Australian Government

Australian Centre for International Agricultural Research

Final report

project	**Improving milk supply, competitiveness and livelihoods of smallholder dairy chains in Indonesia (IndoDairy)**
project number	AGB/2012/099
date published	23/01/2023
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approved by	David Shearer
final report number	FR2023-005
ISBN	978-1-922787-33-0
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

Contents

Acknowledgments **10**

1 Executive summary **11**

2 Background **14**

3 Objectives **17**

4 Methodology **19**

4.1 Where was the work done? 19

4.2 Who was involved in the work? 22

4.3 How was the work done? 22

5 Achievements against activities and outputs/milestones **37**

6 Key results and discussion **51**

6.1 Objective 1 51

6.2 Objective 2 66

Objective 3 68

7 Impacts **84**

7.1 Scientific impacts – now and in 5 years 84

7.2 Capacity impacts – now and in 5 years 84

7.3 Community impacts – now and in 5 years 88

7.4 Communication and dissemination activities 95

8 Conclusions and recommendations **99**

8.1 Conclusions 99

8.2 Recommendations 102

8.3 References cited in report 103

8.4 List of publications produced by project 103

9 Appendixes **108**

9.1 Appendix 1: Summary of Project Variations and Personnel Changes 108

9.2 Appendix 2: List of IndoDairy training activities 111

9.3 Appendix 3: List of students involved in the IndoDairy research 114

List of tables

Table 1. Summary of value chain interviewees in West Java. 24
Table 2. Summary of value chain interviewees in North Sumatra..... 24
Table 3. Dairy farmer population in the study sites across West Java, Indonesia..... 30
Table 4. Sampling population in the study sites across West Java, Indonesia. 30
Table 5. Treatment of farmer groups for the feed dissemination led by ICARD 32
Table 6 Monthly average TPC at the KUD level January – May 2020. 64
Table 7. List of service provider workshops delivered under Objective 3..... 70
Table 8. Breakdown of male and female participants in the discussion groups across the five cooperatives. 71
Table 9. Focus farmer profile for Pak Ma'mur and Pak Yunus..... 79

List of figures

Figure 1. Dairy cattle population in Indonesia, 2000-2020. Data: Statistics Indonesia (2021). 14

Figure 2. Milk supply in Indonesia, comparing domestic supply and imported milk between 1990 and 2016. Data: Ministry of Agriculture 2019. 15

Figure 3. Milk production in 2020 by province. Data: Statistics Indonesia 2021. 20

Figure 4. Location of IndoDairy study sites. 21

Figure 5. IndoDairy study sites and collaborating KUDs in West Java, Indonesia. Membership numbers are from 2017. 21

Figure 6. Timeline of IndoDairy activities by objective. Coloured boxes represent major activities that spanned a significant period of time (e.g., weeks or months). 23

Figure 7. Women participants were learning about SURT mastitis testing at the milk quality and hygiene tranining, Hotel Seruni Bogor, 5 - 7 March 2020. (Photo: UoA/Jack Hetherington) 28

Figure 8. Participants during the workshop titled *"Introduction to Extension and Facilitation Techniques'* at Cinagara training centre, 4 to 5 March 2019. (Photo: UoA/Jack Hetherington) 33

Figure 9. Extension program design of discussion groups (DGs) and Focus Farm (FF) activities in West Java. 34

Figure 10. A timeline of the delivery of the discussion groups (DGs) and evaluation involving the base- and endline surveys for knowledge, attitude and practices (KAP), as well as planning and evaluation sessions. 35

Figure 11. Topics covered in the Discussion Groups. 35

Figure 12. Dairy value chain in West Java. 52

Figure 13. Left: Susu Mbok Darmi is a Bogor-based business selling dairy smoothies via roadside kiosks. Right: Momo milk is a dairy-themed restaurant in Bogor. (Photo: UoA/Jack Hetherington) 53

Figure 14. Dairy value chain in North Sumatra. 54

Figure 15. Value chain map for KPS Bogor farmers. 56

Figure 16. KPS Bogor relationship model 57

Figure 17. Value chain map for Nestlé, East Java. 58

Figure 18. Nestlé East Java relationship model. 59

Figure 19. Summary of farm-level results from the HACCP study. 61

Figure 20. Summary of KUD-level results from the HACCP study. 61

Figure 21. Left: Farmer milking in plastic bucket. Right: Milk at collection point, in a mix of stainless steel, aluminium and plastic delivery cans. (Photo: IPB) 62

Figure 22. Left: KUD collection truck utilising plastic drums to collect from farmers in Ciawi. Right: KUD collection truck made from stainless steel. 63

Figure 23. TPC levels and milk price at the KUD level. 64

Figure 24. Total plate counts (TPC) levels during the price incentive study. Individual farmer results are from random sampling of farmers during each time period. KUD TPC results was results from the milk processor and reflects all milk delivered to the KUD on each day. 65

Figure 25. Farmer participant of the WhatsApp Focus Group in Cisarua shared photos illustrating milk hygiene practices they continued to implement after the project activities. Left to right: (a) Wiping udder before milking; (b) using milk sieves; and (c) washing the shed before milking. 66

Figure 26. Summary of barriers to technology adoption for smallholder dairy farmers. ... 68

Figure 27. Summary of cluster analysis of farmers in the Indonesian Smallholder Household Survey (ISHS). 68

Figure 28. North Sumatra dairy service providers participating in the workshop from 20-23 January 2020. 71

Figure 29. Dairy reproduction workshop with Dr Phil Chamberlain in Bogor, April 2019.. 71

Figure 30. Farmer responses if they had participated in a DG previously and if they had made improvements as a result (n = 184). 72

Figure 31. Overall knowledge self-assessed knowledge change for all six discussion group meetings and all farmers (total of 926 farmer responses)..... 72

Figure 32. Change in knowledge on specific topics by the end of the study. Left chart shows the self-assessed knowledge change across topics presented in the DGs. The right chart shows specific increase in correct answers given to the quiz questions asked in the KAP surveys. 73

Figure 33. Change in farmers' attitudes towards teat dipping with iodine after milking (n = 184). * indicates significant difference ($p < 0.05$). 74

Figure 34. Proportion of farmers who intend to make changes to farming practices after participating in DG meeting (total of 926 farmer responses after 104 meetings). Left: Likelihood of changing practice as a result of recommendations during the meeting; Right: the timeframe intended to implement the change. 74

Figure 35. Change in adoption of eight farm practices for farmers involved in the DGs... 75

Figure 36. Adoption rates of technologies at the endline survey (2021). 76

Figure 37. The final evaluation session with DG in Cisarua, KUD Giri Tani with Rizky Febrianggia (VLR) facilitating. 76

Figure 38. Change in barriers to adoption facing farmers for the eight practices. 77

Figure 39. Focus Farmers Pak Ma'mur with wife Ibu Ening (left photo) and Pak Yunus with his family (right photo). 78

Figure 40. Left – Focus Farm Discussion group meeting at Pak Ma'mur's farm. Right – Ploughing the land at Pak Yunus's block prior to planting odot and elephant grass. 81

Figure 41. IndoDairy team during the field trip to Queenland's dairy industry in 2019. Back row: (from left) Dr. Endang Romjali (ICARD), Dr. Todd Sanderson (ACIAR), Ms. Zita Ritchie (UoA), Dr. Brad Granzin (ADC), Mr. Jack Hetherington (UoA), Mr. Rizky Febrianggia (VLR). Front row: Mr. Rio M Fauzan (VLR Team Leader), Ms. Attin Syahnurotin (VLR), Ms. Eulis Diah Sri Rahayu (VLR), Ms. Vyta W. Hanifah (ICATAD), Mr. Muhammad Fauzi (VLR). Photo: ACIAR/Patrick Cape. 85

Figure 42 Mr. Yan Yan and Mr. Ade, extension officers from KPBS Pangalengan. 87

Figure 43. Farmer group leader (right), Pak Dedi, receiving the milk quality award for the Ciharus farmer group from the KUD representative (left) in Cikajang, West Java. 88

Figure 44. Farmer case study from WFGDs..... 90

Figure 45. Example report provided to farmers during the price incentive study (translated to English). 96

Figure 46. VLRs sharing TPC reports to farmers during the price incentive study. 96

Figure 47. Farmer beneficiary (left) being presented an individual farm business report by an enumerator during the IndoDairy endline survey (December 2021)..... 97

Figure 48. Summary and timeline of IndoDairy project variations. 108

Figure 49. Summary and timeline personnel changes in the IndoDairy project. 109

List of report annexes

Annex 1 - Granzin B., Erwidodo & Hanifah V.W. (2020). 'Business Guidelines and Opportunities for Heifer Importation for Dairy Smallholders in Indonesia'. (in English and Indonesian)

Annex 2 - Daryanto A., Sahara, Erwidodo, Sinaga A.R., Probokawuryan M., Sagita S.D., Resti Y., Azijah Z., Sembada P. (2021). 'Policy Review of Dairy Industry in Indonesia.'

Annex 3 - Daryanto A., Sahara (2019). 'Dairy Value Chain in North Sumatera Province'

Annex 4 - Daryanto A., Sahara (2019). 'Dairy Value Chain in West Java Province'

Annex 5 - Watson G (2020). 'Identify and analyse inclusive business models (IBMs) between smallholder farmers and private companies'.

Annex 6 - 'Milk Quality Study Report'

Annex 7 - 'IndoDairy Smallholder Household Survey (ISHS) 'From Farm to Fact' series'. (English and Indonesian)

Annex 8 - Drysdale G. & Kenny S (2017) 'Review of Extension Methodologies'.

Annex 9 - Hanifah V.W. (2017). 'Literature Review of Dairy Extension in Indonesia'

Annex 10 - IndoDairy 'Essential Farming Facts''. Training factsheets, presentations and posters. (in English and Indonesian)

Annex 11 - Ritchie Z. (2020) 'IndoDairy Objective 3 Final Report'.

Annex 12 - CGFAR-UoA (2022), 'Impact Evaluation report'.

Annex 13 - ICASEPS (2021), 'Analysis of farmers' decision to exit dairy farming'

Annex 14 - Romjali E., Magriyanti T, Hanifah V.W., Talib C, Puastuti W, Herawati T. (2021). 'The Reproductive Performance of Dairy Cattle in Smallholder Farmers'. International Seminar on Livestock Production and Veterinary Technology, 6-7 September 2021, Indonesia.

Annex 15 - 'How to Establish A Focus Farm: A Hand-book' (in English and Indonesian)

Annex 16 - Daryanto A. & Sahara (2022). 'The Voice of Youth: The Future of the Dairy Industry in Indonesia'. IPB Press. ISBN: 978-623-256-962-1.

Annex 17 - Akzar R. (2021). 'Adoption of Multiple Dairy Farming Technologies – Issues and Opportunities for Smallholder Dairy Farmers in West Java, Indonesia'. Thesis for PhD, University of Adelaide. Supervisors: Umberger W.J. & Peralta A.

Annex 18 - Batubara D.K. (2018). 'Study of Dairy Cooperative Business Models in West Java, Indonesia'. Thesis for Masters of Global Food and Agricultural Business (MGFAB), University of Adelaide. Supervisors: Hetherington J.B. & Yargop R.

Annex 19 - Bramantyo Y.D. (2020). 'Characterisation of Women Empowerment in Agriculture in Smallholder Dairy Households in West Java, Indonesia'. Thesis for Masters of Global Food and Agricultural Business (MGFAB), University of Adelaide. Supervisors: Peralta A. & Hetherington J.B.

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
ADC	Australasian Dairy Consultants
AFC	age of first calving
AI	artificial insemination
ANOVA	Analysis of variance
AUD	Australian dollar
AUTS	*Asuransi Usaha Ternak Sapi* - Cattle Farming Insurance
BCS	body condition score
BW	body weight
Ca-FA	calcium fatty acid
CCP	critical control points
cfu	colony-farming unit
CGFAR	Centre for Global Food and Resources
CI	calving interval
Cimory	PT. Cisarua Mountain Dairy
CMT	California Mastitis Test
COVID-19	Coronavirus disease
CP	crude protein
DEDV	Department of Economic Development in Victoria
DG	Discussion Group
DGAIF	Directorate General of Agricultural Infrastructure and Facilities
DGLAHS	Directorate General of Livestock and Animal Health Services
EAWG	Extension Advisory Working Group
FF	Focus Farm
FFI	PT. Frisian Flag Indonesia
FMD	foot-and-mouth disease
GKSI	*Gabungan Koperasi Susu Indonesia* - Indonesian Association of Dairy Cooperatives
GoI	Government of Indonesia
HACCP	Hazard Analysis and Critical Control Points
HFIAS	Household Food Insecurity Access Scale
IAARD	Indonesian Agency for Agricultural Research and Development
IA-CEPA	Indonesia-Australia Comprehensive Economic Partnership Agreement
IBM	Inclusive Business Model
ICARD	Indonesian Center for Animal Research and Development
ICASEPS	Indonesian Center for Agricultural Socio Economic and Policy Studies
ICATAD	Indonesian Center for Agricultural Technology Assessment and Development
IDR	Indonesian Rupiah
IICC	IPB International Convention Centre
IPB	Bogor Agricultural University
ISHS	IndoDairy Smallholder Household Survey
JAF	John Allwright Fellowship
JICA	Japan International Cooperation Agency
Kalem	*kalsium lemak* - calcium salts of fatty acids
KAP	knowledge, attitude, and practice
KPI	key performance indicators
KUD	*Koperasi Unit Desa* - village-level cooperatives
KUPS	*Kredit Usaha Pembibitan Sapi* - Business Credit Schemes for Cow Breeding
KUR	*Kredit Usaha Rakyat* - People's Business Credit

MCP	milk collection point
MoA	Ministry of Agriculture
MPI	Milk Processing Industry
MWECP	Ministry of Women's Empowerment and Children Protection
ORID	Observational, Reflection, Interpretation and Decisional
PERPAMI	*Perhimpunan Peternak Muda Indonesia* – Indonesian Association of Young Livestock Farmers
PIMS	PT. Putra Indo Mandiri Sejahtera
ppm	parts-per million
PRD	Policy Roundtable Discussion
PT	*'Perseroan Terbatas'* – Limited Company
RD&E	research, development and extension
RPM	Research Program Manager
S/C	service per conception
SD	Standard deviation
SIKOMANDAN	*Sapi Kerbau Komoditas Andalan Negeri* - Buffalo Cattle Commodity Mainstay of the Country
SMARTD	Sustainable Management of Agricultural Research and Technology Dissemination
SNV	Netherlands Development Organisation
SRA	Small research and development activity
TPC	total plate count
UoA	University of Adelaide
VLR	Village Level Researcher
WDG	Women's Discussion Group
WEAI	Women's Empowerment in Agriculture Index
WFEA	Whole of Family Extension Approach
WFGD	WhatsApp Focus Group Discussions
WGAFFC	Working Group on Agriculture, Food and Forestry Cooperation
WUR	Wageningen University and Research

Acknowledgments

This report documents the results, outcomes and early-stage impacts of the Australian Centre for International Agricultural Research (ACIAR) funded project “AGB/2012/099: Improving milk supply, competitiveness and livelihoods of smallholder dairy chains in Indonesia”. The project team would like to acknowledge and express gratitude to the many individuals and groups that made this project possible.

The project’s successful completion would not be possible without the ongoing support from project partners namely: Bogor Agricultural University (IPB), the Indonesian Center for Agricultural Socio Economic and Policy Studies (ICASEPS), the Indonesian Center for Animal Research and Development (ICARD) and Australasian Dairy Consultants (ADC). In particular, the leadership from Prof. Arief Daryanto, Prof. Sahara (IPB), Prof. Erwidodo, Prof. Handewi Purwati, Dr. Wahida (ICASEPS), Prof. Atien Priyanti, Dr. Endang Romjali (ICARD), and Dr. Brad Granzin (ADC) is gratefully acknowledged.

The project team would like to express their gratitude to Ms. Vyta W. Hanifah and the Village Level Researchers, Mr. Rio M Fauzan, Ms. Attin Syahnurotin, Ms. Eulis Diah Sri Rahayu, Mr. Rizky Febrianggia and Mr. Muhammad Fauzi for their passion and dedication to the project.

Additionally, the project would not have been possible without the generous support, advice and input into project activities received from many dairy industry and government stakeholders.

