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Knowledge-practice Gap Among Dairy Farmers a Review of Extension Approaches and Interventions

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ABSTRACT

Dairy farmers across income settings consistently know more about scientific dairy management than they practise. This review synthesizes recent evidence on the knowledge-practice gap in dairy farming, drawing on cluster analyses of buffalo and cattle husbandry in India, a mixed-methods study of antimicrobial use in Uganda, and extension-intervention evidence from a randomized contact-farmer trial and structured animal-health planning frameworks. Across these studies, knowledge and adoption diverge most sharply for costly or belief-driven practices — silage preparation, healthcare protocols, and antimicrobial stewardship — and least for practices requiring only information. Farmer segmentation, rather than blanket extension messaging, and rigorously tested delivery models such as trained contact farmers, show the strongest evidence of narrowing the gap cost-effectively. The review also finds a persistent gender dimension: women perform the majority of day-to-day dairy labour but have systematically less access to extension contact than men. It closes with a synthesis framework linking gap type to intervention design and a discussion of remaining evidence gaps.

INTRODUCTION

Dairy farming, whether centred on cattle or buffalo, depends on a wide set of technical practices — breeding, feeding, healthcare, and herd management — that have been extensively researched and packaged into extension recommendations. Yet a consistent finding across recent studies is that dairy farmers' knowledge of these recommendations exceeds their actual practice, sometimes by a wide margin. This knowledge-practice gap, sometimes termed a 'knowledge-action gap' in the animal-health literature, has direct consequences: underused feeding practices depress milk yield and farm income, and gaps in health and antimicrobial practices carry consequences that extend beyond the farm to food safety and antimicrobial resistance.

This review synthesizes recent evidence on the size and pattern of the dairy knowledge-practice gap, examines why conventional knowledge-attitude-practice (KAP) framing may understate the barriers involved, and reviews extension approaches and interventions — including a rigorously evaluated contact-farmer model, structured animal-health planning frameworks, frontline demonstration programmes, and digital tools — that have been tested as responses.

EVIDENCE OF THE KNOWLEDGE-PRACTICE GAP IN DAIRY FARMING

A recent cluster analysis of dairy and buffalo husbandry knowledge, attitudes, and practices (KAP) in India identified five distinct farmer segments with sharply different knowledge-practice relationships. Smallholders, comprising 36.8% of the sample, practised only about 25% of recommended techniques despite holding moderate knowledge of them. Commercial farmers, a much smaller 7.9% of the sample, achieved 90.5% adoption. Most strikingly, a segment

Table 1: Farmer Segments Identified in a Buffalo Husbandry KAP Cluster Analysis, India

Segment	Share of sample	Key finding
Smallholders	36.8%	Practised only ~25% of techniques despite moderate knowledge
Traditional Dairy Farmers	28.9%	Highest knowledge (70.2%) but low adoption (30.4%); 0% training participation — the sharpest knowledge-adoption paradox in the sample
Commercial farmers	7.9%	Highest adoption of any segment (90.5%)
(Two further segments)	26.4% combined	Distinguished primarily by economic-scale and socio-cultural factors rather than knowledge level

Source: Cluster analysis of buffalo husbandry KAP, PLOS ONE [1].

the study labelled Traditional Dairy Farmers (28.9% of the sample) showed a pronounced knowledge-adoption paradox: the highest knowledge score of any segment (70.2%) paired with one of the lowest adoption rates (30.4%), alongside 0% training-programme participation — a combination the authors describe as a critical extension gap [1].

Statistical analysis in the same study found education (odds ratio 3.4) and herd size (odds ratio 2.4) as the strongest predictors of overall KAP scores, with income showing a particularly strong association with practice specifically (odds ratio 4.3), suggesting that adoption barriers are often economic rather than purely informational [1]. Across the full sample, non-practice rates for individual techniques ranged from 54.12% to 65.88%, with silage preparation showing the highest rate of non-implementation (65.88%) despite being a well-established feed-conservation practice — the study attributes this specifically to economic barriers and scepticism about the practice's value, not lack of awareness [1].

A separate, India-specific evaluation of a field-based extension model — the Kisan Sewa Kendra (KSK) in Muzaffarnagar district — found a comparable pattern when comparing programme beneficiaries to non-beneficiaries. Beneficiaries scored 85.17% on knowledge and 74.89% on adoption of scientific dairy farming practices, compared to 69.91% and 59.04% respectively among non-beneficiaries, with both differences statistically significant [2].

