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Assessing Extension Methods for Improving Livestock Health Care in the Indian Himalayas

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A field study in the western Himalayan foothill region of Uttarakhand found widespread resistance to livestock vaccinations and medications based on a number of misconceptions, including that they would cause

miscarriages, reduction in milk yield, reduction in feed consumption, weakness, fibroid formation, or fever. Over a 3-year period, 150 farmers received, free of cost, livestock vaccinations and antiparasite medications along with advice on sanitation and feeding, delivered by using 3 different

communication methods. Group 1 received individualized training by a veterinary professional and a youth volunteer, group 2 received small-group training at a central location, and group 3 was exposed to wall posters that advertised a distribution of free medications at a veterinary outreach event where they could also interact with animal health personnel. The intervention that had the greatest impact was the one with the group that received personalized training, which resulted in a 96% vaccination rate at the end of the third year.

Keywords: Animal health care; foot and mouth disease; ovine rinderpest; misconceptions; extension methods; effectiveness; impact assessment; Uttarakhand; India.

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Introduction

Livestock raising is one of the fastest-growing agricultural sectors. It employs 1.3 billion people and supports 4 billion people worldwide (Descheemacker et al 2010) and helps farmers to improve livelihoods and achieve food security (Devendra and Chantalakhana 2002; Perry and Sones 2007). In Uttarakhand State, India, approximately 70% of the population engages in agriculture and animal husbandry. Livestock contributes nearly 54% to the economy of hill farms and more than 15% of state gross domestic product (GDP), and provides employment to more than 2 million people. Livestock density is generally higher in the hills than on the plains; the livestock population in Uttarakhand has increased over the past 5 decades (Singh et al 2006; Rawat 2010). Farmers appreciate the multiple uses of livestock, which provide meat, milk, wool, draught power, organic manure, biogas energy, and income. Livestock are often used as a buffer against fluctuations in the availability of food or cash and are considered capital assets and status symbols (Farooque 1997; Taneja and Birthal 2003).

Livestock productivity in the hills of Uttarakhand is lower than in the plains or at the national or global level (Bhalla 2006; Meena et al 2007; Chander et al 2010; Glendenning et al 2010). Half of the animals have health problems that severely diminish productivity (Yadav and Singh 2008). Causes of low livestock production include

the prevalence of low-yielding breeds, poor reproductive efficiency, farmers' lack of animal husbandry skills and of knowledge about veterinary services and best practices, and lack of animal health care interventions and extension services (Anonymous 2006) as well as climatic stress (Sirohi and Michaelowa 2007) and scarcity of high-quality fodder (Biswas et al 1994; Sirohi and Michaelowa 2007; Bardhan et al 2010). In the region, livestock diseases and parasite infestations include foot and mouth disease (FMD), hemorrhagic septicemia, ovine rinderpest (goat plague, also referred to as *peste des petits ruminants*), swine fever, gastrointestinal worms (Dixit et al 2009). Of these, FMD and ovine rinderpest are the most widespread (Lal 2000; Nandi and Suresh 2006). Other livestock diseases in the area, such as brucellosis and endoparasites, are transmissible to human beings (Parola and Raoult 2001; Taylor et al 2001; Jones et al 2008; Boral et al 2009; Dhar 2012).

To address these challenges, effective agriculture advisory services are needed. However, experience has shown that persuading farmers to change their practices is a complex process (Swanson and Rajalahti 2010) shaped by farmers' attitudes, values, knowledge, and perceptions. Despite the multipronged nature of India's extension services (Glendenning et al 2010), they are often not effective due to weaknesses, such as a lack of high-quality information and a mismatch between marginalized farmers' needs and the information supplied by the hierarchical Indian veterinary service. To be effective,

extension services need to consider farmers' perspectives; enhance their knowledge base; involve them in participatory learning processes; and empower women, who are often the ones taking care of the livestock.