Lastly, the project team would like to thank the smallholder farmers who gave up their time to participate in project surveys and interventions. The project would not have been possible without their valuable contributions and the feedback they shared with the project team. We hope that the project has improved the livelihoods of all members of these smallholder dairy farming households.

1 Executive summary

2.1 Background and project objectives

Increasing dairy production is a key priority of the Government of Indonesia, which aims to achieve 60% self-sufficiency in milk production by 2025. However, smallholder dairy farmers, which produce most of Indonesia's domestic milk production in the main dairy production region of West Java, face a multitude of constraints. These constraints limit on-farm efficiency, farm growth and profitability, as well as the quality, safety, and quantity of Indonesia's domestic supply of dairy products.

This project aimed to tackle some of growth-limiting issues facing Indonesia's smallholder dairy farming households. Whole-of-chain research and participatory development activities with key stakeholders in the value chain, including smallholder farmers, input suppliers, processors, and policy makers, were undertaken to address the following primary project objectives:

1. Identify and recommend strategies and policies to support development of sustainable and profitable smallholder-inclusive dairy supply chains in North Sumatra and West Java;
2. Identify barriers to adoption of profitable management practices and develop strategies to inform the development of extension programs in West Java and North Sumatra; and
3. Develop, pilot, and evaluate best-bet dissemination to improve adoption of innovative dairy management practices by smallholder farmers in West Java.

2.2 Main research findings

Whole-of-chain research activities conducted in the early stages of the project, including value chain analyses and a baseline survey of dairy farming households, revealed issues throughout the supply chain. The smallholder-dominated domestic dairy sector had very low economies of scale, and growth was impeded by limited forage availability, poor-quality inputs, low animal reproductive performance, poor mastitis management practices, and poor milk quality. Smallholder farmers' knowledge and skills in related technical areas were limited at the inception of the project. Business management skills were also lacking. Various socio-economic and agro-economic barriers appeared to contribute to low adoption of available knowledge and technology; and these barriers limited on-farm efficiency, farm growth and profitability.

Analysis of data from the baseline household study of 600 dairy farming households located in West Java revealed that smallholder dairy farmers were heterogeneous in their socioeconomic characteristics, and these characteristics uniquely influenced farmers' access to relevant services and technologies and their ability to adopt technologies and management practices. The unique needs of farmers identified in the baseline study and the value chain analysis was used to develop innovative development activities, including participatory extension approaches to drive on-farm practice change.

The innovative participatory extension approaches and inclusive value chain activities (e.g., incentives paid to smallholders to improve milk quality) undertaken as part of this project resulted in positive outcomes with respect to improvements in farmers' knowledge, attitudes, and adoption of relevant technologies and management practices. However, farmers' adoption of some technologies was hampered by poorly functioning institutions that limited farmers' access to information and to affordable technology and inputs.

Effective inclusive business models for the dairy industry require innovative models and collaboration in the value chain, ensuring benefits are shared among smallholder farmers, cooperatives, and milk processors. The research which explored existing smallholder-inclusive business models suggests that the Government of Indonesia should not hinder the development of large and mega dairy farms in Indonesia. Instead, they must consider

ways to support and facilitate the simultaneous development of smallholder, medium-scale, large-scale, and mega-dairy farms. Large-scale and mega-dairy farms must be directed outside Java, while small-scale and medium-scale farming can still be carried out in Java in suitable agro-ecological areas.

2.3 Achievements and impact

The project's impact study found that the project activities resulted in improvements in smallholder participants' awareness of and attitudes towards technologies and practices, and significant behaviour change in certain practices covered in the participatory extension programs. Participants in the project interventions (beneficiaries) were significantly more likely than non-beneficiaries to adopt teat dipping after milking (by 31%), mastitis testing (by 23%), and unlimited access to drinking water (by 17%). There was no statistical difference in the adoption of high protein concentrates, forage conservation and recording keeping; with participants reporting that cost, availability of inputs and complexity were their primary reasons for non-adoption. There appear to be persistent institutional barriers facing smallholder farmers with respect to adoption of other important technologies such high quality feed concentrates.

Although there was an overall decrease in milk productivity (due to external factors, partially because of the COVID-19 pandemic) for beneficiary and non-beneficiary farmers, beneficiaries were able to mitigate this to a greater extent. The multivariate analysis found beneficiaries had, on average, 1.24 litres per cow per day higher productivity (which represents 9% of the average milk productivity) compared to non-beneficiaries (p-value < 0.01). Stated differently, without the IndoDairy project interventions, the beneficiary group would have produced, on average, 1.24 litres per cow per day less milk. The higher milk productivity for beneficiaries translates to a tangible economic impact for smallholder farmers. An average of 1.24 litres more milk per cow per day translates to approximately 1,043 litres per farm per year, which represents IDR 6 million additional revenue per year (approximately AUD 599). This is a 6% increase relative to the average household's total income from the dairy enterprise.[1]

An interesting impact of the project activities is the significant increase found in women's involvement in dairy business decision-making. This is likely the result of the participatory extension approaches and the successful pilot of the Women's Discussion Group (WDG) in one of the study sites. The WDG approach has been adopted and implemented by two separate development programs funded by the Asia Development Bank and the Netherlands Development Agency, which are collectively targeting 2,000 women farmers in West Java. These programs employed the IndoDairy Village Level Researchers (VLRs) to deliver the training.

2.4 What needs to be done

Future work is needed to address the following issues and opportunities for the Indonesian smallholder dairy sector:

1. Improving smallholder farmers' access to consistently high-quality dairy feed inputs (forages and high protein concentrates). There are opportunities to develop small-to-medium sized enterprises focused on provision of high-quality feed inputs for smallholder dairy farmers. There is also a need for education, policy, and regulation to ensure feed quality.
2. Promoting and supporting participatory extension approaches, including gender-inclusive farmer discussion groups (e.g., women-led discussion groups) and focus farms, to enhance smallholder farmers' learning

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[1] Based on an average herd size of 2.8 cows, a 305-day lactation, average milk price IDR 5,771 per litre, and average milk production per cow 13.3 litres/cow/day.

experiences. The unique needs of farmers should be identified before developing extension activities. Extension and knowledge sharing activities should be "demand-driven" by the farmers and other key stakeholders (e.g., cooperatives and processors).

3. Investing in human and physical capital to improve access to milk quality testing to assess milk quality for individual farms and reduce information asymmetry in the supply chain. It is important that farmers receive information on their milk quality and information on how to address any quality issues. Premiums paid for higher quality milk can incentivise practice change and improve milk quality and hygiene.
4. Supporting dairy cooperatives, as the established primary input and service providers for smallholder dairy farmers, by improving their business, leadership, innovation, and entrepreneurship skills to overcome post-farm gate (e.g., institutional) barriers.
5. Promoting inclusive business models for dairy input and service provision. Inclusive business models could involve young entrepreneurs and partnerships with milk processing companies.
6. Regulations should be focused on promoting and supporting mutually beneficial multi-stakeholder partnerships, particularly between smallholders and milk processors, to increase productivity and improve the quality of fresh milk. Business models and partnerships which can achieve mutual benefits for both smallholder and mega-dairy farms should be encouraged.

While not a focus of the IndoDairy project, the 2022 outbreak (May 2022) of foot-and-mouth disease (FMD) in Java has significantly impacted smallholder dairy farmers in the region and poses a risk to Australia's biosecurity. ACIAR should consider urgent work to minimise the negative impacts of this outbreak.

The findings, resources, and stories from the IndoDairy project have been compiled and published online: https://www.adelaide.edu.au/global-food/research/international-development/indodairy

2 Background

Key issues leading to project conception

This project *"AGB/2012/099: Improving milk supply, competitiveness and livelihoods of smallholder dairy chains in Indonesia (IndoDairy)"* commenced in June 2016 after a lengthy development phase between 2012 and 2016. The development phase included an ACIAR-funded scoping study, which was conducted in 2012 (*AGB/2011/010)*. The scoping study identified a range of priority constraints that were limiting dairy productivity and profitability, including enterprise scale, access to critical inputs, herd nutrition, animal husbandry, reproductive performance, and low milk quality.

In 2013, the Government of Indonesia (GoI) set a goal of reaching 60% self-sufficiency in milk production by 2030. However, between 2012 and 2013 an estimated 40% of the nation's dairy herd was slaughtered due to high beef prices (Figure 1). Consequently, domestic dairy production decreased in the years to follow. Most of Indonesia's dairy farmers continue to be smallholders, and domestic supply of milk over the past 20 years has averaged less than 30% of total supply (Figure 2).

The high priority placed by the GoI on dairy industry development to address food security and alleviate poverty, and the key issues faced by the sector closely aligned with: (1) ACIAR's research priorities related to strengthening livestock management and marketing systems in Indonesia as well as improving smallholder access and competitiveness in rapidly transforming markets; (2) the Australia-Indonesia Working Group on Agriculture, Food and Forestry Cooperation (WGAFFC); (3) the priorities identified under the Indonesia-Australia Comprehensive Economic Partnership Agreement (IA-CEPA) related to research, development and capacity building; and (4) the 2014 Australian Aid Program performance targets of engaging the private sector, reducing poverty and empowering women and girls.

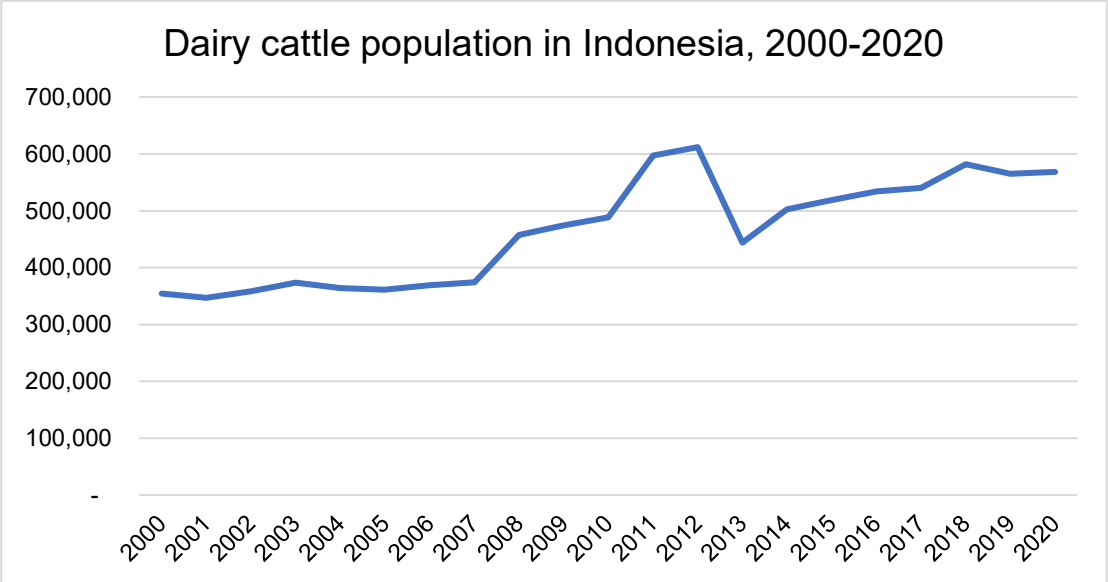


Figure 1. Dairy cattle population in Indonesia, 2000-2020. Data: Statistics Indonesia (2021).

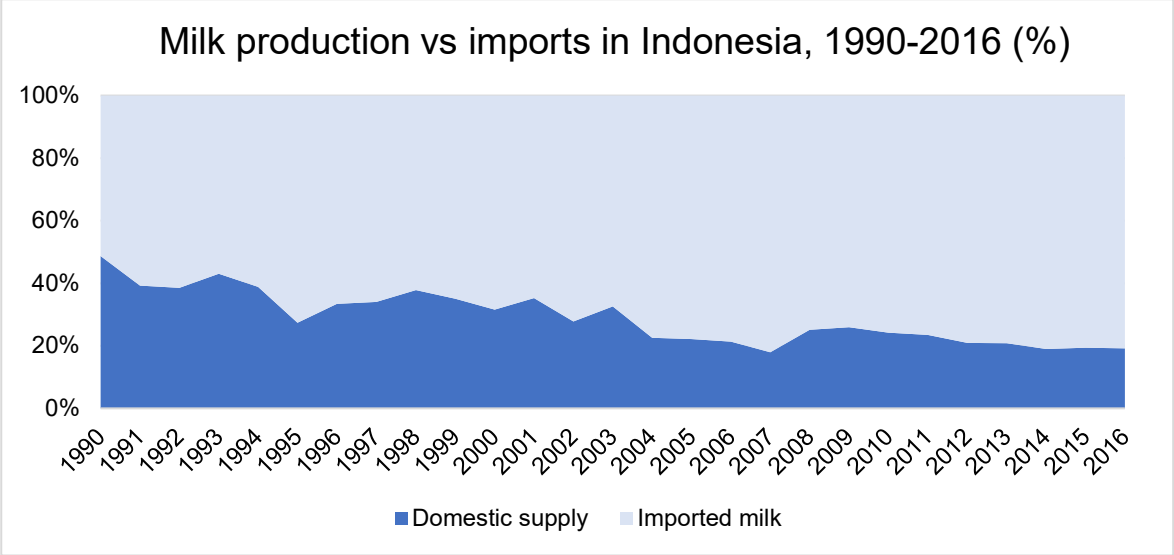


Figure 2. Milk supply in Indonesia, comparing domestic supply and imported milk between 1990 and 2016. Data: Ministry of Agriculture 2019.

Key issues the project addressed

This project aimed to understand and address the growth-limiting constraints faced by smallholder dairy farmers in West Java, including institutional, government, socio-economic, technical, and post-farm gate impediments. Value chain activities and baseline smallholder surveys were undertaken to better understand the key limiting factors and opportunities to address these factors.

Many on-farm technical and supply chain challenges were interrelated. Thus, an integrated whole-of-chain or system approach was taken when conducting the research and development activities, including capacity building activities. Issues and relationships affecting the entire dairy chain, including dairy farmers, traders, village-level cooperatives (’*Koperasi Unit Desa’* – KUD), processors, retailers, and consumers, as well as external factors affecting the dairy sector (e.g., incentive schemes, programs, policies, global markets) were considered.

Formation of the research collaboration team

Following the findings of the scoping study (AGB/2011/010), in late 2012, Agribusiness Research Program Manager (RPM), Dr. Rodd Dyer and ACIAR Indonesia Country Manager, Ms. Mirah Nuryati brought together a team of Australian and Indonesian researchers to form the IndoDairy research team.

From Australia:

- Professor Wendy Umberger, the Executive Director of the Centre for Global Food and Resources (CGFAR) at the University of Adelaide (UoA) with extensive experience in value chain and behavioural research led the project from inception in 2016 to its finish in 2022. Prof. Umberger originally agreed to lead the socioeconomic and value chain activities of the project with input from others in CGFAR-UoA, including other agricultural economists Dr. Risti Permani and Dr. Alexandra Peralta. However, after Dr. Brad Granzin (see below) changed roles in 2014, Prof. Umberger became the project leader.
- Dr. Brad Granzin, Australasian Dairy Consultants (ADC), is also the Executive Officer of Subtropical Dairy Ltd, the regional dairy programme of Dairy Australia responsible to delivering dairy research, development, and extension (RD&E) initiatives in Queensland and northern New South Wales. When the project was being initially developed, Dr. Granzin was the Director of the Dairy Services Branch in the Department of Economic Development in Victoria (DEDV). Dr.

Granzin was involved in the scoping study (AGB/2011/010) and was initially going to be the Project Leader. However, in May 2014 Dr. Granzin moved from DEDV to Subtropical Dairy Ltd, the regional programme of Dairy Australia. This change meant he was unable to be the Project Leader, but he remained involved in the project.

In Indonesia, three research agencies were identified as potential collaborators:

- Bogor Agricultural University (IPB) - Prof. Arief Daryanto, Dean of the Vocational School (formerly the Director of IPB's Business Management division), and Dr. Sahara, Head of School of Economics in the Faculty of Management and Economics, from IPB were identified to lead the value chain activities of the project. Both brought their extensive experience in agribusiness research and development, and experience working with the private sector, various government institutions including regional governments and had previously worked on ACIAR-funded project with CGFAR-UoA. Dr. Sahara is also a John Allwright Fellowship (JAF) alumni.
- The Indonesian Center for Agricultural Socio Economic and Policy Studies (ICASEPS), within the Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture was identified to lead the household survey objective. ICASEPS researchers have expertise not only in survey design and implementation but also data management and analysis and policy analysis and design. ICASEPS had worked closely over the past decade with CGFAR-UoA on ACIAR and other research for development projects. Dr. Wahida from ICASEPS is also a JAF alumni.
- The Indonesian Center for Animal Research and Development (ICARD) located in Bogor, which focused on animal production and veterinary medicine. ICARD's expertise included breeding, nutrition, reproduction, forages and socio-economic. ICARD had two Directors since the project's inception, Dr. Bess Tiesnamurti and later Prof. Atien Priyanti.

