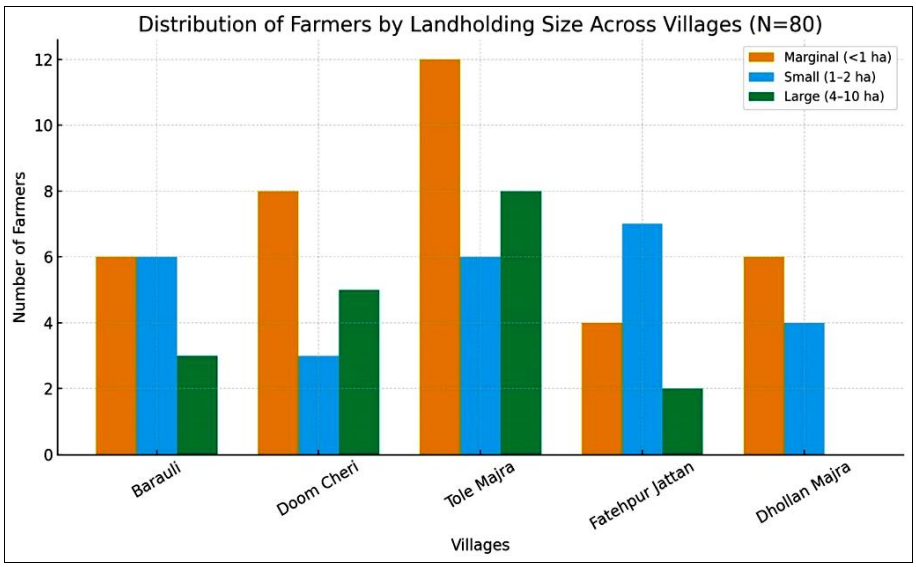

Fig 3: Land Holding Distribution Among Punjab Farmers

Most farmers in these villages barely have enough land to get by. Out of 80 farmers surveyed, 36—so, about 45%—are what you'd call marginal farmers. They work on less than a hectare each. Most of the time, they're just growing enough to feed their families, and they don't have much in the way of modern equipment. Then you've got the small farmers: 26 people, or 32.5% of the group. They work plots between one and two hectares. Sure, that's a bit more space,

but they still deal with the same headaches—low income, not enough resources, and not much technology to make things easier. Only 18 farmers, about 22.5%, have anything that counts as a "large" farm, and even then, we're talking four to ten hectares.

Varieties and Cropping Practice

In these villages, farmers mostly grow rice, wheat, maize, and sugarcane. They don't just plant any variety— they pick ones that actually work for their fields and the local weather. For rice, you'll see PR 126, PR 114, and PR 115 everywhere. These types give great yields and handle the kharif season well. Wheat's a bit different. Most farmers go for PBW 872 and PBW 725. These are semi-dwarf, don't fall over easily, shrug off rust, and do well when there's plenty of water.

Maize is all about hybrids like PMH 18 and PMH 19, plus the composite variety PC 1. People like them because they grow fast and don't get hammered by pests. Sugarcane growers stick with CoPb 93, CoPb 94, and Co 86032. These have loads of sucrose and don't mind the cold.

Really, every variety here gets picked for one reason: to get the most out of the land while dealing with whatever nature throws at them—diseases, pests, drought, or frost. You can check Table 4 for the full details.

Table 4: Variety used by farmers:

Crop	Variety	Key features
Rice	PR 126 PR 114 PR 115	High-yielding early early-maturing, suitable for kharif
Wheat	PBW 872 PBW 725	Semi-dwarf, rust-resistant, suitable for irrigated areas
Maize	PMH 18 PMH 19 PC 1	Hybrid/composite early maturing resistant to pests
Sugarcane	CoPb 93 CoPb 94 Co 86032,	High sucrose content frost and disease-tolerant

Cropping System

India's agriculture is all over the map, but Punjab tells a different story. Thanks to the Green Revolution, farmers there mostly stick to just one or two crops—mainly wheat and rice. Sure, those crops are everywhere now, but it's come at a cost. You don't see much maize, pulses, sugarcane, or oilseeds anymore. Monocropping has really taken over, squeezing out the old variety.