Despite the importance of effective extension (Prokopy et al 2008; Glendenning et al 2010), literature on the adoption of improved, gender-sensitive practices, use of paraveterinary assistants (paravets) in livestock extension systems, and quantitative evaluation of extension methods is scarce and largely unsynthesized (Anonymous 2007). This study assessed the effectiveness of 3 communication methods used with smallholder farmers in the western Himalayan foothills to counter negative perceptions (sometimes deeply rooted in tradition) of modern methods and to improve adoption of animal health care measures. It presents important insights on how to shape communication to promote more productive and sustainable livestock management.

Material and methods

The study was part of a major on-farm research and demonstration project on technology development and extension in Uttarakhand State between 2006 and 2011. It involved 4 villages, Pasauli, Devthala, Dungakheth, and Godaria, located in the Vikasnagar Community Development Block of Dehra Dun District, between 29°58' and 31°2'30"N latitude; 77°34'45" and 78°18'30"E longitude. Dungakheth and Godaria villages were treated as one village because of the limited number of farm families. The study followed a 5-step approach: a baseline study, training of paravets, presentation of health care interventions, impact assessment, and a follow-up survey of farmers who refused the interventions. The free medication campaign implemented during the study closely resembles standard practices in the region's livestock extension system, which supplies most medications free of cost or at subsidized rates.

Baseline study

Before implementing any livestock health care measures, a participatory rural appraisal was conducted to establish baseline information about livestock production, health care, the most important livestock health problems, and farmers' perceptions. The appraisal used a combination of farmers' recall of past experiences, limited physical observations of yield and symptoms, and laboratory testing. Initially, 52 farmers living in the study villages were interviewed about prevailing animal diseases and the farmers' practices regarding vaccination and medication of their livestock. In addition, 20 veterinary officers (VO), doctors, and livestock extension officers (LEO) were interviewed to identify prevailing animal diseases and infections, existing treatment facilities, farmers' perceptions of recommended practices, and potential animal breeds for the region. These 2 surveys allowed

cross-checking of health care status and misconceptions and negative perceptions reported by farmers.

Training of paravets

Ten local literate and unemployed youths interested in animal husbandry were trained about animal medications, urea treatment of dry fodders, and other veterinary assistance, and were provided with a schedule for medications (Table 1).

Presentation of health care interventions

Free vaccinations and antiparasite (deworming) medication (hereafter referred to together as medications) along with advice on sanitation and feeding were offered from 2006 to 2011, implemented by paravets in the presence of a VO or an LEO. To inform farmers of the availability of these interventions, 3 different communication methods were used:

- Group 1 (individual contact, Devthala): every farmer in the study received a one-to-one interaction of up to 30 minutes 5 days before the interventions.
- Group 2 (group contact, Pasauli): 3 small and cohesive groups of 16 or 17 farmers who knew one another met for 1–2 hours 2 days before the interventions to address any doubts about the interventions.
- Group 3 (mass contact, Dungakheth and Godaria): 1-m² posters with information about prevailing animal health problems and the date, time, and place of an animal health outreach event (Figure 1), printed in Hindi, were placed in public areas 1 week before the interventions; the farmers were provided with explanations at the time of medications and were convinced of their utility.

Activities planned to deliver the health care interventions and explanations about potential economic losses if these were not applied were discussed with groups 1 and 2 by using visual aids. Farmers were educated on the nature and importance of the medications and on the benefits of timely administration of interventions to avoid the spread of disease and improve animal health, and benefit farmers' economic status.

Impact assessment

A total of 150 farmers, 50 from each location, including 30 women, were selected for the study through simple random sampling. The surveyed farmers represented various ages, literacy levels, and economic status (size of land holding and herd). During the interventions, data were collected on farmers' socioeconomic status, animal productivity, disease incidences, economic losses or gains, and perceptions of any medications offered previously.