Between 2012 and 2016 multiple trips were undertaken by the project team to develop the project methodology and study sites. An additional small research and development activity (SRA) was commissioned to bridge the initial scoping study and the large project. This intermediary SRA was entitled *"AGB/2014/033: Supporting capacity building for research on improving market integration for dairy production systems in Indonesia*".

In June 2016, the project agreement was finalised and signed by ACIAR and UoA, but project activities were not able to commence due to a breakdown in government-to-government relations. The inception meeting was held on 17 November 2016 at the IPB International Convention Centre (IICC), in Bogor, West Java. Research activities were not allowed to commence until January 2017.

During the project's lifetime there have been significant changes to the project team and seven variations have been undertaken. A summary of these can be found in Appendix 1: Summary of Project Variations and Personnel Changes.

3 Objectives

Aim

The overall aim of this project was to increase milk supply (quantity and quality) by 25% and net-household incomes by 2021 for at least 3,000 dairy producers in West Java and North Sumatra, Indonesia.

Objectives

Objective 1: Identify and recommend strategies and policies to support development of sustainable, profitable, and smallholder-inclusive dairy supply chains in North Sumatra and West Java.

Research questions for Objective 1 included:

1. What market and investment opportunities are most likely to lead to the development of new and sustainable smallholder dairy supply chains in North Sumatra?
2. How can public and private partnerships be improved to enhance dairy development programs particularly with respect to increased live imports?
3. What are the practical policy lessons that can be derived from this research and how should stakeholders collaborate in ways that will benefit smallholders and increase spillovers?
4. What are the relative sources of bacterial contamination (total plate count, TPC) in smallholder dairy supply chains?
5. How do the critical control points (CCP) on smallholder farms compare to a commercial benchmark?
6. What are cost effective on-farm technology and practice change options to reducing microbial contamination in smallholder dairy chains in Indonesia?
7. What is the impact of timely feedback and price incentives on TPC levels and practice change of smallholder farmers?

Objective 2: Identify barriers to adoption of profitable management practices and develop strategies to inform development of extension programs in West Java and North Sumatra.

Research questions to be addressed for Objective 2 were:

1. How and why do rates of adoption of technology and management practices, herd health, input use, productivity and innovative marketing channels differ between farmer segments?
2. Are there farmer and farm household that help explain differences allowing more effective strategies and programs to be developed?
3. What are barriers to adoption and drivers of adoption of profitable management practices and technology?
4. What are the most effective “whole-of-chain” strategies for overcoming barriers to adoption of profitable technology and management practices?
5. How can public and private stakeholders be engaged and work together to implement these strategies?

Objective 3: Develop, pilot, and evaluate best-bet dissemination to improve adoption of innovative dairy management practices by smallholder farmers in West Java.

Research questions for Objective 3 were:

1. What are the most effective extension methods that will enable smallholders to:
    a. optimise feed resources and adopt improved feeding practices and nutrition;

   b. adopt profitable calf rearing and animal husbandry practices;
   c. improve milk quality;
   d. incorporate business management into farming decision making to improve profitability?
2. What technical support and training are a priority for smallholders when endowed with dairy cows by the provincial government or private sector programs?

4 Methodology

4.1 Where was the work done?

The IndoDairy project operated to varying extents in three provinces in Indonesia. However, the main project activities for all objectives were undertaken in West Java. Peripheral activities were conducted in North Sumatra and East Java.

West Java: As seen in Figure 3, milk production in Indonesia is highly concentrated on Java Island, which accounts for 99% of Indonesia's total national production (Statistics Indonesia, 2021). West Java accounts for 31% of total milk production.

Within West Java, sites across four districts were identified based on consultation with IndoDairy partner institutions, village-level cooperatives (*'Koperasi Unit Desa'* – KUD), key stakeholders including the private and public sector and leaders of other dairy development projects. Discussions with the KUD leaders and members included an assessment of:

- their interest and commitment to the goals, objectives and proposed activities of the IndoDairy project;
- their willingness to share information; and
- their willingness to consider changing practices (including pricing) to increase milk quantity and to improve milk quality.

Additionally, the project team considered the activities and outcomes of other development projects (both past and current) operating in the area and the likelihood of spillover effects to a significant number of farmers in the region.

Based on these assessment criteria, five project sites and KUDs were identified: KPS Bogor and KUD Giri Tani in Bogor District; KPS Cianjur Utara in Cianjur District; KPBS Pangalengan in Bandung District; and KPGS Cikajang in Garut. The location of these sites is illustrated in Figure 4 and Figure 5 (below).

North Sumatra: Due to increasing domestic demand for dairy products and growing input constraints, particularly the availability of land for grazing and forage (e.g., due to land use competition) on Java, the Government of Indonesia was especially interested in developing the dairy sector outside of Java. North Sumatra was the province selected by Indonesian project partner, ICARD, due to its proximity to feed inputs from palm oil plantations and access to both domestic and export markets. Scoping work by the project team identified that although land may be more available, a substantial investment in processing infrastructure, supply chain logistics, farmer education and supporting agribusinesses and service providers were needed. Furthermore, there were few smallholders with dairy cows. Therefore, the activities in North Sumatra were primarily limited to value chain analysis and capacity building.

East Java: As part of the activities undertaken to address Objective 1, the project team reviewed established successful smallholder inclusive value chains in East Java, including PT. Nestlé Indonesia (Nestlé) and PT. Greenfields Indonesia (Greenfields). This analysis aimed to understand success factors in existing smallholder inclusive value chains and how these could be built upon.

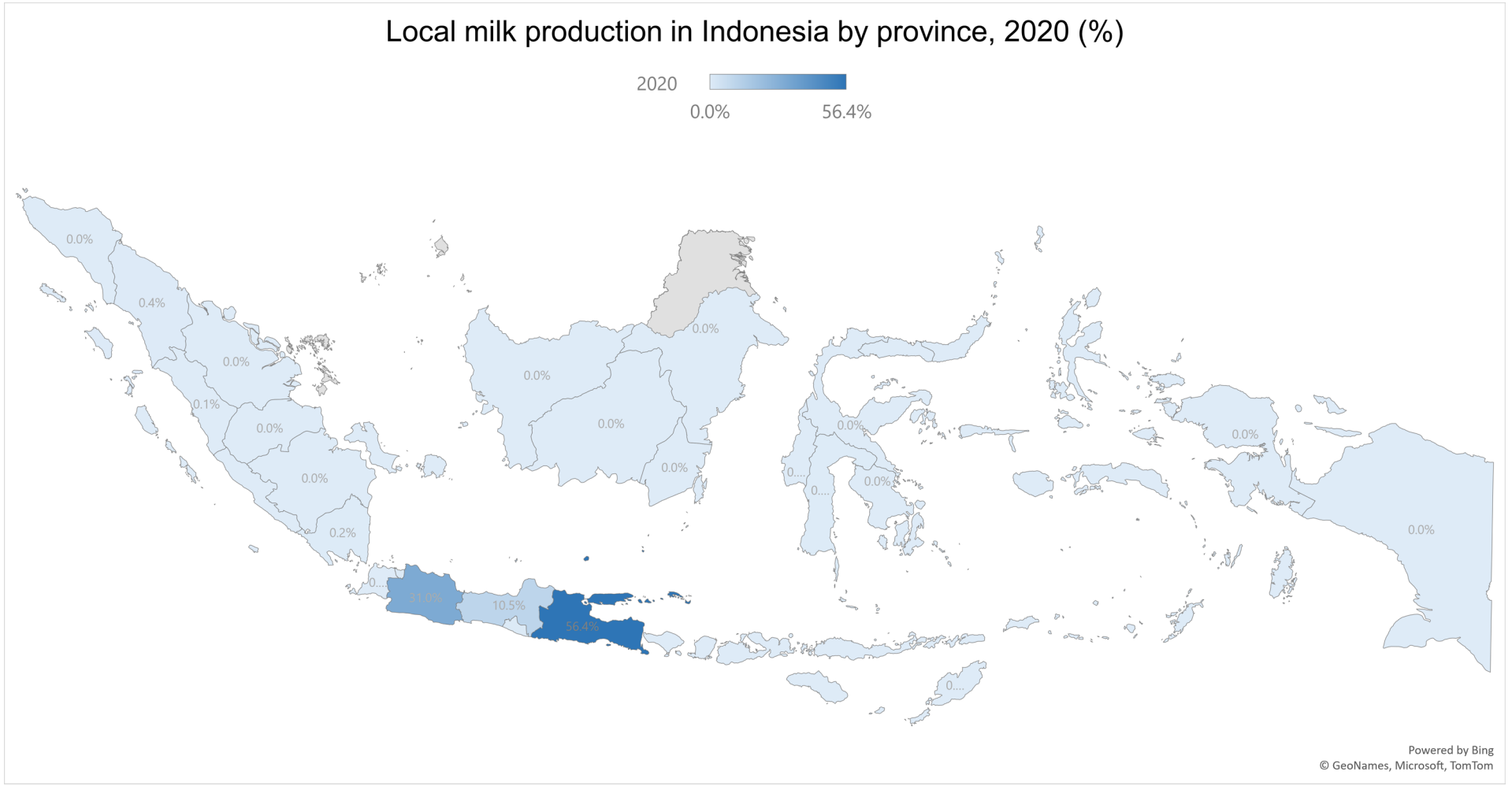


Figure 3. Milk production in 2020 by province. Data: Statistics Indonesia 2021.

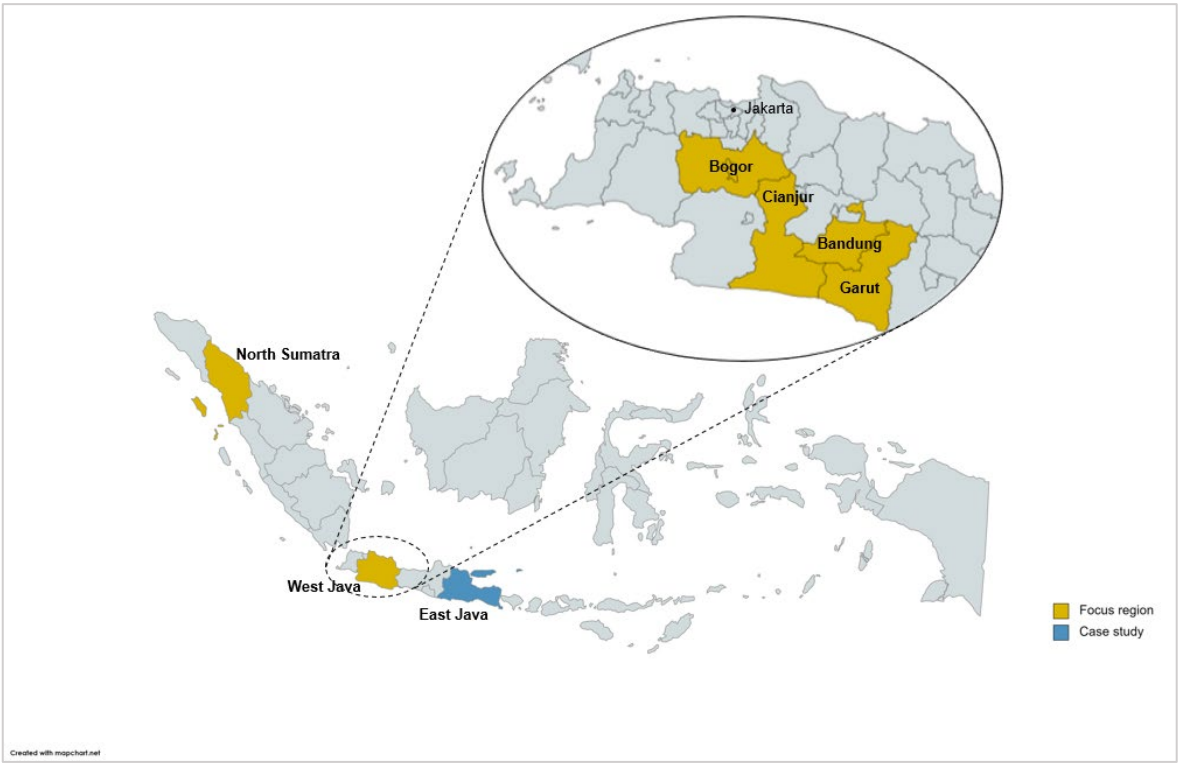


Figure 4. Location of IndoDairy study sites.

Figure 5. IndoDairy study sites and collaborating KUDs in West Java, Indonesia. Membership numbers are from 2017.

4.2 Who was involved in the work?

The project was co-designed with Australian and Indonesian project collaborators. Regarding the Indonesian partners, activities were broadly allocated among the three collaborating institutions and participation was based on the expertise of individuals.

Leadership and management

The Commissioned Organisation was the CGFAR-UoA, led by Prof. Wendy Umberger with Project Coordinator, Mr. Jack Hetherington. The project objectives were broadly allocated to lead Australian and Indonesian counterparts.

Objective 1

IPB, Prof. Arief Daryanto and Dr. Sahara were Indonesian co-leads for Objective 1 which examined the value chain and policy issues. Ms. Vyta W. Hanifah, ICATAD and Prof. Erwidodo, ICASEPS assisted with Activity 1.1. Prof. Erwidodo, also contributed to the review of government regulations affecting the dairy sector (Activity 1.3), given his expertise in trade and regulation.

Australian lead: CGFAR-UoA worked closely with IPB on all Objective 1 activities. Dr. Granzin led the activity and reporting regarding heifer importation (Activity 1.1).

Objective 2

Together CGFAR-UoA and ICASEPS co-led Objective 2. ICARD and IPB also contributed to the design of the survey tool used for the baseline survey. All project team members contributed to Activity 2.2. which involved using information gained through Objective 1 activities and Activity 2.1 to identify profitable management practices, business models and extension strategies to implement as part of the activities for Objective 3.

Objective 3

Dr. Granzin (ADC) led the Objective 3 extension activities with extensive input from Ms. Vyta W. Hanifah (ICATAD), Ms. Zita Ritchie, and the five Village Level Researchers (VLRs). ICARD led the feed technology research (Activity 3.2).

4.3 How was the work done?

Research methods and activities were developed around the three core objectives described above. A timeline of the main activities, by objective, is illustrated in Figure 6 (below). The orange-shaded areas illustrate the confounding circumstances which affected the project team's ability to conduct research. These included: (1) government-to-government communication issues which, at the critical early stages of the project prevented initiation of the project activities; and (2) the Coronavirus disease (COVID-19) pandemic and associated international and local restrictions in the final stages of the projects. In response to these events, ACIAR approved multiple variations to the project proposal. As mentioned previously, a summary of the variations can be found in Appendix 1: Summary of Project Variations and Personnel Changes.