Fertilizer Usage

Table 5: Fertilizer Usage

Village	Total Farmers Surveyed	Urea Dose (Farmers Count) Following Recommendations	Application PAU	DAP Dose Application (Farmers Count) Above PAU Recommendations
Barauli	15	5		10
Fatehpur Jattan	13	4		9
Doom Cheri	16	7		9
Dhollan majra	10	3		7
Tole Majra	26	12		14
Total (%)	80	31(38.75%)		49(61.25%)

Out of 80 farmers across five villages, only 31—so just under 40%—actually follow PAU's recommended fertilizer doses for urea and DAP. Most don't. The other 49 farmers use more than they need, which just wastes fertilizer, costs more money, and puts extra stress on the environment. The numbers make it clear: farmers need better, targeted outreach and education to help them follow the guidelines and get the most out of their crops. Looking closer, Barauli and Fatehpur Jattan do a better job sticking to the recommendations, while Tole Majra and Doomcheri lag behind.

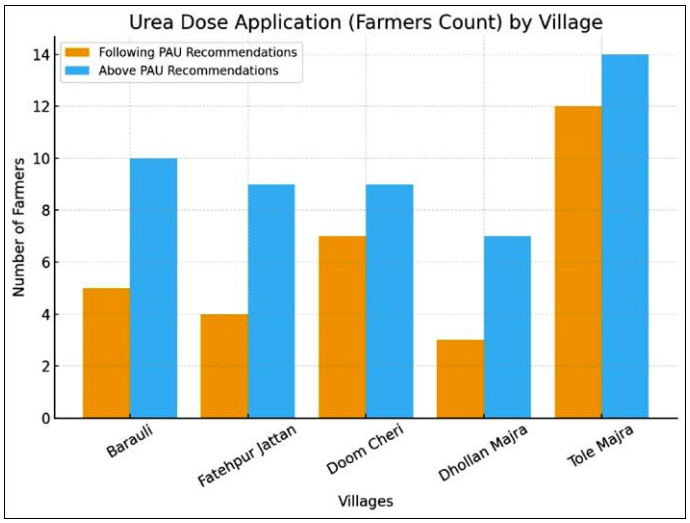

Fig 5: fertilizer usage

Soil Testing

Soil testing gives farmers a real shot at managing nutrients in a smarter way. It tells them what's actually going on in their fields, so they don't waste money or ruin the soil with the wrong fertilizers. In Punjab, most farmers know soil testing matters, but not many actually do it. Studies back this up—while lots of people get why it's important, only a handful take soil samples regularly.

So, why aren't more farmers testing their soil? A big chunk of the problem comes down to a lack of technical know-how, patchy access to testing labs, and not enough support from agricultural advisors. Research shows that farmers who get real training—like hands-on demos or awareness sessions—are more likely to test their soil and use the advice from Soil Health Cards. Bamniya and his team (2025) noticed that when farmers saw soil sampling in action, they were much more open to adopting it. Clearly, education that's practical and direct makes a difference.

Even with big national efforts like the Soil Health Card scheme, plenty of farmers still skip the recommendations when managing fertilizer. So, the main problem isn't just about equipment or labs—it's about habits. If we want more farmers in Punjab using soil tests, we need to connect the dots: better scientific analysis, easier-to-reach advisory services, and real policy support. Building stronger links between farmers and labs, and just making testing easier, can turn awareness into real action. In the end, this boosts soil health and keeps crops growing strong.

Not one surveyed farmer had actually taken up soil testing, which is part of why fertilizer use stays so unbalanced.