Follow-up survey

Of the 150 farmers in the study, 53 (including 12 women) declined the livestock medications. These farmers were asked in 2006 to list the reasons for their refusal and to rate the importance of each reason on a 3-point scale. The

TABLE 1 Schedule of recommended interventions.

Problem	Symptoms observed in the field	Intervention	Timing and target
Foot and mouth disease	Characteristic blisters in hooves and mouth; de-skinning of tongue; high fever; accept only liquid feed until temperature reduces; respiratory problems, particularly during periods of sunshine; difficulty walking or moving	Vaccination	Twice a year, before monsoon (May–Jun) and winter (Oct–Nov) for bovines, sheep, and goats
Ovine rinderpest	Pneumonia symptoms, difficult respiration, nasal discharge, high fever, loss of appetite; occurs particularly during weather changes and mass migration	Vaccination	Twice a year, before monsoon and winter for sheep and goats
Ectoparasites	Presence of insects, itching, skin aberrations	Deworming	At weaning and every 2–3 mo thereafter for bovines, sheep, and goats
Endoparasites	Poor growth, low milk yield, bottle- or pot-shaped belly, dull skin, loose motion, weakness, failure to come to heat, failed pregnancy	Deworming	At weaning and every 6 mo thereafter or as needed for bovines, sheep, and goats
Poor sanitation	Unhygienic conditions	Cleaning	Water troughs and mangers: every 1–3 mo in fields and at least twice a wk at houses; houses and sheds: daily, with weekly sanitation measures

FIGURE 1 Livestock health care outreach event. (Photo by Sh Lakshmi Kant Sharma, technical officer [T 7-8], CSWCRTI, Dehra Dun)



TABLE 2 Demographic characteristics of the study villages.

Village	Number of families	Average family size	Total population
Devthala	151	5.99	905
Pasauli	105	6.41	673
Dungakhet and Godaria	65	6.42	419
Total	321	6.27^{a)}	1997

^{a)}Value is the average for all three villages.

frequency of each reason was multiplied by the respective summed scores to produce a weighted score for each reason. A chi-squared test was used to find the significance levels between age or education and misconceptions.

Evaluation of study results

The impact of all 3 communication methods was measured in terms of the percentage of farmers who agreed to medicate their animals and the percentage of animals medicated. Impact data for the second and third years (2007 and 2008) were combined because of the minimal variation observed between the 2 years. The increase in the number of farmers who agreed to medication and animals medicated during the second and third years over the first year was estimated for all 3 communication methods as an indicator of their effectiveness. A scenario analysis was carried out during 2009–2011 to determine the impact of medications in terms of total adoption rate and the number of animals medicated, reduction in occurrences of animal diseases, increased reproductive efficiency (reduction of age at first calving and of intercalving periods), and increase in milk yield and growth by using a “before and after project” approach and budgeting technique. The actual production data were used for impact analysis.

Results and discussion

Socioeconomic status of study villages and farmers

The study villages are home to 321 families, with an average of 6 members per family and a total human population of 1997 (Table 2). Of the farmers in the villages, 80% are native Boxa tribal members or migrants from the Jaunsar tribal region of Garhwal. The percentage of respondents who were illiterate was low; more than half had

an education up to the intermediate level, and a small number had advanced beyond that level (Table 3). Approximately 95% of the population owned land, but the majority (90%) owned less than 1 ha, with an average landholding size of 0.56 ha. Farmers were highly dependent on livestock to supplement their earnings and gain maximum economic benefits from common property resources through grazing and fodder collection. Agriculture and animal husbandry were managed jointly by men and women. Outmigration of men was significantly lower than in the other parts of the western Himalayan region.