The same study broke knowledge down by practice domain, finding management practices best understood (72.25% weighted mean score) and healthcare practices least understood (52.08%), with feeding (66.94%) and breeding (58.33%) in between — a domain ranking that mirrors the buffalo study's finding that health- and cost-related practices carry the largest gaps [2].

BEYOND KAP: THE KNOWLEDGE-ACTION GAP IN ANIMAL HEALTH

A 2026 mixed-methods study of antimicrobial use (AMU) among dairy farmers in central Uganda pushes the analysis further, questioning whether the conventional KAP framework adequately explains behaviour at all. The study found that farmers' antimicrobial resistance (AMR) knowledge and belief items were only weakly associated with prudent antimicrobial use and related practices in exploratory statistical models — despite AMU practices being clearly associated with farmers' attitudes toward veterinarians and structural access barriers, particularly reliance on private veterinarians due to difficulty accessing public animal health services [3].

The authors term this a 'knowledge-action gap' and argue that conventional KAP-based interventions — which assume that raising knowledge and shifting attitudes will reliably change practice — are insufficient on their own for behaviours as structurally and relationally embedded as antimicrobial use. They call instead for behaviour-centred approaches grounded in theory-driven behaviour change frameworks and interdisciplinary collaboration, rather than continued reliance on knowledge-transfer interventions alone [3]. This finding reinforces, from a different empirical angle, the same pattern seen in the Traditional Dairy Farmers segment in Section 2: high knowledge does not guarantee behaviour change when relational, structural, or belief-based barriers are the actual binding constraint.

EXTENSION APPROACHES AND INTERVENTIONS

Farmer-to-Farmer / Contact-Farmer Extension

The strongest causal evidence reviewed here comes from a large-scale randomized evaluation of the 'contact farmer' extension model among smallholder dairy farmers in Uganda, published in the Journal of Development Economics. In this model, one farmer trainer is selected and trained per village to disseminate feeding-practice knowledge to other farmers. The study tested an at-scale version of this model along with three enhancement components: non-monetary incentives for

farmer trainers, professional extension-agent support, and a curriculum combining core animal-nutrition principles with a broad set of feeding practices. Results showed positive effects along the full causal chain — from farmer-trainer knowledge acquisition, to the knowledge of farmers they trained, to increased technology adoption, milk production, and profits — and the authors report the overall programme as highly cost-effective [4].

This result is notable because it directly answers a scaling question left open by the segmentation evidence in Section 2: a well-designed, incentive-aligned farmer-to-farmer model can extend the reach of scarce professional extension capacity without simply relying on unstructured informal diffusion, which other studies in the broader Farmer Field School literature have found to be an unreliable transmission channel on its own [4].

Frontline Demonstrations and Field-Based Training

India's Krishi Vigyan Kendra (KVK) network and related field-based extension models, such as the Kisan Sewa Kendra evaluated in Section 2, rely on frontline demonstrations and structured, in-person training to build both knowledge and confidence in scientific dairy practices. The consistent finding across such evaluations — a significant knowledge and adoption advantage for trained beneficiaries over untrained comparison farmers — supports continued investment in field-based demonstration as a core extension modality, particularly for domains like healthcare that show the largest knowledge gaps [2].

Structured Animal-Health Planning Frameworks

A qualitative evaluation of the RESET framework for dairy farmer animal-health planning — which addresses Rules, Economics, Social norms, Education, and Tools as interacting drivers of behaviour — found that the most helpful interventions cut across multiple RESET components simultaneously: industry rules requiring certain disease testing, data showing farmers the economic benefit of preventative practices on their own farms, and enhanced farmer confidence and connection with veterinarians and other advisers, which together strengthened both knowledge and follow-through on animal-health planning [5].

The RESET evidence is consistent with the Uganda AMU findings in Section 3: the interventions rated most helpful by farmers combined an economic or relational lever (confidence with a vet, visible farm-level data) alongside education, rather than relying on education alone [5].

Table 2: The RESET Framework for Dairy Animal-Health Behaviour Change

RESET componer	Description	Example lever
Rules	Formal or industry requirements shaping behaviour	Mandatory testing for specific diseases as a condition of milk supply contracts
Economics	Financial incentives and demonstrated costs/benefits	Farm-specific data showing economic return on preventative health investment
Social norms	Peer and community expectations	Visible peer adoption within a farmer's own social network
Education	Knowledge and understanding of practices	Structured training and demonstration, as in Sections 4.1–4.2
Tools	Practical resources enabling action	Access to vets, diagnostic tests, recording systems, and advisory relationships

Source: RESET framework evaluation, dairy farmer animal health planning [5].