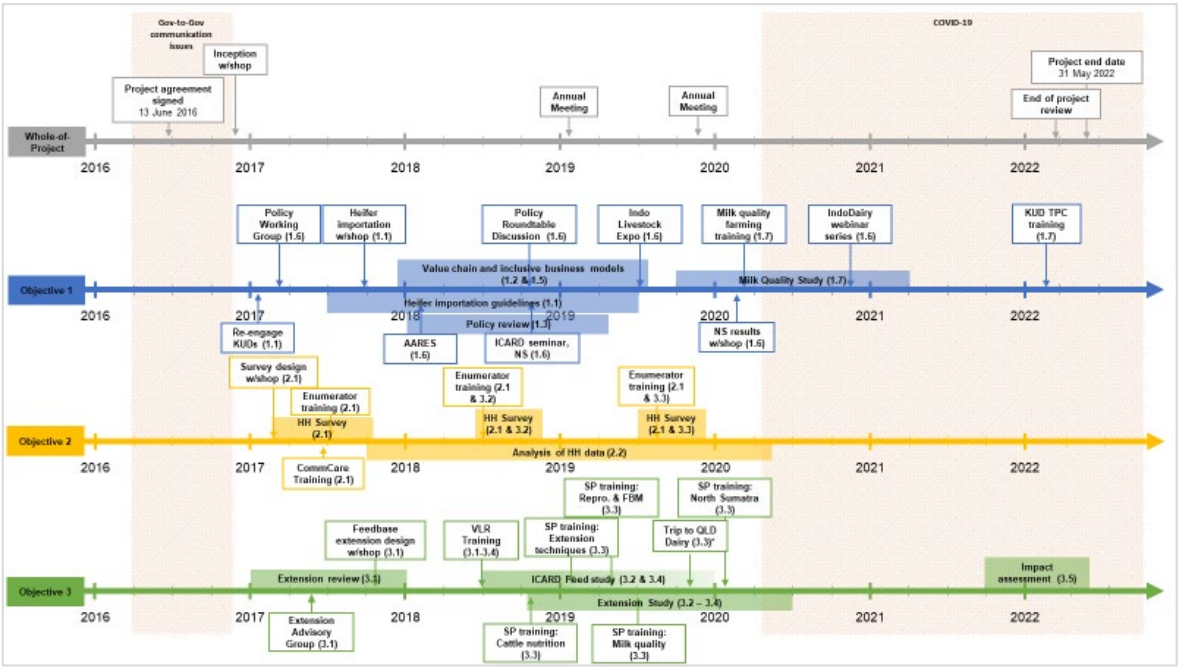


Figure 6. Timeline of IndoDairy activities by objective. Coloured boxes represent major activities that spanned a significant period of time (e.g., weeks or months).

4.3.1 Objective 1: To identify and recommend strategies and policies to support development of sustainable, profitable, and smallholder-inclusive dairy supply chains in North Sumatra and West Java.

Activity 1.1. Development and annual review of business guidelines and opportunities for heifer importation from Australia to Indonesia.

Increasing the size of the North Sumatran and West Javan dairy herds through importing heifers and new genetics was of interest to the Indonesian government partner institute, ICARD. The provision of capital to purchase imported heifers was outside the scope of the project, however, the project developed guidelines to facilitate public-private partnerships to create opportunities to import Australian dairy heifers to Indonesia.

To address this activity, a meeting was held in Bogor with stakeholders and investors interested in dairy herd expansion in Indonesia. This meeting identified barriers to importation of heifers and/or semen including relative policies and disease issues. Other topics discussed included quantitative indices of genetic merit suitable for Indonesian conditions and opportunities to improve the performance of the existing Indonesian dairy herd. The outcomes from this meeting, plus information gained from desktop research and further interviews conducted by the project team, resulted in a report: "*Business Guidelines and Opportunities for Heifer Importation from Australia to Indonesia*". This was reviewed and updated in the second half of the project and shared with stakeholders.

Sub-activity 1.1.1. This sub-activity was formally approved as part of Variation 1 (June 2017). At a project planning meeting in August 2016, it was determined that an additional sub-activity was required to re-engage partners due to the inability to do in-country research and engage with Indonesian stakeholders because of the government-to-government communication breakdown. Additional funds were approved by ACIAR to support the travel costs and consultancy fees for a small research team (Dr. Granzin and an Indonesia-based industry consultant) to re-engage with processors, KUDs and the Government. As a result of the meetings the project scope was updated.

Activity 1.2. A whole-of-chain analysis of the North Sumatra and West Java dairy industries

The project aimed to provide information on programs, policies and innovative institutions that could help smallholder farmers increase their productivity and profitability, without sacrificing the efficiency and competitiveness of the dairy supply or value chains they participated in. Therefore, a whole-of-chain approach was required. Whole-of-chain analyses of the West Javan and North Sumatran dairy sectors were conducted through in-depth and semi-structured interviews with economic agents in the supply chains. Interviews were conducted with input suppliers, farmers, KUDs, processors and retailers. Additionally, enablers and regulators of smallholder inclusive Indonesian dairy value chains were also interviewed. The number of interviews with each value chain actor are summarised in Table 1 and Table 2 below.

West Java

Table 1. Summary of value chain interviewees in West Java.

Value chain segment/actor	Number interviewed
Input suppliers	2
Cooperatives (KUDs)	5
Milk Processors	4
Milk processors and retailers	2
Retailers	2
Modern retailers	1
National dairy cooperative association	1
Total	**17**

North Sumatra

Table 2. Summary of value chain interviewees in North Sumatra.

Value chain segment/actor	Number interviewed
Local government units (Dinas Pertanakan)	3
Farmers/farmer group	5
Ex-dairy farmer	1
Importer/Distributor	1
Retailers	2
Total	**12**

Activity 1.3. Evaluation of regional dairy industry development policies in North Sumatra and West Java

A review of relevant policies and regulations affecting the domestic dairy industry was undertaken by Prof. Daryanto (IPB) and Prof. Erwidodo (ICASEPS). The review considered both domestic (local, regional, and national) and international policies and regulations which can affect the following:

i) dairy inputs;
ii) prices of domestic and imported dairy products;
iii) investments in the domestic industry, including both small-scale and large scale and foreign investment;
iv) access to credit for key players in the dairy industry (smallholders, processors etc);
v) importation regulation of live dairy cattle, semen etc.; and
vi) importation of dairy products

The findings from the review, in addition to other findings from the IndoDairy project, were communicated to policymakers and industry representatives through a Policy Roundtable Discussion (PRD) held in Bogor in October 2018.

Activity 1.4. Identify existing and future market opportunities for the North Sumatra dairy sector

As part of drawing a comprehensive picture of the North Sumatran dairy industry, the project assessed existing market dynamics and future market opportunities for the North Sumatra dairy sector. Using secondary data, historical milk demand patterns were analysed using appropriate time series econometric methods. As part of the value chain research activities in Activity 1.2, farm-gate, wholesale and retail market issues and opportunities related to milk quantity, quality, and safety, were identified through in-depth interviews. Activity 1.5. Identify whole-of-chain opportunities for industry and government in North Sumatra and West Java.

This activity used information and data from Activities 1.2 to 1.4 to investigate options to promote improved economies of scale and efficiency in the smallholder dairy production sector. Consideration was given to innovative farmer organisations, alternative business models, industry restructuring, structural re-adjustment, and various policy approaches to develop opportunities for smallholders.

A key part of the analysis in Activity 1.5 was to identify farmers with high propensities to become commercial and market-orientated and circumstances under which these farmers will be able to improve their farm production including support from the Government, for example, in the form of credit and improved access to inputs, training and development to improve adoption of technologies and management practices; institutional changes, milk and input quality and safety standard. Additionally, opportunities for the private sector to engage and support smallholders were considered.

Sub-activity 1.5.1. Identify and analyse inclusive business models (IBMs) between smallholder farmers and private companies

This sub-activity was added as part of Variation 2 (June 2018) and utilised outputs from Activities 1.2, 1.3 and 1.4. Mr. Guy Watson was recommended by ACIAR Agribusiness RPM Dr. Rodd Dyer to lead this analysis.

Field trips were undertaken (by Mr. Watson and members of the IPB research team) in September and November 2018 to further analyse the commercial relations between existing operators in the dairy value chains, and specifically smallholder farmers. Interviews with private sector leaders, KUDs and farmer group leaders conducted during the field trips identified successful relationships between the players, explored reasons for success, and explored and identified prospective business relations in both the West Java and East Java dairy industry.

The research team considered how existing smallholder inclusive business models could provide entry points for greater inclusion of women in the value chains, greater equity for farmers, and fairer distribution of equity and value through the entire value chain. By identifying these key drivers, the research framed an analysis of key opportunities and barriers for expansion and scaling of the models. Current thinking on inclusive business models was integrated to further identify opportunities for improving commercial arrangements and potentially informing policy outcomes.

Activity 1.6. Encourage development, policy dialogue and industry advocacy in ways that benefit smallholder dairy farmers and improve research capacity of lead agencies

To enhance awareness, engagement and input of stakeholders, the project delivered several strategic activities. Focus group discussions were organised in early stages of the

project to design a smallholder household survey (Objective 2) and to identify main issues in the dairy industry in North Sumatra and West Java.

The project hosted multiple policy dialogues and workshops (led by IPB), which included industry and stakeholders from multiple government portfolios, including the Ministries of Coordinating Economics Affairs, Agriculture, Trade and Cooperatives. Additionally, the project was represented at different industry forums, for instance the Indo Livestock Expo.

Capacity development was a significant focus of IndoDairy, including for research capability. The project engaged in several seminars, forums and conferences which provided the opportunity to disseminate project findings and provide opportunities for Indonesian and Australian researchers to present their findings. Multiple training activities and workshops were designed and implemented to develop the skills of researchers and service providers in Indonesia. These are detailed in Section 10.2: List of publications produced by project and Appendix 2: List of IndoDairy training activities. Training topics included:

1. Survey sampling, implementation, digital data collection app (CommCare) and analysis software.
2. Technical dairy and management topics, including advanced nutrition, animal husbandry and reproduction, milk quality and hygiene and farm business management.
3. Extension program design and facilitation
4. Scientific writing

In October 2019, seven Indonesian and three Australian project personnel participated in an IndoDairy funded field trip to better understand Queensland's dairy industry. This included visits to the Atherton Tablelands near Cairns, and Toowoomba and Malanda outside of Brisbane. The trip program was developed and led by Dr. Granzin and coincided with the Subtropical Dairy annual conference. The program included multiple farm visits and interactions with innovative dairy farmers and researchers from the University of Queensland. Additional funding was approved by ACIAR through the Launch Funding grants program.

To maintain regular contacts with key stakeholders and inform the progress of the projects, the project set up a website[2], Facebook page[3] and undertook various social media activities (e.g., Twitter) to disseminate project updates and resources. Project planning meetings were held regularly. Additionally, regular communications and coordination was achieved through regular travel of Australian Project Coordinator Mr. Jack Hetherington to each of the Indonesian study sites.

Activity 1.7. Design, implement and evaluate a value chain approach to improving on-farm hygiene practices (TPC) leading to improved milk quality and food safety

This activity was formally added during Variation 4 (approved in October 2019).

The first study used a Hazard Analysis and Critical Control Points (HACCP) approach from farm to the point of delivery at the milk processing factory (more details under sub-activity 1.7.1). These results were to be compared to a local commercial operation (1.7.2). and recommendations were to be made regarding investment opportunities (e.g., technology or training programs) to best target breakdowns in hygiene integrity along the chain (1.7.3). The second study (under 1.7.4) was a controlled trial to examine the provision of timely total plate count (TPC) results and price incentives on a per farm basis

[2] *https://www.indodairy.net (the information and resources from the project website were migrated to https://www.adelaide.edu.au/global-food/research/international-development/indodairy at the completion of the project).*
[3] *https://www.facebook.com/indodairy*

to drive farmer behaviour change, ultimately, to reduce microbial contamination and proliferation of microbes along smallholder dairy chains.

These new activities were implemented between January 2020 and June 2021 and delivered in partnership with the local milk processing and retail company, PT Cisarua Mountain Dairy (Cimory) and their dairy cooperative supplier, KUD Giri Tani, which are both located near Bogor, West Java. As part of this activity the project provisioned equipment to allow TPC inoculation at the KUD's collection facility. Due to the COVID-19 pandemic, the activities were amended – relevant changes are discussed below.

Sub-activity 1.7.1. To identify the sources of microbial contamination (TPC) within a representative smallholder dairy supply chain (farm to processing plant) in West Java, and to assess their relative contribution to overall milk quality

A systematic HACCP approach was used to collect milk and environmental samples at critical control points along the supply chain. This included sampling water used for cleaning milking equipment, milking equipment and milk from the udder. Milk samples were as it was delivered to the KUD and to the point of delivery at the milk processing factory. Milk and environmental samples were analysed to determine TPC. Temperature and time lapse were also recorded at key points through the supply chain.

Sub-activity 1.7.2. Compare smallholder on-farm results to a best practice, commercial (large scale) dairy farm supplying to premium markets (e.g. short-life dairy products)

Findings from Sub-activity 1.7.1 were intended to be compared to a local benchmark; a commercial dairy operation in West Java where best management practices with regards to milk hygiene were employed. However, this sub-activity was disrupted and ultimately prevented due to COVID-19 restrictions which prevented travel in the region.

Cimory's commercial dairy farm agreed to allow sampling of their operation, which was undertaken in February 2020. However, initial results were inconclusive. The team made an appointment to resample the farm but with the increasing risk associated with COVID-19 in March 2020, this was put on hold until it was safe to proceed and Cimory would allow access to external personnel. Once the price incentive study (Activity 1.7.4) was underway in early 2021, the team made plans to resample Cimory's farm in the second half of its implementation. However, an outbreak within the study site meant the field activities ceased.

Ultimately the IPB and UoA collaborators decided the potential benefits gained from this activity did not outweigh the risks (health, financial, and reputational). Therefore, it was decided that this activity would not proceed and used the information gained from Sub-activity 1.7.1 to provide recommendations.

Sub-activity 1.7.3. To recommend opportunities for investments in supply chain technologies and on-farm practice change to reduce microbial contamination

Based on the outcomes from 1.7.1, recommendations regarding options for government and industry to target investment to reduce the presence of microbes in milk were made. These included technological investments downstream, on-farm demonstrations and interventions, and training programs for farmers and cooperative staff. The recommended farm practice changes were incorporated into the training program delivered under sub-activity 1.7.4.

Sub-activity 1.7.4. Evaluate farm-level TPC information feedback and price incentives on milk quality as drivers of practice change to improve milk quality

Using KUD Giri Tani and its member farmer as a case study, the team designed and implemented a milk price incentive program to improve information feedback and price incentives to improve milk quality.

A day-long workshop was delivered to 70 participants (42 men and 28 women) over three days (5-7 March 2020) in Hotel Seruni, Cisarua, Bogor District. Participants were farmers and KUD staff. The training was delivered by dairy experts Ms. Denise Burrell and Ms. Zita Ritchie with support from Ms. Vyta W. Hanifah (ICATAD), Ms. Yuni Resti (IPB), and Dr. Pria Sembada (IPB).

The theme of the training was “milk quality and hygiene”, with topics on milk quality, specifically: (i) factors impacting milk quality on farm, including environmental, animal, human and transportation, and storage aspects; (ii) critical control points for milk quality on-farm; (iii) best practice actions to enhance milk quality; (iv) and mastitis. Before and after the training, farmers were asked pre-training and post-training questions, respectively, that assessed their knowledge about milk quality and hygiene. This aims to measure the improvement of farmers’ knowledge after the training.

Figure 7. Women participants were learning about SURT mastitis testing at the milk quality and hygiene training, Hotel Seruni Bogor, 5 - 7 March 2020. (Photo: UoA/Jack Hetherington)

A total of 66 dairy farming households that were members of KUD Giri Tani took part in the study which was conducted in February 2021. Following consultation with the Indonesian research counterparts, the KUD board and farmers, the team decided not to conduct a randomised allocation of treatment effects (e.g., ‘incentives’ versus ‘no incentives’ farmers) as originally planned. It was determined that randomised allocation might cause conflict between farmers in the same village. The approach outlined below ensured all farmers were given an equal opportunity to participate and to benefit from the study.

Before the study began, each farmer’s milk quality was sampled to establish a baseline of TPC. The TPC samplings were collected for individual farmers at the milk collection point before their milk was transferred to the KUD truck for storage and transport. Farmers were also interviewed to capture information on the practices they implemented, especially practices that related to improve milk hygiene practices. Beside TPC at the individual farm, the study also was able to get information on the TPC of the KUD at various locations- the tests were conducted by Cimory.

The milk price incentives were given to smallholder farmers in two periods. The first period was during 1-15 February 2021 and the second period was two weeks later, between16-28 February 2021. In each period, farmers’ milk TPC were tested at-random once per payment cycle. The TPC was tested after morning milking at the milk collection point before it was transferred to the KUD trucks – this was the same approach used during the baseline. Incentives were given once per payment cycle, where farmers were paid a bonus for all the milk that they delivered to the KUD during the payment cycle.

In between payment cycles 1 and 2, farmers were given individual reports that contained information regarding the milk grade (based on the total TPC), total milk they delivered, and the total price incentives that they received. The individual reports also provided suggestions to the farmers on the practices that they needed to change to improve their milk quality in the second cycle.

This study was originally planned to be undertaken in the first part of 2020. However, due to the impact of COVID-19 and subsequent travel restrictions for Australian and Indonesian counterparts, this activity was postponed until February 2021.