Livestock population

The total livestock population in the villages was 1385 animals, including bullocks (30.76%), goats (37.04%), cows (17.54%), and buffaloes (14.66%), of which 813 animals belonged to the farmers who were surveyed. The average size of respondents’ herds ranged from 5.28 to 7.58 animals. The region is dominated by traditional breeds like Badri cows, Murrah buffalo, and goats of mixed or undetermined breed. Approximately 85–90% of animals had low milk yield (1–3 L per cow, 3–5 L per buffalo, and 0.2–0.5 L per goat per day), high age at first calving (2–3 years for small animals and 4–5 years for large animals), and calving intervals (1–2 years). Approximately 70–80% of the animals were maintained on conventional fodders and open grazing without feed supplements. Only milk animals and those dedicated to temples or ritual feasts occasionally received concentrated feeds or table salt crystals.

Extension system

Advisory systems that involve many government agencies and nongovernmental organizations work in the region mainly as public systems. Veterinary staff of the State Animal

TABLE 3 Social and personal characteristics of respondents. (Table extended on next page.)

Village	Age group (%)			Education level (%)
	Young (18–30 yr)	Middle (31–50 yr)	Old (>50 yr)	Illiterate
Devthala	16	58	26	14
Pasauli	18	64	18	10
Dungakhet and Godaria	12	66	22	08
Average	15	63	22	11

FIGURE 2 A veterinary officer checks a cow's health status. (Photo by Sh Lakshmi Kant Sharma, technical officer [T 7-8], CSWCRTI, Dehra Dun)



Husbandry Department (SAHD) and State Agricultural University coordinate and manage livestock developmental activities in the district, including training for paravets and farmers. The extension system lacks adequate staff and infrastructure, especially in marginal areas, and is not as well funded compared with other regions in India (Swanson and Rajalahti 2010). Usually, a VO or an LEO stationed in a veterinary hospital or community development block health center covered an animal population of more than 0.2 million in more than 150 villages in a 15–20 km radius and functioned under the administrative control of a

district-level chief veterinary officer. A nominal charge of Rs. 1–2 (US\$ 0.02–0.04) per dose of vaccine and Rs. 5–10 (US\$ 0.09–0.18) per animal for basic medicines was collected from livestock owners by the VO or the LEO.

Prevalence of animal diseases

FMD, parasitic gastrointestinal worms, and ectoparasites were named by farmers as the dominant health problems for all farm animals, along with ovine rinderpest for goats and sheep; this was confirmed by the VO or the LEO, or through physical observation during the survey (Figure 2).

TABLE 3 Extended. (First part of Table 3 on previous page.)

Village	Education level (%)			Animals reared	
	Up to primary	Up to intermediate	Above intermediate	Total	Average herd size
Devthala	24	60	2	379	7.58
Pasauli	29	58	3	328	6.56
Dungakhet and Godaria	22	66	4	106	5.28
Average	25	61	3	813	6.47

Infertility causes productivity loss in 20–30% of animals. Also reported to occur occasionally were hemorrhagic septicemia, pasteurellosis, brucellosis, diarrhea, tuberculosis, black quarter, and walking difficulties in some large animals, and enterotoxemia, blue-tongue disease, *Escherichia coli* and coccidial infections, and abortions in goats and sheep. In the study villages, up to 70% of the animals had FMD, 78% suffered from ovine rinderpest, 90–95% from ectoparasites, and 67–88% from endoparasites before project interventions; these diseases occurred mainly during the monsoon and winter seasons and when sick animals were introduced into the herds. The high baseline prevalence of disease was primarily due to open grazing and substandard animal husbandry practices, which increased the probability of healthy animals mixing with infected farm or wild animals, potentially causing large-scale infection (Kilpatrick et al 2009; Rawat 2010; White et al 2011).

Misconceptions about health care measures

Fifty-two farmers participated in the baseline study; 69% were reluctant to use preventive medications or were skeptical about their performance. They were not always aware of their animals' health problems (this has also been reported from other regions of India (see Meena et al 2007; Dixit et al 2009; Tiwari et al 2010). Despite the prevalence of such problems, the baseline rate for use of preventive medications was only 7%. Only 10–20% of farmers took sick animals to a veterinary center for treatment; the remaining farmers relied on traditional treatments. Farmers preferred to slaughter sick goats and sheep and to distribute the meat to village households either free or at reduced cost, rather than investing in treatment. This increases the risk of disease transmission from animals to humans (Jones 2008; White et al 2011; Dhar 2012).

