SUPPLEMENTARY EVIDENCE FOR POULTRY BIOSECURITY IN SOUTH ASIA

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S1 Search and selection record

This supplement accompanies the critical narrative review of evidence published before May 2022. The historical publication cutoff was applied to the first available publication date, independently of fieldwork dates. No lower publication-date limit was imposed.

PubMed, PubMed Central, publisher sites, and institutional repositories were used to retrieve primary text or bibliographic metadata. Neither a standalone subscription-database search nor a comprehensive citation-export denominator was available. The four search queries are reproduced below. The search engine returned some later records despite the before operator, making manual date checking necessary.

1. poultry biosecurity South Asia Bangladesh India Pakistan Nepal Sri Lanka Bhutan Afghanistan before:2022-05-01
2. "biosecurity" "poultry" "Sri Lanka" before:2022-05-01
3. "biosecurity" "poultry" "adoption" India Nepal before:2022-05-01
4. "poultry" "biosecurity" "Maldives" before:2022-05-01

Targeted title and DOI searches and backward reference tracing checked candidate reports. Eligible empirical studies addressed farmer knowledge, practices, decision authority, implementation, or management-related infection or production outcomes in South Asian poultry systems. Market and household studies were eligible when they explained relevant farm or human contacts. Technical guidance, SANRA, and the earlier backyard-poultry review were retained as contextual or methodological sources and excluded from empirical counts.

The selected corpus comprises 27 empirical publications. The main manuscript also cites four conceptual or methodological sources, giving 31 references. These are recoverable inclusion counts, not a flow diagram of all search hits. No claim of complete retrieval is made. Afghanistan contributes one empirical publication, Bangladesh 15, Bhutan two, India one, Nepal four, Pakistan two, and Sri Lanka two. No comparable eligible Maldives study was identified.

Primary-source claims, dates, denominators, and bibliographic details were checked. Disagreements were resolved by revisiting the original report. Unresolved internal inconsistencies or inaccessible details were retained as limitations. Independent duplicate screening was not performed. Known shared settings or potentially linked reports are identified below, and publication counts are not counts of independent participants or interventions.

Candidate reports were excluded when they were published after the cutoff, reported no relevant management connection, or added general training information without a biosecurity endpoint. Hatchery and abstract-only antimicrobial analyses were not retained.

S2 Included empirical studies

Each row describes a publication and its local study population. “Not verified” indicates that the field was unavailable in the accessible record; a publication year has not been substituted for a fieldwork year. Quantitative results describe the reported sample. The study-specific limitations prevent treating the rows as interchangeable adoption estimates. Links point to the verified original report or publisher record.

Publication and setting	System and sampling	Design and measurement	Outcome	Limitations and linked reports
Leslie et al. (2008) Afghanistan - Five accessible provinces Fieldwork May 2007 https://doi.org/10.3201/eid1409.071382	Households in outbreak-communication-exposed and comparison provinces; 65.2% poultry owners. 304 households, including poultry owners and nonowners	Cross-sectional comparison of areas with different outbreak/campaign exposure. Household knowledge, attitude and practice questionnaire; weighted KAP score	Mean KAP 50.2% in exposed provinces versus 40.1% elsewhere; socioeconomic differences associated with scores	Outbreak and campaign exposure coincide; no pre-campaign baseline; accessibility limits coverage. No sample overlap established with other included reports
B. Alam et al. (2020) Bangladesh - Dhaka, Gazipur and Tangail Fieldwork August-October 2017 https://doi.org/10.3390/microorganisms8111778	Small commercial broilers; supported good-practice and conventional farms. 32 selected farms, 16 per group; 352 environmental, bird and carcass samples	Cross-sectional post-program comparison; conventional farms as comparator. Culture, biochemical tests and PCR; carcasses sampled after slaughter in live-bird-market stalls	Campylobacter: 16.5% versus 36.4% across samples; carcass positives 3/16 versus 9/16	Nonrandomized farm selection and confounding; carcass findings include transport/slaughter exposure. No sample overlap established with other included reports
Biswas et al. (2017) Bangladesh - 32 large live-bird markets; finer locations not recovered from accessible abstract Fieldwork 2012 https://doi.org/10.1111/tbed.12454	Live-bird markets; poultry-chain setting. 32 markets: 10 FAO-assisted and 22 unassisted; sampling details not recovered	Observational comparison of existing assistance groups; allocation not established as random. Biosecurity questionnaire; environmental H5N1 assessment of floors, poultry stalls, holding cages and slaughter areas	Several practices better in assisted markets; H5N1 RR 1.10 (95% CI 0.44-2.76), assisted versus unassisted	Wide interval, observational selection and no pre-intervention comparator; environmental detection does not establish infection incidence or human health effects. Separate from Mondal et al. (2012) STOP AI programme; no overlapping cohort established
Chattopadhyay et al. (2018) Bangladesh - National stakeholders; validation roundtable in Dhaka Fieldwork Interviews February-March 2016; roundtable May 2016 https://doi.org/10.1007/s10393-017-1285-2	Poultry-sector policy and institutional governance. Purposive interviews with 23 stakeholders; validation roundtable attended by 40 stakeholders	Two-stage qualitative stakeholder analysis; no intervention comparator. Semistructured interviews and recorded group discussion; interpretive thematic analysis	Stakeholders emphasized leadership, resources, cooperation and sustainable compensation for disease control	Institutional perspectives rather than representative farmer responses; policy proposals not evaluated experimentally. No sample overlap established with other included reports