Digital Tools: Smartphone Apps in High-Income Dairy Systems

In contrast to the developing-country evidence above, a 2019 study of 280 German dairy farmers examined adoption of herd-management smartphone apps using an extended technology acceptance model. Rather than a basic-awareness gap, the constraint here was adoption despite awareness: 38% of farmers used such apps daily, but 39% did not use any herd-management app at all, with perceived usefulness and perceived ease of use — not basic knowledge of the technology's existence — the strongest predictors of actual usage behaviour [6].

This finding parallels the developed-country contrast documented in vegetable-sector technology adoption literature: in higher-income dairy systems, the binding constraint shifts from basic knowledge to usability, trust, and perceived value — underscoring that 'closing the knowledge-practice gap' requires a different design response depending on which barrier is actually binding in a given farming system [6].

GENDER DIMENSIONS IN DAIRY EXTENSION

Women perform a large share of day-to-day dairy labour — fodder collection, feed preparation, cleaning, milking, and animal care — yet a study of dairy farming households in Haryana, India, found that women had markedly less contact with formal extension and veterinary sources than men, who more often accessed

both extension personnel and informal peer networks. Women's contact with extension services and institutions such as dairy research institutes was described as only occasional, despite their central role in daily animal care [7].

This access gap matters directly for the knowledge-practice patterns documented in Sections 2 and 3: if the people performing the majority of hands-on dairy labour have systematically less access to the extension contact associated with higher knowledge and adoption in every study reviewed here, closing the aggregate knowledge-practice gap will require extension models that deliberately reach women dairy workers rather than assuming household-level training reaches all household members equally [7].

TOWARDS TARGETED, SEGMENTED EXTENSION: A SYNTHESIS FRAMEWORK

The evidence reviewed in Sections 2 through 5 converges on a consistent policy implication, stated explicitly by the buffalo husbandry cluster study: blanket extension messaging aimed at an undifferentiated 'average farmer' is poorly matched to a farmer population that splits into segments with very different knowledge-practice relationships and different binding constraints [1]. That study's own proposed response — targeted training for smallholders through farmer groups, subsidized input bundles paired with mobile advisories, and market incentives for quality milk — illustrates the kind of segmented design this review's evidence supports.

- **For farmers with low knowledge and low adoption:** conventional education and demonstration (frontline demonstrations, farmer-trainer models) is well-matched, since the binding constraint is genuinely informational [2], [4].

- **For farmers with high knowledge but low adoption (the 'Traditional Dairy Farmer' paradox and the Uganda AMU pattern):** education-only interventions are unlikely to work; economic, relational, and structural levers (input subsidies, veterinary access, trusted advisory relationships) should be prioritized [1], [3], [5].

- **For farmers already adopting at high rates (commercial segment):** extension resources are better redirected elsewhere, since this segment already demonstrates the intended outcome [1].

- **For higher-income, technology-aware systems:** the priority shifts to usability and demonstrated value of digital and precision tools, not basic knowledge transfer [6].

- **Across all segments:** extension design should explicitly verify it is reaching women, who perform the bulk of hands-on dairy labour but consistently show weaker extension access in the reviewed evidence [7].

BARRIERS TO CLOSING THE GAP

- **Blanket, undifferentiated extension design:** treating all farmers as a single target audience overlooks the sharply different knowledge-practice relationships documented across farmer segments [1].

- **Over-reliance on conventional KAP assumptions:** assuming that raising knowledge and shifting attitudes will reliably change practice does not hold for structurally or relationally embedded behaviours such as antimicrobial use [3].

- **Weak informal diffusion:** extension models that rely on trained farmers informally passing knowledge to neighbours, without additional structure or incentive, show limited spillover in the broader literature, reinforcing the value of the more structured contact-farmer model in Section 4.1 [4].

- **Persistent gender gaps in extension access:** women, who perform most hands-on dairy labour, are less likely to be reached by formal extension and veterinary contact than men [7].

- **Cost and belief barriers behind 'known but not adopted' practices:** practices like silage preparation are often well understood but skipped for economic or belief-based reasons that education alone does not address [1].