A majority of the farmers in the study area agreed to interventions such as the introduction of fodder tree species, planting of hybrid Napier grass on field bunds, use of urea molasses mineral blocks, and urea treatment of dry fodders. But 35% of the farmers interviewed (including 12 women) opposed medications due to a lack of awareness about animal health care. It seems that farmers are not usually concerned about disease until it becomes an outbreak or causes economic losses. They rely more on curative rather than preventive measures, often not applying medication until the last stage of an infection and thus have had to bear substantial losses. Both misconceptions and economic constraints make herd owners unwilling to register their animals for extension agency services such as preventive medications, feed blocks, and fodder seeds, even though the fees are nominal, sometimes subsidized up to 90%, as VOs and LEOs of the SAHD reported.

The survey revealed 9 common misconceptions about the effects of vaccines, listed here in order of their weighted scores: reduction in milk yield (990); miscarriage (760); reduction in feed consumption (746); higher body

temperature, panting, and weakness (714); swelling and fibroid formation (703); fever and general poor health (646); reduction in draught power (544); death (390); and the need to periodically repeat the medication (180). The first 6 misconceptions were widely held. Many farmers expressed the view that an epidemic is a bane imposed by God, and that it is futile to attempt to prevent or cure it. Farmers who were more than 50 years old, who were illiterate, or who had attended school only through the primary level had significantly more misconceptions ($p < 0.05$) than farmers aged 18–50 years and those with an intermediate or higher level of education. Farmers' age and education appeared to influence their perceptions and willingness to try new techniques (Pannel et al 2006; Gedikoglu and McCann 2012). Therefore, raising awareness of innovations, especially among the less-receptive groups, is essential, as volunteers involved in the study reported and Sastry and Raju (2008) also suggested.

Unvaccinated animals are more susceptible to diseases like brucellosis and FMD, which can lead to abortions (Chhabra et al 1998; Kaur et al 2006; Boral et al 2009), lower productivity, and even death (Lal 2000; Kumar et al 2003; Homewood et al 2006). However, more than one-third of respondents expressed the belief that vaccinations and medications cause animal health problems. There is no easy and economical cure for most animal diseases; treatments begun after an outbreak has started are often not effective. Thus, repetition of medications is often necessary because diseases may occur in previously medicated animals as well (Singh and Gupta 1987). Vaccination campaigns and continued medications against predominant diseases may eliminate the cause permanently, as in the case of bovine rinderpest (Sud 2006), effected through continuous immunization programs organized by the government. But this information needs to reach the farmers.

Impacts of different communication methods

Of the farmers approached through personal contact (group 1), 72% easily agreed to try medications and another 12% agreed after 2–3 contacts in the initial year, 2006. This total increased to 94% (88% easily agreed and 6% agreed after 2–3 contacts) in 2007–2008 (Table 4). This was reflected in an increasing number of animals being vaccinated, dewormed, or both. Similar trends were observed in group 2 (group contact) and group 3 (mass contact) but to a lesser extent. As shown in Table 5, group 3 (mass contact), although it had the lowest total adoptions, had the highest rate of increase in the number of farmers agreeing to the intervention and animals medicated, followed by group 2 (group contact) and then group 1 (individual contact). These rates continued to increase slightly, by 2–5% in 2009–2010 and by 3–7% in 2010–2011, in all study villages. By 2010–2011, almost all

TABLE 4 Effect of different communication methods on farmers' consent to livestock medication and number of animals medicated.