4.3.2 Objective 2: Identify barriers to adoption of profitable management practices and farm business models and develop strategies to inform development of extension programs in West Java and North Sumatra.

Activity 2.1. Develop, conduct, and analyse a baseline formal survey of a representative sample of dairy farming households in West Java and North Sumatra.

During the scoping study it is was noted that despite significant extension dissemination programs multiple potentially productivity- and profitability- enhancing technologies and management practices were not being implemented by smallholder farmers. Therefore, under Objective 2 the project aimed to understand barriers to adoption and implementation and opportunities to change behaviour. The primary activity which aimed to address this objective was the design, implementation, and analysis of a detailed structured household survey. This survey was called the IndoDairy Smallholder Household Survey (ISHS).

Survey tool

After extensive interviews with key stakeholders in the dairy sector, including national and local government, universities, milk processing companies, and dairy co-operatives, the ISHS was designed to collect a wide range of useful information from dairy farming households. The information allowed the research team (and interested stakeholders) to understand the current socio-demographic and farm characteristics of dairy farming households in West Java as well as issues affecting and limiting smallholder profitability and opportunities to improve smallholder livelihoods. The survey included 20 sections, collecting information on the following:

- Household characteristics of dairy farmers
- Information on livestock and land assets
- Individual animal information
- Management of dairy farm animals
- Access to credit
- Information on inputs and labour
- Costs and expenses of managing dairy farm operations
- Information on household income
- Information on milk production
- Sales and marketing information
- Information on adoption of dairy farming technologies
- Group membership of dairy farmers
- Farmers' attitudes and perceptions
- Information on role of women by using the 'Women's Empowerment in Agriculture Index' (WEAI)
- Information on household food security by using the 'Household Food Insecurity Access Scale' (HFIAS)

Sampling

A purposive proportional random sampling method was developed and utilised to identify the sample of 600 smallholder dairy farmers.

The identification of the sample consisted of the following stages:

1. The five dairy cooperatives who were key collaborators on the project were contacted and a list of active farmers with each cooperative (KUD) was shared.
2. The active member farmers became the study's population for sampling.
3. A proportional sampling method was used to determine the number of farmers that were interviewed from each KUD.
4. The farmers (including a back-up list) were randomly selected using simple random sampling tools (Microsoft Excel).
5. Lists of farmers from the random sampling results were sent to the KUD to confirm the current status of the farmers (active or not active).
6. If the farmers were found to be inactive, the farmers were replaced by taking respondents from a back-up list.

This sampling design method ensured that our survey sample was representative of the population of smallholder dairy farmers in West Java. Table 3 presents the sampling distribution of the ISHS.

Table 3. Dairy farmer population in the study sites across West Java, Indonesia.

District	Farmers population	Percentage (%)	No. of respondents (estimated)*	Backup 10%
Pangalengan	2,860	62.13	373	37
Garut	1,268	27.55	165	17
Cianjur Utara	170	3.69	22	2
Bogor	305	6.63	40	4
Total	**4,603**	**100.00**	**600**	**60**

**Note: the number of respondents is calculated by multiplying the percentage by 600.*

The farmer population column in Table 3 is the number of total farmers (KUD members) provided by the KUD. Some cooperative members were still listed as an active member even if they no longer sold milk to the KUD – for example, members who still had loans with the cooperative. Given the number of respondents for Cianjur and Bogor was relatively small, both districts were assigned a minimum threshold of 80 farmers to survey to ensure a significant sample size for analysis. Therefore, the final sampling distribution was determined by the minimum threshold of 80 households from each district (see Table 4 below).

Table 4. Sampling population in the study sites across West Java, Indonesia.

District	Farmers population	Percentage (%)	No. of respondents (actual)*	Backup 10%
Pangalengan	2,860	50.00	300	30
Garut	1,268	23.33	140	14
Cianjur Utara	170	13.33	80	8
Bogor	305	13.33	80	8
Total	4,603	100.00	600	60

**Note: the number of respondents is calculated by assigning the minimum threshold of 80 respondents per district and readjusting remaining available number for the remaining districts.*

Implementation

To improve the efficiency and quality of data collection the project digitised the survey using CommCare, a mobile-based application, allowing data to be input and monitored in

near real time. The IndoDairy project brought in the technical expertise of Oikoi, a Research for Development Support Company, to build and refine the digital survey application to ensure a smooth implementation of the study.

The data was collected during the months of August-September 2017 by an experienced team of enumerators that were all fluent in Bahasa Indonesia. The enumerators visited selected households and administered the survey under the supervision of researchers from ICASEPS. The enumerators had prior experience in conducting agricultural household surveys, including prior surveys with the ICASEPS and CGFAR-UoA team.

Activity 2.2. Identify profitable management practices, business, and extension models, and use this information to develop strategies that will increase on-farm profitability.

The research team, including members from all Indonesian and Australian institutions analysed the data from Activity 2.1 and from the focus groups and semi-structured interviews with the members of the dairy supply chain and stakeholders (Activities 1.2-1.4). Additional information on the analyses of data for these activities is provided in the Appendix.

Information gained on the following topics was used to develop the practice change strategies for Activity 3.1:

- Differences in input use, technology, knowledge, marketing channels, household characteristics and perception of adoption of profitable management and technology between farmer segments;
- Differences in access to government support after adjusting for farm size, age, education, the role of local institutions and social structure, and other factors;
- Differences in drivers and barriers to adoption of profitable management and technology and drivers or key determinants of these differences; and
- Changes in production systems and farmers' welfare over the project period.

4.3.3 Objective 3: Develop, pilot, and evaluate best-bet dissemination to improve adoption of innovative dairy management practices by smallholder farmers in West Java.

The training programs that were part of Objective 3 were developed to not only increase the technology adoption uptake but also remove barriers to adoption, particularly the ones that could be practically addressed at the farm household and KUD levels. In some cases, more complex strategies to remove barriers to adoption were determined to be needed. For example, to address lack of credit markets, involvement of the government agencies and private financial institutions is required. This was beyond the scope of this project and is an opportunity for future research and development activities.

Activity 3.1. Co-design an integrated dissemination program through training and focus farms, with extension staff, service providers and the private sector across the technical areas of nutrition and forage management, animal husbandry and reproduction, milk quality, and business management.

As part of the design under Activity 3.1, a review of extension methodologies was completed in Year 1, to explore and analyse a range of information sources culminating in the identification of best-bet extension methodologies for the project. This review can be found in Annex 9.

Activity 3.2. Application of feed technology through focus farms and implementation of training on feed, milking and reproduction management, animal house and animal health.

This activity, led by ICARD aimed to introduce improved feed technologies, including 16% crude protein (CP) concentrate and Kalem (*kalsium lemak* - calcium salts of fatty acids) to farmers, and to measure changes in adoption of these technologies. A total of 90 farmers were purposively selected across five KUDs in West Java (18 farmers in each district) including KPBS Pangalengan, KPGS Garut, Giri Tani Cisarua, KPS Cianjur and KPS Bogor.

Farmers in each region were divided into three groups of six farmers, of which three different treatments were applied. These included: 1) Group 1 – provided with 16% CP concentrate, technical mentoring (training workshops and one to one visits) and subsidised building materials for improving feed and drinking troughs; 2) Group 2 - provided only with technological assistance and 3) Group 3 - no treatment or technology support was provided.

Criteria for selecting farmers was a maximum milking herd size of 4 cows, milk production of less than 13 litres/cow/day, willingness to adopt new technologies and farm access during the treatment period.

Table 5. Treatment of farmer groups for the feed dissemination led by ICARD

Group 1	Group 2	Group 3
• Supplementation of 16% CP concentrate and Kalem • Training and 1:1 visits • Ad libitum drinking water system	• Training and 1:1 visits	• No treatment support or training provided

The introduction of the feed technologies was carried out between August 2018 and January 2019. A total of 86 head of cattle across the five KUDs were given the concentrate feed treatment. Supplementation of Kalem was also given to cows in Group 1. Feeding of Kalem was provided for 1 month before and after calving. The introduction of an *ad libitum* drinking water system was also established as a pilot for each farmer in Group 1. Training for farmers was carried out across the five KUDs for Group 1 and Group 2 farmers as part of the technology assistance, which included feed, reproduction, milk management, livestock housing, and animal health. Supporting one-to-one visits were also provided to Group 1 and 2 farmers.

Data collected during this activity was daily milk production, milk composition, indicators of subclinical mastitis infection (for individual cows), reproduction, feeding, temperature and humidity, and socio-economic parameters. Data was collected by Village Level Researchers (discussed in more depth below) for Group 1 farmers twice per month and once per month for Groups 2 and 3.

Activity 3.3. Pilot and evaluate dissemination programs with researchers, extension staff and dairy service providers in West Java.

This activity evaluated the impacts of extension methodologies in Indonesia which have been previously found to result in practice change in countries with more developed dairy sectors such as Australia and New Zealand. Several activities were delivered under Activity 3.3 between January 2019 to April 2020 (year 4). These activities were a mix of methods including developing technical resources, dairy service provider training, discussion groups (DGs) and a Focus Farm (FF) pilot targeting farmers in West Java. The aim of these activities was to build knowledge and skills of farmers across the four main technical areas to facilitate practice change on farm and adoption of improved practices. More specifically, the FF approach aimed to demonstrate practice change under real farming conditions for individual farmers.

1. Development of technical resources

A number of technical resources were developed to support the delivery of extension activities in Years 3 and 4 (2019 to 2020). These resources aimed to complement face-to-face learnings in the field and included technical factsheets, an IndoDairy website, social media uploads, videos, factsheets, newsletters, and posters.

2. Service Provider training

Service provider training was delivered over a 12-month period to build the capacity of advisors and milk cooperative staff in the regions in the four main technical areas. A group of approximately 20 Indonesian advisors were trained intensively in:

i) Feed management and nutrition;
ii) Animal reproduction and calf rearing;
iii) Milk quality and hygiene;
iv) Farm business management.

Before commencing delivery of DGs and FFs, a training workshop on extension and facilitation techniques was delivered to a core group of service providers including cooperative extension staff, Village Level Researchers (VLRs), and researchers from ICARD and IPB to enable them to effectively support extension activities. The techniques on adult learning and group facilitation were critical to support delivery of the DGs and FFs, with oversight by the senior IndoDairy project team. Overall, the full complement of training contributed to the development of a network of skilled dairy service providers in West Java who are enabled to continue to support farmers in their regions.

Additionally, an intensive week-long training was also delivered to 20 service providers (provincial government extension staff and researchers) in Medan, North Sumatra addressing the four technical areas of feeding and nutrition, reproduction and husbandry, milk quality and hygiene and farm business management.

Figure 8. Participants during the workshop titled *"Introduction to Extension and Facilitation Techniques'* at Cinagara training centre, 4 to 5 March 2019. (Photo: UoA/Jack Hetherington)

3. Discussion groups

Across the five regions, 13 discussion groups (DGs) were established involving a total of 184 farmers from beginning to end (with 12 to 16 participating farmers in each group) (Figure 9). This also included a women's discussion group (WDG) in Cijeruk, Bogor. Each

DG had a planning session to prioritise six technical topics of most interest to them to review during meetings over 10 months. A VLR (facilitator) and KUD extension staff supported each DG. Across all 13 DGs, 104 meetings were delivered with a total attendance for the six meetings of 926 farmer participations (i.e. one farmer participating multiple times). The average attendance for each farmer was 5.3 meetings.

Resources to support the delivery of the DGs included factsheets covering technical disciplines and a farm technology package, including a paddle tray (used for testing sub-clinical mastitis), teat dipping cups and iodine, microfiber towel, cattle weight tape, and a farm business recording book and calculator. This technology package was provided *in lieu* of any cash incentives for participants as a strategy to ensure greater sustainability after the project completion, rather than creating a dependency on cash incentives.

There was a final review session to evaluate and provide feedback for each of the groups. Farmer's knowledge, practices and attitudes were surveyed before participating in the DGs and after they were completed in March 2020.

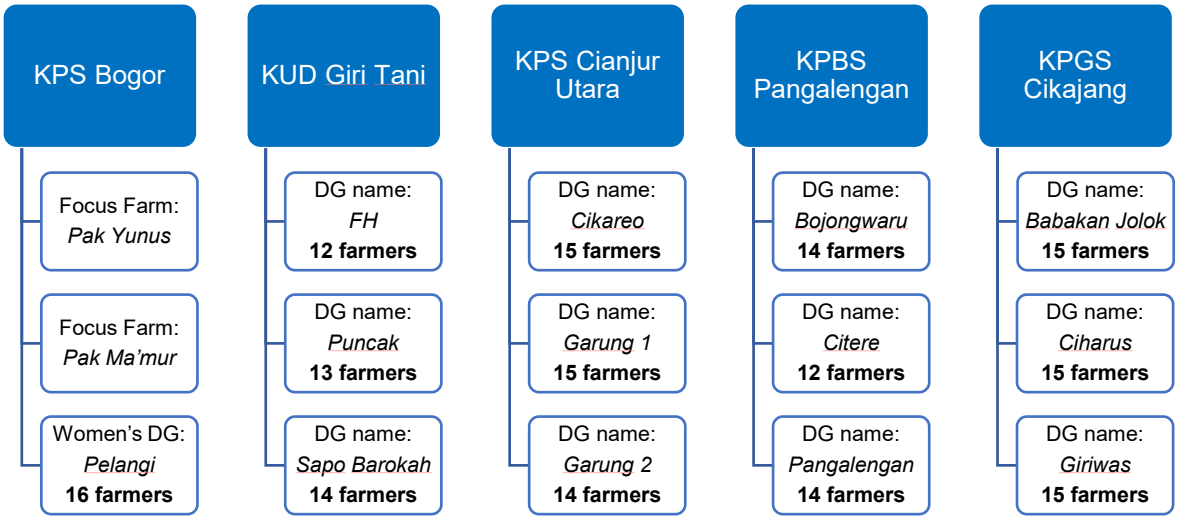


Figure 9. Extension program design of discussion groups (DGs) and Focus Farm (FF) activities in West Java.

4. Focus Farm

Focus Farms (FFs) were piloted for the first time as an extension activity in West Java. An FF is a farmer who has specific goals and aspirations to improve the production and profitability of their farm. Over a 12-month period, the FF was supported by a group of advisors and farmers during regular meetings. The goals of the farmer were prioritised, and activities were trialled or discussed throughout the meetings to help reach their goals with the support of the facilitator. Two FFs were established in Cijeruk, Bogor. Farmers were selected based on their willingness and desire to improve their farm, be open to providing their farm financial data and sharing their learnings with the advisory group. Some of the impacts of the FFs are shared in the results section below. More information can be found on the project website about each farmer, Pak Ma'mur[4] and Pak Yunus[5], and later in this report (pages 66-68).

[4] Focus Farmer Pak Ma'mur summary: https://www.adelaide.edu.au/global-food/news/list/2020/04/05/focus-farmer-pak-mamur
[5] Focus Farmer Pak Yunus summary: https://www.adelaide.edu.au/global-food/news/list/2020/04/01/focus-farmer-pak-yunus

Activity 3.4. Embed, monitor and evaluate the practice change activities delivered in 3.2 and 3.3.

A variety of monitoring and evaluation methods were used to measure changes in knowledge and attitudes of participating farmers and capture any on-farm changes as well wider impacts in the farming community.

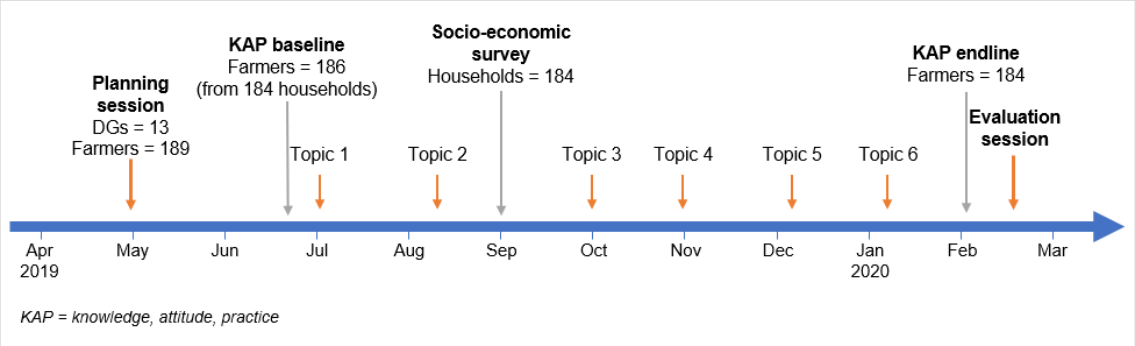


Figure 10. A timeline of the delivery of the discussion groups (DGs) and evaluation involving the base- and endline surveys for knowledge, attitude, and practices (KAP), as well as planning and evaluation sessions.