DISCUSSION AND RESEARCH GAPS

The strongest evidence in this review — the randomized contact-farmer evaluation in Uganda — remains a single, if rigorously executed, study; replication across other dairy systems and animal-health domains beyond feeding practices would strengthen confidence that the contact-farmer model generalizes. The buffalo husbandry cluster analysis offers a rich segmentation framework but is drawn from a single country context, and it is not yet clear whether the same five-segment structure, or a similar one, would emerge in other dairy-producing regions. The Uganda AMU study's critique of conventional KAP interventions is an important corrective, but behaviour-centred alternatives it recommends are still an emerging research area with limited large-scale evaluation evidence specific to dairy

antimicrobial use. Finally, very few studies in this review directly combine gender-disaggregated extension-access data with knowledge-practice outcome data in the same research design, leaving the precise size of the gender-related knowledge-practice gap in dairy farming to be inferred rather than directly measured.

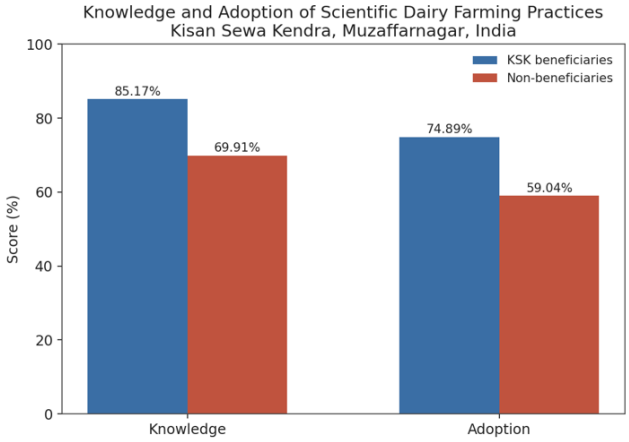

Figure 1: Knowledge and adoption of scientific dairy farming practices among Kisan Sewa Kendra beneficiaries versus non-beneficiaries, Muzaffarnagar, India [2].

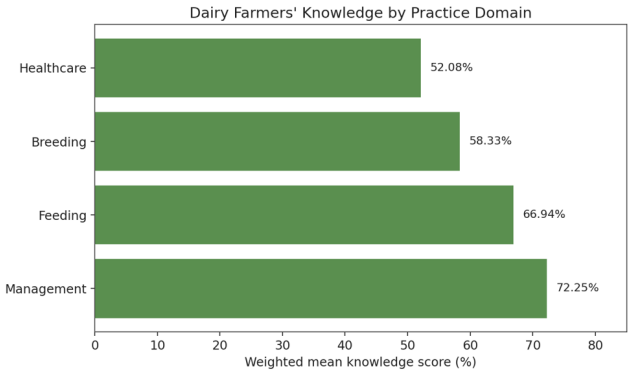

Figure 2: Dairy farmers' knowledge scores by practice domain, Kisan Sewa Kendra study area [2].

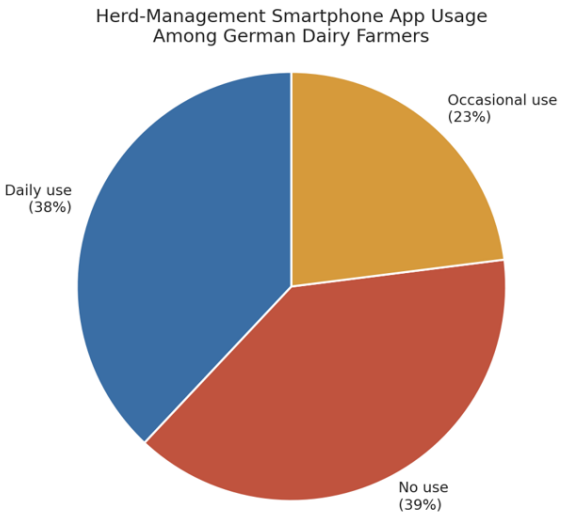

Figure 3: Herd-management smartphone app usage frequency among German dairy farmers [6].

CONCLUSION

Dairy farmers' knowledge of scientific production and animal-health practices consistently outpaces their actual practice, and the size of that gap varies systematically by farmer segment, practice domain, and income context. The most informative recent evidence suggests that this is not primarily a knowledge-transmission problem to be solved with more information alone: high-knowledge farmer segments with low adoption, weak associations between AMR knowledge and antimicrobial practice, and adoption gaps in technology-aware, high-income dairy systems all point toward economic, relational, structural, and usability barriers as the actual binding constraints in large parts of the dairy farmer population. Extension approaches that segment farmers by their specific knowledge-practice profile, combine education with economic and relational levers as in the RESET framework, deploy rigorously tested delivery models such as incentivized contact farmers, and deliberately reach women dairy workers offer the most evidence-backed path to closing the gap durably.

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