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Gupta et al. (2021) Bangladesh - Bangladeshi backyard and commercial chicken farms Fieldwork 2016-2017 https://doi.org/10.1111/tbed.13757	Backyard, broiler and layer chicken production. Two cross-sectional surveys: 144 backyard, 106 broiler and 113 layer farmers	Cross-sectional behavioural analysis; separate models by production system. Health Belief Model questionnaire; structural-equation models of self-efficacy	Perceived benefits/barriers related differently to self-efficacy across farm systems	Self-efficacy measures perceived capability, not verified implementation; cross-sectional associations lack temporal ordering. Related epidemiological programme; overlap with other original included reports not established
Hassan et al. (2021) Bangladesh - Seven poultry-dense districts; 21 upazilas Fieldwork October 2019-March 2020 https://doi.org/10.3390/antibiotics10070784	Commercial broiler and layer farms. 420 male farmers; 210 broiler and 210 layer; 60 per district; farmers selected from livestock-office lists	Cross-sectional questionnaire survey; no assigned intervention. Self-reported antimicrobial knowledge, attitudes, use and related practices	One-third sought antimicrobials outside registered veterinary advice; knowledge-practice Spearman correlation 0.3472, whereas attitude-practice correlation was not significant	Self-report, recall and cross-sectional limits; seven districts and all-male sample; some normatively scored items are debatable; no microbiological AMR endpoint. Antimicrobial behaviour context, not a direct biosecurity-effect study
Hennessey et al. (2021) Bangladesh - Chattogram and Dhaka poultry production/distribution networks Fieldwork Interview dates not verified; validation in November 2019 and January 2020 https://doi.org/10.1016/j.prevetmed.2021.105367	Indigenous, crossbred, broiler and layer production/distribution subnetworks. 27 purposive/snowball interviews; 20 randomly selected distributors; validation with seven previous informants and a 35-participant workshop	Qualitative value-chain mapping; comparison across production/distribution subnetworks. Stakeholder accounts, structured distributor information and literature-based network characterization	Credit dependence, unequal bargaining power and economic fragility shaped disease-related decisions	Qualitative snowball sample, predominantly men; accounts identify mechanisms without estimating causal transmission effects. Distributor frame reused from earlier Moyen research; overlap with included Moyen et al. (2021) not established
Høg et al. (2019) Bangladesh - Chittagong poultry commodity chain Fieldwork September 2015-January 2016 https://doi.org/10.1057/s41292-018-0131-2	Backyard/commercial farms, hatcheries, feed dealers, transporters and live-bird traders. Gatekeeper and snowball recruitment; 173 interviews with 144 informants at 33 sites	Multisite ethnographic study; contrasting actor perspectives, no untreated comparator. Interviews, observation and group discussion; interpretive analysis of risk rationalities	Economic insecurity, credit obligations and reputational concerns constrained preventive investment	Purposive qualitative sample; findings explain mechanisms without quantifying prevalence or intervention efficacy. Related Bangladesh value-chain research; participant overlap with Hennessey et al. not established