Evaluation methods for the DGs included:

1. A knowledge, attitude, and practice (KAP) survey was repeated at the start and completion of training with 184 farmers in July 2019 and February 2020 to assess changes in knowledge, attitudes, and practices, as well as barriers to adoption.
2. After each DG session, participants were asked to fill out questionnaires for self-assessment of changes in knowledge, attitudes, and intentions to change with respect to the technical topics covered in the session.
3. The Observational, Reflection, Interpretation and Decisional (ORID) technique was used with farmer groups to capture changes in their knowledge and intentions.
4. A case study approach to understand drivers of change for selected farmers who had initiated changes on farm, resulting in changes in milk yield or quality.

For the DGs, assessments were made relating to the change in a core set of knowledge of disciplines, attitudes, practices, and barriers to adoption. The technical focus and practices included:

Dairy Feed & Nutrition	Husbandry & Calf Management	Milk Quality & Hygiene	Farm Business Management
1. *Ad libitum* water	4. Feeding colostrum	6. Teat dipping	8. Record keeping
2. 16% CP concentrate	5. *Ad libitum* feeding to calves	7. Washing milk equipment	
3. Conserving forages			

Figure 11. Topics covered in the Discussion Groups.

For the two FFs, farm business data was collected for 8 months to train participants in farm business analysis and to capture changes in farm profit during the activity.

Activity 3.5. Assess the short-run and potential long-run impacts of project activities through a follow up survey during the final phase of the project.

At the end of the project period in July to October 2022, a formal follow-up survey was implemented to evaluate the short run impacts of the project activities (i.e., milk quality training and SCC testing) and to predict potential long-run impacts of the project activities. Data analysed was from a 480-household panel dataset (2017 and 2021) and WhatsApp Focus Group Discussions (WFGDs) where farmer participants were able to share their feedback, including with photos and videos. While the project activities covered a wide

range of practices and technologies, there were six technologies that were consistently covered across all groups: two milk hygiene practices (teat dipping after milking, mastitis testing); three dairy nutrition practices (high protein concentrates, forage conservation, and ad libitum drinking water availability); and one business management practice (record keeping).

As with sub-activity 1.7.4, the endline survey was originally scheduled to be conducted in 2020 but was postponed due to COVID-19 travel restrictions for Australian and Indonesian counterparts. This activity was conducted once COVID-19 travel restrictions eased and the incentive study (sub-activity 1.7.4) had concluded. This activity was implemented in December 2021 and 480 of the dairy farming households were surveyed. Data cleaning and analysis was conducted in 2022. The WFGDs were conducted in June 2020, as means of collecting interim information about the project impacts. Further details about the methodology of the endline survey and WFGDs can be found in Annex 12.

During the planning and implementation of the endline survey, a high level of attrition in the smallholder dairy industry in West Java was revealed. Interestingly, approximately 30% of farmers that had been surveyed as part of Activity 2.1 in 2017 had subsequently ceased their dairy operation. ICASEPS conducted the targeted survey with a subset of the original households to understand the reasons why they had discontinued dairy farming Annex 13.

5 Achievements against activities and outputs/milestones

Objective 1: To identify and recommend strategies and policies to support development of sustainable, profitable, and smallholder-inclusive dairy supply chains in North Sumatra and West Java.

No	Activity	Outputs/ milestones	Completion date	Comments
1.1	Development and annual review of business guidelines and opportunities for heifer importation from Australia to Indonesia.	Guidelines for sustainable public private joint ventures for dairy heifer importation and reviewed annually.	Dec 2019 (Y4 M6)	**Completed – Year 4 (2019/20)** A workshop was hosted on 28 September 2017 bring together government and industry stakeholders to understand the issues and opportunities related to heifer importation. Further review of policies and opportunities was led by Dr. Brad Granzin and supported by Prof. Erwidodo and Ms. Vyta W Hanifah. The report, titled "Business Guidelines and Opportunities for Heifer Importation for Dairy Smallholders in Indonesia", was first published in July 2018. It was later reviewed and re-published in June 2020. These are available in English and Bahasa Indonesia (see Annex 1). There were delays in receiving necessary information from Indonesian government officials in the second version which caused a delay in finalising the updated report.
	Sub-activity 1.1.1. re-engagement of partners, including processors, KUDs and government to update scope of activities.	A completed trip report	Jan 2017 (Y1 M7)	**Completed – Year 1 (2016/17)** A group of Australia and Indonesia team members conducted multiple field trips in January 2017 to meet and engage with KUDs, government and industry stakeholders.

1.2	A whole-of-chain analysis of the North Sumatra and West Java dairy industries Sub activities included: Development of a tablet-based application using CommCare software to collect baseline and monitoring data at the household level. Farmer survey in North Sumatra Value chain analysis in North Sumatra and West Java including semi-structured interviews and focus group meetings with processors, retailers, cooperatives (in West Java), and other relevant bodies.	Data set on farmers' production practices based on purposive sampling in North Sumatra. A tablet-based application was used by research team for data collection for the baseline survey and ongoing monitoring Data sets and notes of results of interviews and focus group discussions with cooperatives (in West Java), processors and retailers in West Java and North Sumatra. Detailed report highlighting the key findings from dairy value chain analysis in North Sumatra and West Java. The report will address research questions posed under Objective 1 including market and investment opportunities which will lead to new and sustainable smallholder dairy supply chains.	Dec 2018 (Y3 M6) for North Sumatra and West Java	**Completed - Year 2 (2017/18)** 29 semi-structured interviews were conducted with dairy value chain actors in West Java and North Sumatra between January and May 2018, with a focus group discussion held on 1 May 2018 in Medan. A tablet-based application was developed for North Sumatra farmers using CommCare. However, during scoping of the study, the nascent nature of smallholder dairy farming in North Sumatra meant that it was more appropriate to conduct semi-structured interviews. CommCare applications have been used in the baseline survey (Activity 2.1) and monitoring and evaluation of extension activities (Activity 3.3). Interview recordings were transcribed and translated.

1.3	Evaluation of regional dairy industry development policies in North Sumatra and West Java	Information and data from government agencies on existing dairy industry development programs. Detailed report on the effectiveness of regional dairy industry development policies and strategies to improve public and private partnerships to enhance dairy development programs.	Jun 2019 (Y3 M12) for North Sumatra and West Java	**Completed – Year 3 (2018/19)** IPB and ICASEPS led the review of relevant policies and regulations affecting the domestic dairy industry with reference to North Sumatra and West Java. The review considers both domestic (local and national) and international policies and regulations which effect the following: I. Dairy inputs II. Price of domestic and imported dairy products III. Investments in the domestic industry, including both small-scale and large scale and domestic foreign investment. IV. Access to credit for key players in the dairy industry (smallholders, processors etc) V. Importation regulation of live dairy cattle, semen etc. VI. Importation of dairy products This was first completed in 2019, and later updated in 2022. See Annex 2 for the review of Indonesian dairy policy review.
1.4	Identification of existing and future market opportunities for the North Sumatra dairy sector	Report on existing market dynamics and future opportunities for the dairy sector in North Sumatra.	Dec 2019 (Y4 M6)	**Completed in Year 3 (2018/19)** Prof. Arief Daryanto and Dr. Sahara (IPB) prepared a report outlining opportunities for developing the North Sumatran dairy sector. The report is available in Annex 3.
1.5	Identification of whole-of-chain opportunities for industry and government in North Sumatra and West Java	Report and/or chapter on whole-of-chain opportunities for industry and government in North Sumatra and West Java including options to promote improved economies of scale and efficiency in the smallholder-dominant dairy production sector. These may include changes in farmer organisation, industry restructuring and structural re-adjustment approaches	May 2020 (Y4 M11) for both North Sumatra and West Java	**Completed in Year 3 (2018/19)** Prof. Daryanto and Dr. Sahara (IPB) prepared reports outlining opportunities for developing the dairy sector in North Sumatra and West Java are available in Annex 3 and Annex 4, respectively.

	Sub-activity 1.5.1. Identification and analysis of inclusive business models (IBMs) between smallholder farmers and private companies	Report on inclusive business models outlining feasible partnership options between smallholder dairy farmers and private companies (such as milk processors) that will improve milk production (quantity and quality) and maintain the commercial viability of smallholder dairy farming. This report will also include recommendations for improving engagement of women in smallholder dairy enterprises and pathways to scale-up and scale-out inclusive business models	Oct 2019 (Y4 M4)	**Completed – Year 4 (2019/20)** Two trips were conducted by Mr. Guy Watson, Mr. Jack Hetherington and the IPB team (in September and November 2018), building on the value chain study in West Java (Activity 1.2), to better understand existing partnership models in place between the private sector and smallholder farmers and the policy environment. The trip in September 2018 included consultation with KUDs in Cijeruk and Pangalengan, and small to medium processes / retailers (Susu Mbok Darmi and Rumah Kopi Ranin). In November 2018, the team met with milk processors (Cimory in West Java and Nestlé and Greenfields in East Java) and a medium to large dairy farmer in Bogor. The analysis of Inclusive Business Models (IBMs), led by Business Analyst Consultant Mr. Guy Watson, and was finalised in June 2020. The report can be found in Annex 5. There were delays in receiving the report outputs from the sub-contractor for this activity.
1.6	Encourage development, policy dialogue and industry advocacy in ways that benefit smallholder dairy farmers and improve research capacity of lead agencies	1.6.1. Participation and contribution of local researchers	Jun 2021 (Y5 M12)	**Completed – Year 5 (2020/21)** Indonesian researchers fully participated in planning, implementation, and analysis of all activities. This was achieved through regular communication and face-to-face meetings. Ongoing reviewal and updating of the project plan was achieved during annual planning meetings with strong representation of from Indonesian counterparts.
		1.6.2. Conference papers prepared by Indonesian researchers;	Jun 2021 (Y5 M12)	**Completed – Year 5 (2020/21)** In total, 9 Indonesian researchers were lead authors/presenters at conferences and other journal publications. Many more presentations and technical reports have been (co-) authored by Indonesian collaborators and students (see publication list in Section 8.4). Prof. Daryanto and Dr. Sahara from the IPB team published a book titled 'The Voice of Youth: The Future of Dairy Industry in Indonesia' in 2022, which included 44 articles written by young Indonesian students, researchers and professions (between 15 and 34 years old). The topics covered value chain, blockchain, and partnerships; certification, food safety, and challenges in the industry; and policies and prospects of dairy industry development in Indonesia. The book was launched at the End of Project Review in April 2022.
		1.6.3. Report on inception workshop	Jun 2017 (Y1 M12)	**Completed - Year 1 (2016/17)** The Inception workshop was held on 17 November 2016 in the IPB International Convention Centre (IICC), Bogor Indonesia.

		1.6.4. Report on Annual workshop – Year 1 (e.g., survey design training);	Dec 2016 (Y1 M6)	**Completed - Year 1 (2016/17)** Survey design and sampling methodology workshops were conducted between 22 to 24 February 2017 with all collaborators. This was delayed to due to project collaborators able to coordinate the survey activities amidst the government-to-government issues.
		1.6.5. Report on Annual Workshop – Year 2 (e.g., statistical analysis training);	Jun 2018 (Y2 M12)	**Completed – Year 3 (2018/19)** Multiple meetings and workshops were held with collaborators, including ICASEPS, ICARD and IPB researchers, between Year 2 and 4 to discuss and progress and train in data analysis. Additionally, Mr. Hetherington delivered a training session on the open-source statistical program 'R' in Year 3 to 100 students and researchers at IPB.
		1.6.6. Report on result dissemination workshop in North Sumatra and West Java	Jun 2020 (Y4 M12)	**Completed – Year 4 (2019/20)** IndoDairy results were shared during multiple workshops, forums and seminars. These include: 1. Ms. Hanifah and Mr. Hetherington presented results at the International Seminary on Livestock and Veterinary Technology in Medan, North Sumatra (16 to 18 October 2018). 2. the Indo Livestock Expo in Surabaya (3 to 5 July 2019). 3. A project-hosted workshop was held on 12 March 2020 in Medan, North Sumatra by IPB. 4. Results from the Objective 3 extension activities were disseminated to dairy service providers and researchers in North Sumatra (between 20 and 23 January 2020) and West Java (over the course of the extension activities, through multiple meetings with the KUD). This was aided by the communications material prepared by the Village Level Researchers (VLRs), Ms. Hanifah, Ms. Zita Ritchie, and Mr. Hetherington. 5. Multiple webinars were hosted in 2020 by the IndoDairy project. Additionally, IndoDairy team members were invited to present in IndoDairy research in multiple webinars.

		1.6.7. Report on final workshop	Jun 2021 (Y5 M12)	**1.6.7. Completed** An End of Project Review workshop was completed on 28 March and 21 April 2022 (virtually). The delay was to accommodate the collation, cleaning and initial analysis of the endline survey, however, this was further delayed due to COVID-19 and then Foot and Mouth Disease and data analysis continued throughout 2022. All presentations were pre-recorded and made available prior to the workshop day, which focused on discussion. External reviewers were Mr. Teddy Kristedi (ARP-PRISMA Program Manager) and Dr David McGill (University of Melbourne and Project Leader for the Pakistan dairy-beef project).
1.7	Design, implement and evaluate a value chain approach to improving on-farm hygiene practices (TPC) leading to improved milk quality and food safety	1.7.1. HACCP Study implemented conducted in smallholder dairy chain in West Java.	Jun 2020 (Y5 M12)	**1.6.6. Completed – Year 4 (2019/20)** 1.7.1. The HACCP Study was implemented between January and March 2020. This study was led by Dr. Granzin, Mr. Hetherington and IPB researchers Prof. Daryanto, Dr. Sahara, Ms. Yuni Resti, and Dr Pria Sembada and collaborated with a national milk processor and retailer, PT Cisarua Mountain Dairy (Cimory), and the local village cooperative, KUD Giri Tani in Cisarua. Four Village Level Researchers (VLRs) moved to Cisarua to support the implementation of the study. The study involved establishing a microbiological laboratory (e.g., with incubators) to culture bacteria on-site, which was led by Ms. Resti (IPB) and Mr. Hetherington. Training and coaching of KUD staff, the VLRs and IPB diploma graduates was also led by Ms. Resti. This study was in final stages of implementation before COVID-19 prevented field work. In total 26 farmers had complete datasets.
		1.7.2. HACCP Study completed on commercial dairy farm.	Jun 2021 (Y5 M12)	**Completed – Year 5 (2020/21)** Cimory have their own large-scale farm near Bogor, West Java. They allowed the project team to collect samples from this farm. In the first round of sampling there were issues with the sampling methodology and the team intended to return to collect these samples in late March 2020. However, COVID-19 prevented this. Cimory's farm was planned to be resampled during the incentive study (Feb to Mar 2021) but the outbreak among the field team during this time meant this could not proceed.

		1.7.3. Report delivered outlining results from HACCP study and comparison to a commercial benchmark, including recommendations for investment options to reduce microbial contamination along the chain.	Jun 2021 (Y5 M12)	**Completed – Year 5 (2020/21)** A report from the Hazard Analysis and Critical Control Points (HACCP) Study was finalised of the KUD Giri Tani farmers (see Annex 6)
		1.7.4 Quality-based price incentive study implemented, results analysed, and report written.	Jun 2021 (Y5 M12)	**Completed – Year 5 (2020/21)** In the original plan, this activity was planned to be concluded by July 2020, following the completion of the HACCP Study. However, this was not possible due to the COVID-19 lockdown. A component of the Incentive Study was to deliver training to farmers to ensure a common level of knowledge on milk quality best practice. The team was able to deliver this training before the COVID-19 lockdown occurred. A day-long training program on “Milk Quality and Hygiene” was delivered to 70 farmers and KUD Giri Tani staff in Cisarua, West Java between 5 and 7 March 2020. The training was delivered by Ms. Denise Burrell and co-facilitated by Ms. Ritchie, Ms. Hanifah, Ms. Resti, Dr. Sembada and Mr. Hetherington. The training included an interactive workshop – covering a global perspective of milk quality, factors affecting milk quality on-farm, best practice to enhance milk quality and prevent mastitis, and practical on-farm demonstrations with farmers regarding good hygiene practices, detecting subclinical mastitis (using the Surf test) and prevention of mastitis (with the use of iodine). Between January and March 2021, the Objective 1 team conducted the Incentive Study with farmers in KUD Giri Tani. The first phase was to baseline total plate count (TPC) levels for individual farmers. This was followed by two (fortnightly) payment cycles where incentives were delivered. KUD TPC levels were also recorded. In March 2021, several IPB team members contracted COVID-19. Based on health, financial and reputational risks, the study concluded early. The team intended to conduct a follow-up assessment of individual farmer TPC levels. However, this was not able to be carried out due to COVID-19. The KUD TPC results were used to indicate the change post implementation of the intervention.