Challenges and Constraints

A recent survey in five villages across Punjab, plus some newer studies, pinpoints two major problems farmers face:

Overuse and Imbalanced Fertilizer Use

Farmers lean hard on chemical fertilizers like urea and DAP to keep their yields up. The thing is, piling on too much fertilizer throws the soil out of whack. You get declining soil health, nutrients out of balance, and everybody depending even more on chemicals just to keep their heads above water. It's not just the soil that suffers—pollution goes up, productivity drops, and the cost of farming keeps climbing.

Declining Water Table

Groundwater is vanishing fast. Farmers are stuck because crops like wheat and rice need a ton of water, so they keep pumping, even as groundwater levels sink lower every year. Every farmer in the survey said falling water tables are eating into their profits. The heavy dependence on groundwater doesn't just threaten irrigation—it pushes costs up and puts the whole system on shaky ground. If things don't change, it's not just individual farmers who pay the price; the whole future of agriculture gets put at risk.

Table 6: Major Challenges Faced by Punjab Farmers% of Farmers Affected

Challenge	Total Affected	Farmers	% of Total (N=80)	Prevalence in Villages	Impact Level
Water level dropping	30		37.5	All 5 (affecting most farmers)	High
Urea shortage	26		32.5	All 5 (majority affected)	Medium
Machinery costs	15		18.75	All 5 (scattered cases)	low
Pesticide resistance	9		11.25	All 5 (scattered cases)	Low

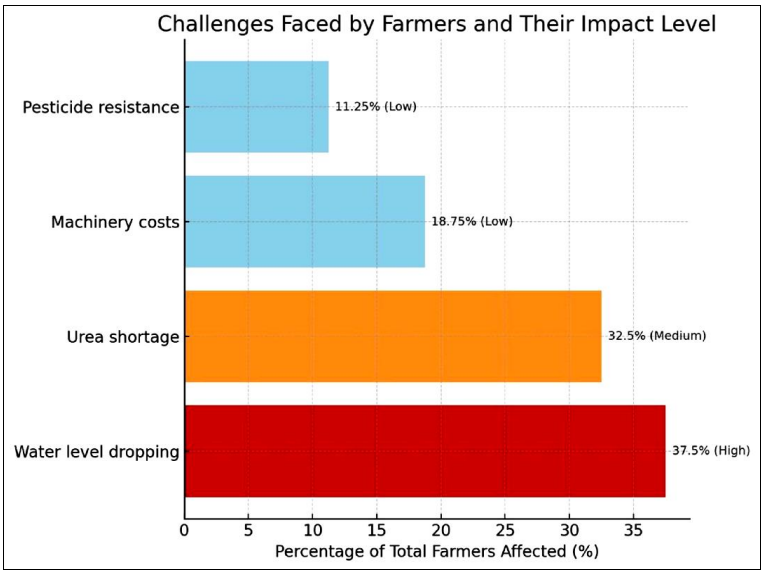

Fig 6: Challenges faced by farmers

Here's what the bar graph says about the 80 farmers in the study.

The biggest headache? Dropping water levels. It hits about 37.5% of the farmers, and honestly, it's everywhere—every single village deals with it, and the impact is huge. After that, the next big challenge is getting enough urea. Roughly 32.5% of farmers run into this problem. Again, it's an issue across all the villages, but it doesn't hit quite as hard as the water shortage.

High machinery costs bother about 18.8% of the farmers.

All five villages mention it, but people don't see it as a major problem. Then there's pesticide resistance, which affects around 11% of farmers. Every village has seen it, but, like machinery costs, folks don't rate it as a serious issue.

So, what's the takeaway? Water scarcity—whether it's dropping groundwater or just not enough water to go around—and not having enough urea are the biggest problems. Machinery costs and pesticide resistance pop up too, but they don't cause as much trouble.

Now, about pest management: Farmers shared their thoughts on how often they deal with pests, weeds, and diseases. Most agree these problems have gotten worse over the last decade. When it comes to finding solutions, farmers turn to lots of places—state agricultural universities, other farmers nearby, social media, and even the local Kisan Mela.

They don't stick to just one approach, either. Some go with cultural methods, others use chemicals, some rely on biological solutions. The tables that follow show the details on these different management strategies.