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Mondal et al. (2012) Bangladesh - Gazipur and Dinajpur districts Fieldwork 2009-2010 https://doi.org/10.3201/eid1812.120635	Poultry value chain, including backyard and commercial producers, hatcheries, transporters and market vendors. 1,319 trainees in 53 sessions; 12 commercial demonstration farms and four markets. Narrative survey totals 1,372 baseline/514 final differ from table totals 1,346/509	Uncontrolled before-and-after programme; subsector training, stakeholder workshops, technical support and cost-shared infrastructure. Questionnaire responses before/after programme; reported HPAI outbreaks	Improved awareness and reported practices; reported outbreak reductions during implementation were transient; behavioral persistence unmeasured	Changing samples, inconsistent survey totals, no concurrent untreated comparator; surveillance/culling co-interventions prevent causal attribution. Separate STOP AI programme; not the Biswas et al. (2017) market comparison
Moyen et al. (2021) Bangladesh - 119 live-poultry markets in Dhaka and Chattogram Fieldwork Cross-sectional March-September 2015; trader cohort followed monthly for one year https://doi.org/10.1038/s41598-021-98989-4	Live-poultry vendors and mobile traders. 1,389 vendors and 520 mobile traders; longitudinal subset of 43 vendors and 37 mobile traders	Cross-sectional and longitudinal trading-network surveys with transmission modelling. Reported preceding-week trading contacts; network reconstruction and modelled transmission risk	City-specific trade structures implied different market-to-market and mobile-trader opportunities for spread	Contact recall and model assumptions; connections are not direct observations of infection transmission. Related Bangladesh trading-network programme; sample overlap with other included reports not established
Rimi et al. (2016) Bangladesh - One village each in Rajshahi and Chittagong districts Fieldwork 2009 pre/post observation months; additional die-off investigation January 2010 https://doi.org/10.1186/s12889-016-3543-6	Backyard poultry and household slaughter/handling practices. Two purposively selected villages; repeated interviews/observations; January follow-up added 45 interviews and four observations	Uncontrolled qualitative pre/post evaluation of courtyard meetings, illustrated messages and posters. Separate intervention/evaluation teams; observation, informal interviews and ethnographic diaries	Awareness improved but observed behavior changed little; inconvenience, ridicule and low perceived risk persisted	No untreated village; brief initial follow-up; repeated topic-specific observations cannot be treated as independent participants. Shares 2009 village research setting with Rimi et al. (2018); participant-level overlap unresolved
Rimi et al. (2017) Bangladesh - Gazipur and Tangail districts Fieldwork September 2011-January 2012 https://doi.org/10.1007/s10393-017-1224-2	Small commercial broiler and layer farms within household premises. Purposive eight broiler and eight layer farms; seven feed vendors; 44 observations totaling 57 hours	Qualitative observational study; comparison across farm types and actors. Direct observations, maps, interviews and two group discussions	15/16 farms lacked complete fencing; people/animals crossed boundaries; untreated manure commonly sold or used	Small purposive sample; observed mechanisms cannot provide nationally representative adoption rates. Distinct commercial-farm investigation from the Rimi backyard-village reports