Group	Farmers who agreed to medication (%)		Animals medicated (%)			
			2006		2007 and 2008	
	2006	2007 and 2008	Vaccinated	Dewormed	Vaccinated	Dewormed
1 ^{a)}	84	94	83	89	96	97
2 ^{b)}	66	78	67	68	81	83
3 ^{c)}	44	62	46	48	63	68

^{a)}Group 1 members received one-to-one training.

^{b)}Group 2 members received small-group training.

^{c)}Group 3 members attended an animal health event advertised by posters in public places.

the animals in groups 1 and 2 and approximately 75% in group 3 had been medicated.

Thus, the personal contact method was found to be most effective, possibly because the firsthand provision of appropriate knowledge, and the clarity, continuity, and consistency of the messages were able to reduce most misconceptions. Farm women with long working days and limited mobility seem to benefit most from this form of communication. These observations are supported by other studies (Sulaiman and van den Ban 2000; Natarajan and Venkataranganaika 2002; Chander et al 2010; Lemke et al 2010; Gedikoglu and McCann 2012). However, the face-to-face method may be costlier and more time consuming.

The mass contact method appeared to be the least effective. A meaningful combination of all 3 methods could promote large-scale adoption at an affordable cost in the shortest time. The number of farmers who declined the intervention, with a majority from group 3, dropped from 53 to 33 in 2007–2008, which indicated a reduction of misconceptions among a considerable number of farmers as a result of the extension methods used. Male farmers, especially those who were young and literate, had slightly more positive attitudes regarding the interventions than women. This substantiates results by Prokopy et al (2008). Of 30 women in the study, 12 (2 in group 1, 4 in group 2, and 6 in group 3) did not adopt the recommendations. Women in group 1 showed higher

willingness to adopt recommendations than women in the other 2 groups (Table 6). Although women play an important role in animal husbandry (IFAD 2009; Quisumbing and Pandolfelli 2009) and men consider their opinions to some extent, women took more time to be convinced to adopt the recommendations. They needed to consult or get approval from their male head of family. This indicates that final decision-making in the region is vested with men.

The farmers who adopted improved livestock management practices and medicated their animals showed a keen interest in continuing the recommended practices by using their own resources; they met each other on different occasions to discuss livestock management informally. The medication program developed farmers' confidence, which helped diffuse the practices to additional farmers. This confirmed the finding by Roder (2004) that farmers from the hill region quickly respond to new opportunities.

The recruitment of paravets in the study area may have been made easier by the presence of more literate farmers who are better able to understand technological details, but this may be a constraint as well, because their education may give them access to more remunerative employment opportunities than working as paravets. Where the illiteracy rate is higher, as in Nepal, people who are illiterate may be more motivated to become a paravet and work for a livestock management program,

TABLE 5 Increase in the number of farmers adopting livestock interventions and number of animals treated.^{a)}

Group	Increase in number of farmers who consented (%)	Increase in number of animals treated (%)	
		Vaccinated	Dewormed
1 ^{b)}	12	16	9
2 ^{c)}	18	21	22
3 ^{d)}	41	37	42

^{a)}Percentages reflect increases between 2006 (first campaign) and 2007–2008 (second and third campaigns).

^{b)}Group 1 members received one-to-one training.

^{c)}Group 2 members received small-group training.

^{d)}Group 3 members attended an animal health event advertised by posters in public places.

TABLE 6 Rate of adoption of interventions by farmers' gender and communication method, 2006.

	Number of farmers			Adoption rate (%) ^{a)}		
	Group 1 ^{b)}	Group 2 ^{c)}	Group 3 ^{d)}	Group 1 ^{b)}	Group 2 ^{c)}	Group 3 ^{d)}
Male	38	40	42	84	67	48
Female	12	10	8	83	60	25
Total	50	50	50	84	66	44

^{a)}Values are the averages for each group.

^{b)}Group 1 members received one-to-one training.

^{c)}Group 2 members received small-group training.

^{d)}Group 3 members attended an animal health event advertised by posters in public places.

because this might be one of the most desirable job opportunities available to them.