Objective 2: Identify barriers to adoption of profitable management practices and farm business models and develop strategies to inform development of extension programs in West Java and North Sumatra.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Develop, conduct, and analyse a baseline formal survey of a representative sample of dairy farming households in West Java and North Sumatra. (n= 700 total; n=600 West Java; n=100 Sumatra))	Notes on results of semi-structured interviews and focus group discussions with key informants prior to designing the survey Datasets on farm households	Dec 2018 (Y3 M6)	**Completed - Year 2 (2017/18)** 600 households were interviewed in West Java between August and September 2017. This was led by UoA and ICASEPS. This included the use of CommCare as the survey platform. Amber Gregory from Oikoi (formerly 'AgImpact') was contracted to assist with the development of the questionnaire on CommCare and train project team members. Based on the field trips conducted in January and February 2021, it was evident that the dairy industry was too small in North Sumatra to conduct a detailed survey. The value chain study included semi-structured interviews with farmers (and ex-farmers).
2.2	Identify profitable management practices, business, and extension models, and use this information to develop strategies that will increase on-farm profitability.	Report on: (i) the difference in input use, technology, knowledge, marketing channels and perception of adoption of profitable management and technology between farmer segments; (ii) the difference in access to government support; (iii) drivers and barriers to adoption of profitable management and technology; (iv) the change in production systems and farmers' welfare over the project period (v) the most effective "whole- of-chain" strategies for overcoming barriers to adoption of profitable technology and management practises and how stakeholders can be engaged and work together to implement these strategies.	Dec 2020 (Y5 M6)	**Completed - Year 4 (2019/20)** The IndoDairy Smallholder Household Survey (ISHS) 'Farm to Fact' series was published in October 2018 in English and Bahasa, which included 14 factsheets. In May 2020, these factsheets were republished with an additional seven (total 21) factsheets included in the series. These factsheets cover the following aspects of the survey: - Implementation details - Household and farming characteristics, - Dairy cow characteristics and management practices - Farm inputs - Labour - Milk productivity, quality and price - Cost, revenue and profit - Technology adoption - Farmer attitudes, perceptions and aspirations - Gender inclusiveness - Assessment of profitability and comparison of characteristics based on profitability See Annex 7

Objective 3: Develop, pilot and evaluate best-bet dissemination to improve adoption of innovative dairy management practices by smallholder farmers in West Java.

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Co-design an integrated dissemination program through training and focus farms for extension staff and service providers across the technical areas of nutrition and forage management, animal husbandry and reproduction, milk quality and business management.	3.1.1: Consult and establish a network of key advisers, extension staff, researchers and industry representatives in Indonesia and Australia.	Jun 2017 (Y1 M12)	**Completed – Year 1 (2016/17)** An Extension Advisory Working Group (EAWG) was established in May 2017 comprising of extension staff from five dairy cooperatives (KUDs), personnel from ICARD, UoA and Dr. Granzin. The EAWG did not have a formal meet during Year 3 and 4. However, there has been ongoing engagement with the KUDs by ICARD under Activity 3.2. Village Level Researchers (VLRs) have also provided a direct link to KUDs in their respective regions through 3.2 and the delivery of DGs. Additionally, the EAWG have been engaged through technical training workshop (under Sub-activity 3.3.1) and were invited to all policy forums and discussions.
		3.1.2: Review existing technical material and successful extension methods both in Indonesia and internationally.	Jun 2017 (Y1 M12)	**Completed – Year 2 (2017/18)** A review was undertaken on extension methodologies in Indonesia and internationally. Reports based on the review were written and published: 'Review of extension methodologies' (Annex 8) and 'Literature Review Dairy Extension in Indonesia' (Annex 9).
		3.1.3: Design and develop pilot training to test novel extension methods across technical areas	Dec 2017 (Y2 M6)	**Completed – Year 3 (2018/19)** Three extension methods within the feed technology dissemination activities were conducted by ICARD (see more details under Activity 3.2). These were one-on-one mentoring, resource support and e-communication. Data collection relating to the impact of these extension methods commenced in July 2018 and was completed in December 2019. The Focus Farm (FF) extension methodology was adapted from Australia for the Bogor region and was implemented in Years 3 and 4. Two farms were selected. The identification of business goals and the establishment of an Advisory Groups for each FF was completed by June 30, 2019. Year 3 also involved the establishment of three farmer Discussion Groups (DGs) for each of the four KUDs. KUD Giri Tani, KPS Cianjur Utara, KPBS Pangalengan and KPGS Cikajang (a total of 12 groups). One Women's Discussion Group (WDG) was also established in KPS Bogor. These groups held their first meetings in early July 2019 following a planning session in May 2019. All DGs and FFs were completed by March 2020, completing six meetings each followed by an evaluation session for all groups.

		3.1.4: Co-design online communication methods with Indonesian counterparts	Jun 2018 (Y2 M12)	**Completed – Year 1 (2016/17)** The project website (www.indodairy.net) was a central location for all project resources (managed by Mr. Hetherington and Mr. Rida Akzar). A project Facebook page (www.facebook.com/indodairy) was created and led by Indonesian counterpart (Ms. Hanifah). Social media including GFAR's social media and the IndoDairy Facebook page were used to further disseminate information. At the completion of the project, the team migrated all the project information and resources from the project website to a page hosted by the University of Adelaide (https://www.adelaide.edu.au/global-food/research/international-development/indodairy). Three project videos were produced: 1. Voices from the field (https://youtu.be/0KWqDlSmYxo) 2. Focus Farms (https://youtu.be/bq6qGNFIWaM) 3. Animated video of extension study outcomes: English (https://youtu.be/-vAZsC9j70o) and Bahasa (https://youtu.be/W5qijXmv3oA)
3.2	Application of feed technology through focus farms and implementation of training on feed, milking and reproduction management, animal house and animal health.	3.2.1: Pilot feed technology dissemination and training program	Dec 2018 (Y3 M6)	**Completed – Year 4 (2019/20)** During Year 3 (2018/19), two key technologies were selected for dissemination on-farm: high protein concentrates; and a bypass fat supplement (Kalem). In addition to the technical treatments imposed, three different extension approaches were implemented: the provision of technical mentoring through workshops and one-on-one support; subsidization of technology; and development of e-communication networks using WhatsApp for communication between researchers, extension workers and farmers. Monitoring of adoption and data collection was completed in December 2019. The Bureau of Foreign Cooperation, Ministry of Agriculture Indonesia produced a video of this work: (https://youtu.be/t_t5Jkc27C0)

		3.2.2: Deliver milk quality and hygiene training workshops with staff and farmers at the milk collection centres	Aug 2019 (Y4 M2)	**Completed – Year 3 (2018/19)** Several training initiatives were delivered on milk quality: 1. ICARD delivered milk quality training in Year 2 to farmers as part of the program that introduced feed technologies to farmers (see more information under 3.2.1). 2. In June 2019, a 2-day training program was delivered to service providers and researchers in Bogor (see activity 3.3.1). 3. As part of the extension study training on methods to improve milk quality was delivered to discussion groups (DGs) between 2019 and 2020 (see activity 3.3.3). 4. Milk quality training was delivered to 70 farmers in KUD Giri Tani in March 2020 (see activity 1.7.3).
3.3	Pilot and evaluate technical dissemination programs with researchers, extension staff and dairy services providers in West Java	3.3.1: Deliver pilot training of integrated programs for extension staff and smallholder farmers in collaboration with key partners across the prioritised technical areas such as feeding systems and herd nutrition, rearing young stock and reproduction management, and business management	May 2020 (Y4 M11)	**Completed - Year 3 (2018/19)** A trial of different extension programs was integrated into the feed technology dissemination study (3.2.1). This helped identify extension options to trial prior to full deployment (3.3.3). An integrated training program for dairy service providers (KUD staff, VLRs, ICARD and IPB) was delivered over the course of Year 3. This program was comprised of four multi-day training workshops addressing the four core technical areas: feed and nutrition, (2) farm business management, and (3) dairy reproduction, and (4) milk quality and hygiene. An additional training workshop was delivered to the same cohort of service providers to develop their skills in facilitating discussion groups and delivering extension activities. Service provider workshops helped identify and refine the farmer training resources 'IndoDairy: Essential Farming Facts' (see Annex 10), which were developed in Year 3, and which were utilised in 3.3.3.

		3.3.2: Monitor and evaluate impact and relative success of pilot activities.	May 2020 (Y4 M11)	**Completed – Year 4 (2019/20)** Adoption levels and farm production performance indicators were monitored throughout the ICARD-led feed technology study (see Activity 3.2) by the VLRs using CommCare. This monitoring concluded in December 2019. Evaluations of the training workshops were completed by Ms. Tessa Magrianti, Ms. Hanifah, and Ms. Ritchie. Overall, the workshops were highly successful in increasing the knowledge of participants in all areas. Anecdotally, it was also noted that delivering the workshops in West Java over a long period of time to the same cohort contributed to developing a network of KUD staff, project team (i.e. the VLRs) and researchers, which has helped with sharing of information and resources between regions.
		3.3.3: Using the findings from 3.3.2 re-design and schedule full deployment of training for smallholder farmers and service providers in North Sumatra	May 2020 (Y4 M11)	**Completed – Year 4 (2019/20)** Discussion Groups (DGs), two Focus Farmers (FFs) and a Women's Discussion Group (WDG) were established in Year 3, with meetings held until March 2020 (Year 4). Three DGs were established in each of the following KUDs: KUD Giri Tani, KPS Cianjur Utara, KPBS Pangalengan and KPGS Cikajang. The two FFs and WDG were established in Cijeruk (near Bogor city). In total 184 farmers participated in the DGs, in addition to 2 FFs. See Appendix 2: List of IndoDairy training activities for more details. Farmers were provided with a technology support package from the project, including the IndoDairy: Essential Farming Facts (Annex 10) booklet, a cattle weight tape, iodine and a teat-dip container, a paddle trays (for testing subclinical mastitis), and record keeping booklets and calculator. The packages were designed to support farmers with improving their farm performance and were in lieu of cash incentives for their participation in the extension activities. A four-day training workshop was delivered to 20 service providers in North Sumatra (23 to 27 January 2020) by Dr. Granzin, Ms. Ritchie, Dr. Endand Romjali, and Ms. Hanifah. This covered all four topics (nutrition, milk quality, dairy reproduction and business management) and included service providers from the local government offices and BPTP. An internal report of the outcomes of the full deployment of extension activities has been prepared by Ms. Ritchie, Dr. Granzin, Ms. Hanifah, Mr. Hetherington and Prof. Wendy Umberger. Report is available in Annex 11.

3.4	Monitoring and evaluation of practice change activities delivered in 3.2 and 3.3	Collect ongoing evaluation data using participatory approaches after all delivery of activities	May 2020 (Y4)	**Completed – Year 4 (2019/20)** A range of productivity and business key performance indicators (KPIs) were recorded by VLRs associated with 3.2. These were captured using a comprehensive CommCare application which monitored biophysical and socio-economic data on the KUDs, farms, cows and calves. In addition to the project baseline study, a household survey was (re)conducted with the 90 farmers selected for 3.2 in Year 3 (2018/19). In Year 4 (2019/20), farmers participating in Sub-activity 3.3.3 were involved in the number of evaluation methods, as well as having the detailed household socio-economic survey being conducted with all households (186 farmers in 184 households). The socio-economic information was used to understand impact under Activity 3.5. Evaluation methods for the DGs included: 1. A knowledge, attitude and practice (KAP) survey which was repeated with 184 farmers in July 2019 and February 2020 to assess changes in knowledge, practices and attitudes and barriers to adoption. 2. Meeting questionnaires for self-assessed changes in knowledge, attitudes and intentions on the technical topics after each session. 3. Participatory planning and evaluation sessions for DGs and FF's. The Observational, Reflection, Interpretation and Decisional (ORID) technique was used with farmer groups to capture changes in their knowledge and intentions. 4. A case study approach to review selected farmers in more detail who had initiated changes on farm, resulting in changes in milk yield or quality. 5. For the DGs, assessments were made relating to the change in a core set of knowledge of disciplines, attitudes, practices and barriers to adoption. 6. For the two FFs, farm business data was collected for eight months to improve participants understanding of farm business analysis and to capture changes in farm profit during the activity.
		Pilot the effectiveness of focus farms as a tool to evaluate skill development in service providers and farmers.	May 2020 (Y4)	**Completed – Year 4 (2019/20)** Two FFs were selected from farmers in Cijeruk, Bogor; Pak Yunus (KUD member) and Pak Ma'mur (leader of an independent farmer group). The planning meeting with each FF was held on 28 June 2019. A total of six meetings were held for each farmer, including a short evaluation session during the last meeting in March 2020.

3.5	Assess the short run and potential long run impacts of the project activities through a follow up survey during the final phase of the project.	Data will be collected from 400 households using structured survey methods.	June 2021 (Y5 M12)	**Completed – Year 6 (2021/22)** This was delayed multiple times due to COVID. An additional study was conducted by the UoA team, Ms. Hanifah and the VLRs in June-July 2021 due to the ongoing restrictions to field activities. Focus Groups were conducted with participants of the discussion group via WhatsApp. 28 Farmers and 6 KUD extension staff participated in the Focus Group discussion including sharing photos, videos and audio recording. In December 2021, UoA and ICASEPS were able to implement this activity safely. In total, 480 farmers were interviewed. This included 411 who were in the 2017 baseline. Additional farmers were interviewed in the endline survey based on their participation in project interventions. Reporting on the short-run and potential long-run impacts, including the qualitative responses, can be found in Annex 12. ICASEPS reported on farmer attrition (see Annex 13).

6 Key results and discussion

6.1 Objective 1

6.1.1 Dairy value chain

The dairy value chain analyses revealed several key actors with important roles in the Indonesian dairy industry.

- DGLAHS – The Directorate General of Livestock and Animal Health Services at the Ministry of Agriculture oversees the national strategy and government policy affecting Indonesia's dairy industry. There are five directorates under DGLAHS which cover: (1) breeding, (2) livestock production, (3) livestock fodder, (4) animal health and (5) veterinary public health and post-harvest.
- GKSI – '*Gabungan Koperasi Susu Indonesia'* (The Indonesian Association of Dairy Cooperatives) oversees the industry development including policies regarding accessing funding for infrastructure and cattle. The activities of GKSI are mainly handled by branches in East Java, Central Java and West Java.
- KUDs – as mentioned earlier, a KUD ('*Koperasi Unit Desa'*) is a village-level cooperative. KUDs supply farmers with technical services related to production and animal health. The KUDs also serve as the local milk collection centre and play an important role in marketing milk by linking smallholder dairy farmers and milk processors. KUDs deliver milk to processors and collect and distribute payments to their members (dairy farmers). Payments from processors are based on milk quality and volume. Some of the KUDs have exclusive arrangements to supply a major milk processor and some have established their own milk products and brands for the local market.
- MPI – Milk Processing Industry represents the milk processing sector. MPI buys milk from KUDs and can buy direct from large farm and import milk powders to fulfil their needs. Indonesia's five largest milk processors are members of MPI – PT. Nestlé Indonesia, PT. Frisian Flag Indonesia (FFI), PT. Sarihusada Generasi Mahardhika, PT. Indolakto, and PT. Ultrajaya Milk Industry.
- Artificial Insemination (AI) Centres – Semen for AI in cattle is domestically produced by two centres located in Malang, East Java and Lembang, West Java.
- Cikole Dairy Training Centre– The Centre is funded by the Japan International Cooperation Agency (JICA) and provides training to encourage technology transfer to improve dairy farming and milk production.
- Smallholders – Smallholder dairy farmers own on average of three to four cows each and are usually a member of a KUD. Smallholder dairy farmers face several challenges including enterprise scale, herd nutrition, animal husbandry, reproductive performance, and milk harvesting.