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Rimi et al. (2018) Bangladesh - One village each in Rajshahi and Chittagong districts Fieldwork June-August 2009 https://doi.org/10.1186/s12889-018-5819-5	Backyard poultry and local veterinary-care networks. Purposive interviews with 70 raisers, six local care providers and five government veterinary professionals	Qualitative care-seeking study; comparison among informant groups. In-depth/informal interviews, field notes and thematic analysis	60/70 raisers used local providers; ten used home remedies alone; none sought government veterinary care	Two accessible villages; care-seeking accounts are not estimates of statutory outbreak-reporting frequency. Same 2009 village research setting cited in Rimi et al. (2016); participant-level overlap not fully resolved
Sarkar et al. (2017) Bangladesh - Mohanganj, Netrokona, northeastern wetland region Fieldwork Winter 2011-2012 https://doi.org/10.1111/irv.12438	Nomadic duck flocks. 62 flocks; 1,860 egg-yolk and 496 fecal samples; flock-owner questionnaires	Cross-sectional serological and virological survey with husbandry assessment. H5 antibody ELISA on egg yolks; influenza-A fecal PCR; raising-practice questionnaire	58/62 flocks H5-antibody positive; 33/62 influenza-A-RNA positive; shared wetland and flock contacts documented	Single region/season; antibodies and RNA represent distinct endpoints and establish no transmission direction. No sample overlap established with other included reports
Shanta et al. (2017) Bangladesh - 115 rural villages sampled nationally Fieldwork 2009-2012; households followed for 2-12 months https://doi.org/10.1111/tbed.12536	Rural backyard poultry households. Probability-proportional-to-size village sampling; 2,489 primary poultry raisers	Longitudinal household study of poultry economics, nutrition and practices. Repeated household questionnaires and production/economic records; reported poultry-management practices	Poultry contributed 2.8% of net monthly household income; risky practices persisted despite advice	Self-report and economic valuation assumptions; no randomized communication comparator. No sample overlap established with other included reports
Sultana et al. (2012) Bangladesh - Two rural communities Fieldwork 2007-2008 https://doi.org/10.3855/jidc.2242	Household backyard poultry. 40 interviews, 40 household maps and 16 observations	Qualitative perceptions/practices study; no intervention comparator. Interviews, household mapping and direct observation	Recognition of bird-to-bird disease contrasted with weak zoonotic understanding; sick birds kept indoors or consumed/sold	Localized qualitative findings; disease episodes were not laboratory-confirmed avian influenza. Earlier formative work cited by subsequent Rimi studies; participant overlap not established
Jamtsho et al. (2020) Bhutan - Five southern districts Fieldwork November-December 2018 https://ojs.moal.gov.bt/index.php/bjas/article/view/308	Open-sided deep-litter semi-commercial/commercial farms with more than 200 birds. 96 purposively selected poultry-owning households	Cross-sectional farm biosecurity survey. Farmer interviews on infrastructure and operational practices	Footdips reported at 87/96 farms, perimeter fencing 30/96 and visitor records seven farms	Purposive sample; reported infrastructure does not establish use; fencing percentages inconsistent between abstract and table. Distinct production system and localities from Tenzin et al. (2017)

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Tenzin et al. (2017) Bhutan - 12 settlements in Thimphu city area Fieldwork April 2015, during HPAI outbreak response https://doi.org/10.1186/s12917-017-1033-4	Urban/peri-urban backyard poultry. 62 backyard poultry owners surveyed across the settlements	Cross-sectional outbreak-context biosecurity survey. Owner questionnaires on awareness, practices and contact with veterinary services	55 knew of local outbreak; 17 knew veterinary contact; 29 scattered feed and 33 used clean containers	Self-report during outbreak response; local sample and no infection-source attribution. No sample overlap established with other included reports
Samanta et al. (2015) India - Terai agroclimatic zone, West Bengal Fieldwork June-September 2013 https://doi.org/10.14202/vetworld.2015.177-182	Backyard Rhode Island Red laying chickens under semiscavenging management. 30 flock owners selected through local veterinarian in a receptive locality	Uncontrolled three-month pre/post biosecurity-package evaluation. Repeated farmer interviews and flock egg records after veterinary instruction	Mean eggs per flock over three months increased from 495.3 to 618.2	No concurrent control; maturation, reporting and other temporal effects; outcome is per flock, not hen-day productivity. No sample overlap established with other included reports
Gompo et al. (2020) Nepal - Kathmandu, Bhaktapur and Lalitpur districts Fieldwork Case registry March 2018-April 2019; exact subsequent interview dates not separately verified https://doi.org/10.1371/journal.pone.0223550	Poultry farms with clinical/diagnostic H9 surveillance. 50 PCR-confirmed H9 cases and 50 nearby PCR-negative controls matched on farm size	Retrospective case-control study. Laboratory records and 19-item structured farm-management/exposure interviews	Absent visitor-boot requirement associated with H9 case status: OR 4.32 (95% CI 1.52-12.29)	Diagnostic selection, retrospective recall and wide intervals; association does not isolate footwear efficacy. No sample overlap established with other publications retained before the cutoff
Lambrou et al. (2020) Nepal - Chitwan district Fieldwork 2018 https://doi.org/10.1016/j.onehlt.2020.100189	Registered commercial farms; predominantly layers and broilers, with one turkey farm. 150 farms: 149 chicken farms and one turkey farm	Cross-sectional KAP survey with recalled five-year outbreak history. Structured questionnaire; perceived reporting barriers and self-reported HPAI/LPAI history	Culling feared by 95/150; perceived absent compensation 83/150; reporting-knowledge gap 23/150	Overlapping reported barriers and recalled outbreaks; no laboratory-confirmed incidence estimate. No sample overlap established with other included reports
Neupane et al. (2012) Nepal - Three poultry-dense village-development committees, Rupandehi Fieldwork April 2009 https://doi.org/10.1186/1471-2334-12-76	Poultry farms registered as habitually housing more than 50 chickens; owners and paid workers. 30 randomly selected farms; 96 workers recruited within farms through proportional/snowball selection	Cross-sectional cluster survey. Face-to-face questionnaire; open recall of protective measures and reported frequency of precautions	Procedural knowledge and paid-worker status associated with more precautions; information exposure associated mainly with knowledge	Self-reported behavior and cross-sectional temporal ambiguity; purposive district and committee selection. No sample overlap established with other included reports