Pest Management

Farmer knowledge of pest management was examined based on their views on the extent of pest problems. In the study area, most farmers have noticed that the frequency of pests has increased over the past 10 years [13]. Farmers obtain management information from various sources, including state agricultural universities, neighboring farmers, social media, and the Kisan Mela.

Farmers practice different ways of management, such as cultural, chemical, biological, mechanical, etc.

Table 7: Pest management in Rice and Wheat

Villages	Total farmers	Cultural	Chemical	Biological
Barauli	6	2	4	-
Doom cheri	5	2	3	-
Tolle majra	6	2	4	-
Fattehpur jattan	7	3	4	-
Dhollan majra	6	1	5	-

Look at the table, and you'll see most farmers across these villages stick to cultural and chemical methods to manage pests. With cultural methods, they're out there doing things like deep summer plowing, getting rid of crop leftovers, and planting tough, resistant crops. On the chemical side, they use pesticides—but only when pest levels hit a certain point. Hardly anyone uses mechanical or biological controls. Those options barely register.

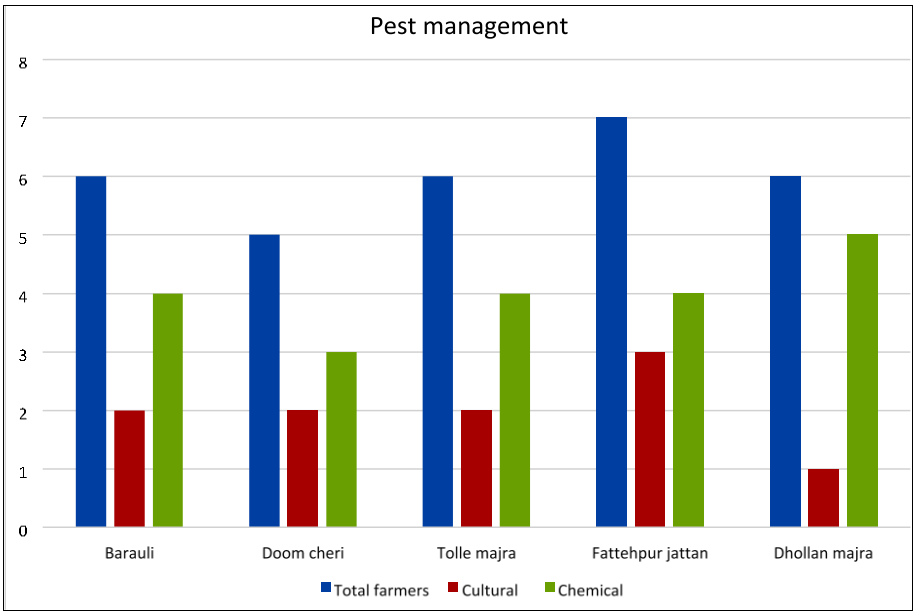

Fig 7: Pest Management

Here's what the numbers say. In all five villages, chemical pest control wins out. Out of 80 farmers, most lean on chemicals instead of cultural practices. Take Dhollan Majra—five out of six farmers there chose chemical methods, just one stuck with cultural. In Barauli, Doom Cheri, and Tolle Majra, it's about two farmers going for cultural methods, while the other four go straight for chemicals. Fattehpur Jattan is the only village where things are a bit more even—three farmers use cultural techniques, four use chemicals. So across the board, chemicals come out on top. Farmers want quick, reliable results, even now, when they're starting to learn more about sustainable options.

Conclusion

So, farmers in Punjab mostly stick to the old routine—growing rice and wheat, season after season. They use some machines, but high-tech tools and precision farming? Not really. Switching things up with other crops doesn't happen much either. Chemical fertilizers and pesticides are everywhere, and most folks skip soil testing or better ways to manage pests, which just makes environmental problems and resistance worse. They face some big hurdles: groundwater is dropping fast, farming costs keep rising, and getting hold of newer technologies or government programs isn't easy.

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