The recommended medications and planting of hybrid Napier grass on field bunds were adopted by two-thirds of the farmers in the study. However, the use of urea molasses mineral blocks and fodder blocks was less widely adopted because it was considered less profitable. Urea treatment of dry fodders was least adopted because farmers found the process overly complex (Pannell et al 2006).

Impacts of medication

Recent feedback from farmers confirmed that the interventions had positive impacts. The absence of FMD and ovine rinderpest, and a reduction of ecto- and endoparasitic infestations to 13–20% could be observed in the area (Table 7). Medications to treat major diseases and infestations, and improvement in the availability of protein-rich feeds reduced animals' age at first calving and intercalving periods, increased milk yields, and

promoted weight gain in goats and sheep. Thus, as an extension effort, the project can be rated excellent. However, as a study, it was unable to pinpoint the extent to which each intervention (such as medication and improved feed) contributed to the positive outcome.

Conclusions

Livestock raising is an integral part of a complex farming system and contributes significantly to the livelihood security of hill farmers in the western Himalaya. The region faces problems of low animal productivity, the absence of needed medications (mainly due to taboos and misconceptions), and poor diets. Older and less educated people are more prone to misconceptions. The personal contact method showed better results than group or mass contact. Therefore, a judicious combination of methods is needed to create awareness in a large contiguous area at affordable cost.

TABLE 7 Impact of interventions on health, production, and reproductive efficiency.^{a)}

	Average range (%) before study period	Average range (%) at end of study period
Infected animals		
Foot and mouth disease	30–70	0
Ovine rinderpest	43–78	0
Ectoparasites	90–95	15–20
Endoparasites	67–88	13–16
Production		
Higher milk yield in cows and buffaloes	NA	10–20
Body weight gain in goats and sheep	NA	5–20
Reproductive efficiency		
Younger age of first calving (mo)	NA	6–12
Shorter intercalving period (mo)	NA	3–6

^{a)}NA, not applicable.

Sustainability of the interventions

The results of the study have been shared with a variety of stakeholders in the region, including administrators, policy-makers, SAHD staff, communities, farmer representatives (village leaders), and local nongovernmental organizations, through programs organized by the Central Soil and Water Conservation Research and Training Institute and the National Agricultural Research System. Farmers were brought together with the SAHD to ensure the sustainability of the interventions and to provide follow-up support as needed. However, without continued technical support to paravets and farmers, and the timely supply of medications and other inputs, the improved livestock health cannot be sustained. The creation of linkages with markets for livestock products by the SAHD is of paramount importance to sustain livestock-based businesses, as has been shown in other areas (Homewood et al 2006; Senthil Kumar et al 2008).

The way forward

This study provided important insights on ways to reduce farmers' misconceptions about livestock medications, and it promoted increased adoption of such interventions. However, when considering the precarious livestock situation and the current state of livestock extension systems in the region, more far-reaching and comprehensive measures and more in-depth research are needed to effectively transform the livestock sector for the long term. These include the following:

- Existing extension services need to continue building capacity, farmers need to be better linked with extension agencies, paraveterinary services should be fostered, and mobile clinics should be created to distribute essential medications.
- Integrated consultative processes, with participation by all categories of stakeholders, are needed to improve ownership and implementation of interventions and to increase the impact of animal health services.
- Thorough research of farmers' perceptions, information-seeking behaviors, knowledge, and information needs is necessary to inform further development of extension methods.
- Because farmers in the region largely depend on herbal and traditional medicines, studies on causes of various diseases and the screening of medicines and management practices, including traditional ethnoveterinary medicines, could provide effective alternative precautionary measures and advance the use of appropriate medications.
- Assessing the disaggregated impacts of improved nutrition, fodder development, sanitation, and medications on livestock production would help to promote the most promising measures.

The findings of this study could inform livestock programs in other mountainous areas where knowledge about improved animal husbandry is limited and poor socioeconomic conditions and inadequate extension services prevail.

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