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Shrestha et al. (2016) Nepal - Kamalamai Municipality, Sindhuli Fieldwork Not reported in full article; publication 2016 https://www.jnhrc.com.np/index.php/jnhrc/article/view/3969	Poultry farmworkers; production types not specified. 122 workers from 44 farms; lottery selection using district livestock-service list; target 132 workers	Cross-sectional knowledge and preventive-practice assessment; no intervention comparator. Face-to-face Nepali questionnaire; 23 knowledge and 18 practice items; some facility observation	93.4% had heard of avian influenza; handwashing reported much more after farm visits than before entry; protective clothing uncommon	Self-report, one municipality, variable item denominators; mean-split quadrants differ from fixed score categories; no infection endpoint. Distinct from Neupane et al. (2012) and Lambrou et al. (2020); possible earlier conference report not separately counted
Chaudhry et al. (2015) Pakistan - 16 Punjab districts and one administrative unit Fieldwork May 2009-January 2010 https://doi.org/10.1371/journal.pone.0119019	Commercial broiler and layer farms. 133 H9N2-confirmed case farms and 133 controls matched by month of laboratory sample submission	Retrospective matched case-control study. Laboratory isolation/subtyping and structured farm-owner/manager exposure questionnaire	Direct live-bird-market sales and several farm/contact variables associated with case status	Diagnostic-service sampling; clinically unaffected controls could have unrecognized infection; recall and residual confounding. Same research group as 2021 Lahore serosurvey; different production system and sampling design
Chaudhry et al. (2021) Pakistan - Lahore district Fieldwork July-August 2009 https://doi.org/10.3389/fvets.2021.631164	Unvaccinated backyard poultry. Cluster survey of 210 birds older than two months from 35 clusters	Cross-sectional serosurvey with farm-risk-factor analysis. Hemagglutination-inhibition serology for H5/H7/H9; management questionnaire	Proximity to poultry retail shops associated with overall AI seropositivity: OR 6.9 (95% CI 2.5-18.7)	Antibodies indicate past exposure; timing/source unresolved; association is not H9-specific and intervals are wide. Different sample from commercial case-control report by Chaudhry et al. (2015)
Kottawatta et al. (2017) Sri Lanka - Two semi-automated plants, four wet-market processing facilities and 37 retail shops; districts not specified Fieldwork October 2006-July 2007 https://doi.org/10.3390/foods6120105	Commercial broilers from open houses with deep litter; processing and retail interfaces. 127 flock batches: 102 at semi-automated plants, 25 at wet markets; 37 retail meat samples; 65 isolates characterized	Observational microbiological comparison; paired caecal/neck-skin sampling within flocks; no assigned intervention. Campylobacter culture; PCR species confirmation and antimicrobial MIC testing on isolate subset	Positive caeca in 86/127 flocks; neck-skin positives 28/102 versus 12/25 (p=.057); retail meat 22/37 positive	Nonrandom facilities, unequal pooling, old fieldwork; processing differences not statistically conclusive; no measured farmer-adoption effect. Farm-to-food-chain contextual evidence; no overlap established with other included studies
Wijesinghe et al. (2017) Sri Lanka - Central Province Fieldwork Not reported; publication April 2017 https://www.ijsrp.org/research-paper-0417/ijsrp-p6419.pdf	Medium-scale commercial broilers. 80 farms described as randomly selected; sampling frame and selection details not supplied	Cross-sectional questionnaire and performance comparison across existing biosecurity categories. Study-specific weighted 120-point conceptual, structural and operational assessment; production performance	56.25% graded average; 75% used all-in/all-out; catching age inversely associated with score, but mortality/FCR associations not significant	Sparse methods, score validation and performance-source details absent; unadjusted correlations; only one excellent farm; no causal effect established. Distinct Central Province survey; no cohort overlap established