Dairy value chains were mapped for West Java and North Sumatra and are illustrated in Figure 12 and Figure 14, respectively.

West Javan value chain

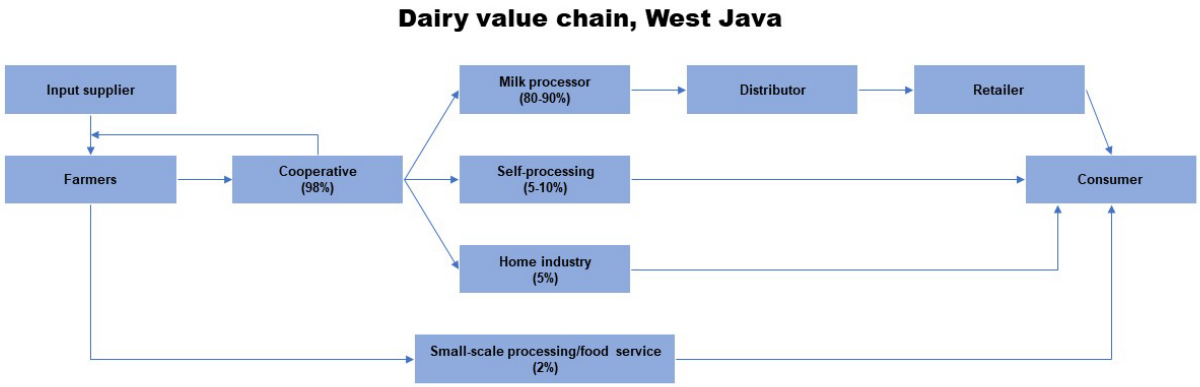


Figure 12. Dairy value chain in West Java.

The following is insight gained from the dairy value chain analysis in West Java:

- The significant role of the KUDs to smallholder dairy farmers as they supply inputs (e.g., feed, supplements, veterinary medicines), market their milk, deliver training activities and provide access to credit. In some cases, they provide insurance for their dairy cattle and family health (e.g., in KPGS Cikajang and KPBS Pangalengan).
- There were no formal contracts between farmers and KUDs regarding the quantity of milk that needed to be delivered. The milk price received by farmers differed between KUDs. In some cases, the milk price paid to farmers was determined by milk composition (e.g., fat content, total solids, etc). Milk quality testing also varied between KUDs, with some KUDs (e.g., KPBS Pangalengan) testing individual farmers' milk, but most KUDs tested milk at a group level – i.e. co-mingled milk from several smallholders who all delivered to the same milk collection point. The KUDs usually paid farmers once or twice per month for their milk. Milk containing antibiotic residues was accepted by the dairy cooperative but was separated. The milk price paid to farmers was IDR 4,590 per litre (46 cents AUD) on average, the lowest price received by farmers was IDR 4,350 per litre (43 cents AUD) and the highest was IDR 4,850 per litre (48 cents AUD).
- In urbanised areas, like Bogor, some farmers also sold milk to small-scale processors and food service businesses, such as "*Momo milk*" and "*Susu Mbok Darmi*" (see Figure 13). Both businesses buy milk directly from farmers at IDR 6,000 – 6,250 per litre (60 - 62 cents AUD). Although the price for milk is higher, they require higher standards of milk, therefore these businesses tended to buy directly from larger farmers.

Figure 13. Left: Susu Mbok Darmi is a Bogor-based business selling dairy smoothies via roadside kiosks. Right: Momo milk is a dairy-themed restaurant in Bogor. (Photo: UoA/Jack Hetherington)

- The major milk processors operating in West Java at the time of the study included: PT. Cisarua Mountain Dairy (Cimory), PT. Indolakto, PT. Frisian Flag Indonesia (FFI) and PT. Ultrajaya Milk Industry. Contract arrangements between the KUDs and these major milk processors varied, with some having written contracts while others were only verbal. For instance, Cimory generally did not use written contracts with their KUDs. Payments were based on quality parameters, including milk composition (fat, total solids) and TPC. The payment schedules were re-negotiated periodically.
- Milk processors also supported farmer training programs (e.g., FFI's *farmer-to-farmer program*). Farmers from the Netherlands were invited to meet with Indonesian farmers who were selected by their KUD through a competition. FFI regularly shared information about technical aspects of dairy farming through radio programs and a magazine. Farmers indicated that they listened to the radio programs.
- Milk processors primarily sold their products through major retail channels, including supermarkets (e.g., Giant), minimarkets (e.g., Indomart and Alfamart), and traditional markets. The market area was mostly spread throughout Java, especially heavily concentrated areas such as Jakarta. Some milk processors stated that it was difficult to expand their operations outside of Java because there was little to no dairy farming in other regions. In many cases processors also marketed their products directly to consumers. For example, Cimory had two restaurants and retailed milk directly to consumers through other outlets.
- The main brands of dairy products available in Indonesian supermarkets at the time of the study included: Ultrajaya, Frisian Flag, Indomilk, Diamond, Cimory, Greenfields, and Boneeta. Supermarkets interviewed indicated that they had not experienced any quality issues for products with certifications from the National Agency of Drug and Food Control and certified as halal. Any customer return of products was reported to have been due to products exceeding the expiration date.

More detailed results from the West Javan value chain research can be found in Annex 4.

North Sumatran value chain

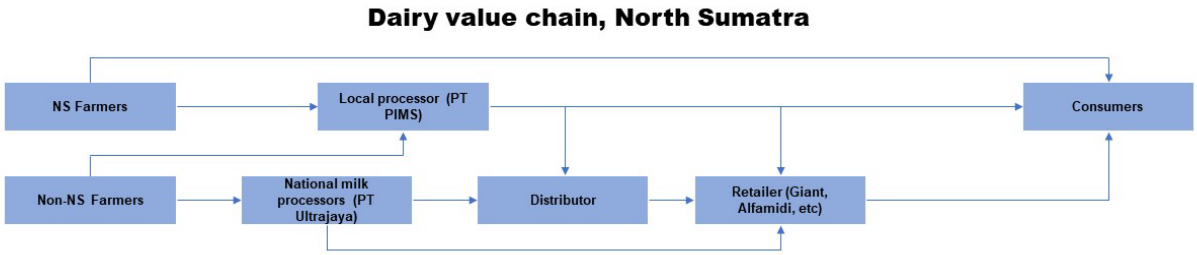


Figure 14. Dairy value chain in North Sumatra.

The following is a summary of the key findings from the North Sumatran dairy value chain analysis:

- The dairy value chain in North Sumatra was considerably less developed than West Java. Additionally, the number of dairy farmers was considerably smaller than West Java and there were no KUDs operating. Most dairy farmers in North Sumatra sold directly to consumers and were able to receive IDR 15,000-20,000 per litre (AUD 1.5 – 2.0), which is between three to four times the average price received in West Java.
- Average milk production was 8 to 12 litres per cow per dairy for Holstein Friesian cattle and 3 to 4 litres for local breeds of cattle. Pasture-based production systems were more common in North Sumatra than in West Java.
- A local government program had been initiated to supply farmers with dairy heifers as well training and support for farmers to undertake an internship and other capacity building activities in Java. The program also provided milking and processing tools to support the establishment of KUDs. However, many farmers that participated in the program were not able to sustain their operation and many farmers subsequently sold or slaughtered their herd. However, it appears that some of the recipients of dairy cattle may not have been legitimate farmers and benefited from the program despite not being dairy farmers. Among the 12 groups receiving assistance, only 2 remained and only 1 group still had dairy cows at the time of the study. The remaining group managed dairy cattle communally.
- PT. Putra Indo Mandiri Sejahtera (PIMS) was the only milk processor operating in North Sumatra at the time of the of study. Their processing setup was considered to be '*simple',* but it was being developed further. Their three main products included fresh milk, flavoured milk, and yoghurt. PIMS also owned 230 dairy cattle with 85 lactating cows, which averaged 12 litres per cow per day. PIMS was also attempting to improve their management practices by sourcing input from experts based in Malang.
- Retail opportunities for dairy products in North Sumatra were very positive due to growing demand. While there were a variety of brands, flavours and package sizes available in retail outlets. Retailers reported price as a major driver for consumer purchasing. Giant Medan was a major supermarket outlet for dairy products. In the previous five years, Giant had opened five stores opened in North Sumatra. Minimarkets were another major outlet for dairy products. Alfamidi had approximately 200 stores across North Sumatra.
- Corporate farming was expected to expand in North Sumatra with two major fluid milk companies planning to establish dairy farms and milk processing plants near Medan with a focus on export to Asian markets.
- The outlook for commercial dairy industry development was very positive due to the market potential despite there being very few smallholders and the local supply of milk being low. Farmers expressed some interest in participating in dairy farming, but they found it difficult to obtain good quality heifers and cows.

- North Sumatra had available land and forage to support a growing dairy industry. However, there were significant barriers including access to other inputs, marketing of milk and support services. Two feasible options were identified to develop the dairy industry in the region. The first is through vertically integrated corporate farms. For example, the PT. Ultra Sumatera Dairy Farm near Medan, was reported to have 3,000 cows. The second is to support smallholder systems via the establishment and support of KUDs and potential partnerships with corporate farms.

More detailed results from the North Sumatran value chain can be found Annex 3.

6.1.2 Policy Review

A detailed mapping and analysis of national dairy policies was undertaken (see Annex 2 for the full report). The reports and analyses highlighted the extensive regulations faced by the dairy industry, especially related to dairy inputs, investment, and access to credit for key stakeholders. However, the analysis showed that there is still a lack of implementation of regulations and there is little synchronization of regulation and stakeholders. Government policies should be synergized with the relevant stakeholders. A special review is needed on regarding policies related to regional mapping for milk self-sufficiency. The following are key findings from the review:

- **Dairy inputs** - Government policies to support domestic milk production include improving forage and cow seed (female cow) quality and availability which can be gained both from domestic and imports. Specific policy for “livestock farmer empowerment” is available which include provision and management of common grazing land, superior seeds, artificial insemination and rescue for productive female livestock.
- **Price of domestic and imported dairy products** - High dependence on imported dairy products makes the domestic dairy product market vulnerable to price fluctuations depending on the world market.
- **Investments in the domestic industry**, including both small-scale and large scale and foreign investment - There is a lack of regulation and programs to enhance foreign and domestic investment activities to accelerate the development of micro, small and medium enterprises, and cooperatives in the dairy industry. The domestic dairy industry is still a low priority for development. The dominant investment (domestic and foreign) is the poultry industry. Policies are needed to promote partnerships which facilitate development of the following: (1) production facilities: provision of equipment and buildings); (2) milk production: increasing the population of dairy cattle; provision rearing facilities; enhancement of skills and competence of farmers, farmers groups and/or cooperatives; and (3) capital or financing: facilitation of business capital with affordable interest; and/or guarantees to obtain business credit.
- **Access to credit for key players in the dairy industry** (smallholders, KUDs, processors, etc.) - While current partnerships are available, farmers and farmer groups are challenged to access credit from banks due limited collateral.
- **Regulation of imports of live dairy cattle and semen** - No government or ministerial regulation ‘explicitly’ regulates the importation of live dairy cattle/cows. The focus of the regulation is more on beef cattle, not on dairy to increase milk production.
- **Laws and regulation regarding importation of dairy products** - Indonesia is a net importer of dairy products, mainly powdered milk. Government policies that have been issued to increase competitiveness of domestic milk production include the development of post-harvest facilities, fostering partnerships between milk processing companies and farmers and/or cooperatives, provision of income tax facilities in the investment of dairy industries and livestock, and provision of Business Credit schemes for Cow Breeding (‘*Kredit Usaha Pembibitan Sapi*’ -

KUPS). For importers who cannot produce processed milk, they are required to establish partnerships with relevant actors along the dairy values chain in the form of production facilities and capital for dairy farmers.

6.1.3 Smallholder-inclusive business model analysis

For this study, the IndoDairy team visited and analysed key elements of dairy value chains in East Java and West Java:

1. PT. Nestlé Indonesia (Nestlé), East Java
2. PT. Greenfields Indonesia (Greenfields), East Java,
3. PT. Cisarua Mountain Dairy (Cimory), West Java
4. KPS Bogor, West Java
5. KPBS Pangalengan, West Java

In addition, two small start-up businesses targeting Bogor consumer markets and the owner of a medium-sized farm near Bogor that convenes a youth-focused farmers' network, PERPAMI (*'Perhimpunan Peternak Muda Indonesia'* – Indonesian Association of Young Livestock Farmers), were interviewed:

6. Susu Mbok Darmi (*'Mrs Darmi's Milk'*)
7. Rumah Kopi Ranin (*'Ranin Coffee House'*)
8. PERPAMI

The analyses of these business models explored the relationships between the key actors, the relative power relations between the actors, and the relative benefits gained by each actor as a result of their business relationship.

The full report of these business models is available in Annex 5. Additionally, case studies of KPS Bogor and Nestlé are summarised below and compared to the large-scale enterprise model of Greenfields.

Case study: KPS Bogor, West Java

The KUD structure of KPS Bogor provided the baseline for scope improvement analysis.

KPS Bogor operates in a similar structure to most of KUDs in West Java. They have several milk collection points (MCPs) and purchase milk from farmers through these MCPs (Figure 15). The KUD sells the milk to several processors in the region (e.g., Indolakto and FFI in South Jakarta), at an IDR 1,000 per litre (10 cents AUD) margin on the price paid to the farmers. The processors paid a higher price for higher quality milk, based on total plate count (TPC), which was reflected in the price they paid farmers. This ranged from IDR 4,100 per litre (42 cents AUD) for a TPC of >1.0Mppm, to IDR 5,300 per litre (53 cents AUD) for a TPC of <500ppm.

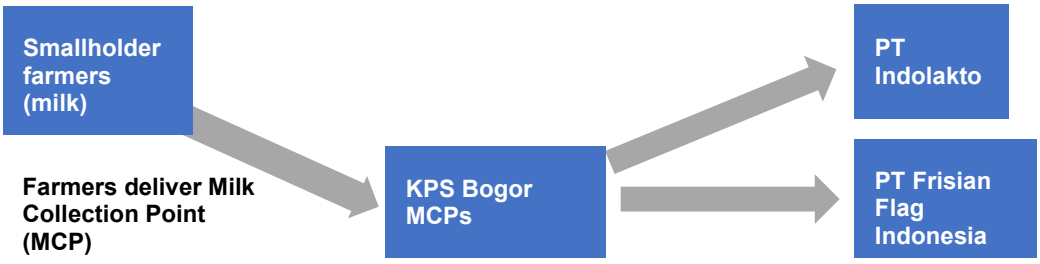


Figure 15. Value chain map for KPS Bogor farmers.

The KUD indicated the key challenge for their farmers was increasing and maintaining a higher quality milk supply. To achieve this quality standard consistently (for example a TPC of less than 500 parts per million (ppm)) the following were needed:

- increased skills and training for farmers,
- improved logistics including the use of stainless-steel containers for transport,
- improved chilling and storage capacity at the MCPs,
- improved access to new technologies for maintaining healthier animals,
- better testing of animals and milk quality, and
- improved feed supplies.

Although the KUD was funded through milk sales, they indicated that they did not generate the level of revenue required to fund improvements in the supply chain. The farmers' approach to lower milk prices due to lower quality was to increase the volume of their production through more cattle, rather than address quality issues. Local processors hedged against the lower quality of locally supplied milk by purchasing their inputs from further afield and using the lower quality milk for products other than high-margin fresh milk.

Thus, the driver for change in the supply chain was not just the processors, as they were able to source better quality milk elsewhere, nor was it being driven by the KUD as their revenues limited their ability to invest capital where it was needed in the supply chain. The farmers lacked adequate knowledge and training, and thus, were also limited in their ability to make the necessary changes needed to improve milk quality.

Therefore, market forces are not enough to drive change in the industry in Bogor. No one stakeholder can drive the change required in dairy supply chains. All stakeholders must work together to drive and incentivise change. If there remains a policy direction to strengthen and improve the domestic dairy industry, then the unique needs of the different actors in the supply chain need to be understood, this is likely to include extension training, support to access quality farm inputs, and capital investment in logistics to provide a baseline for the market to build on. The relationship model is illustrated in Figure 16.

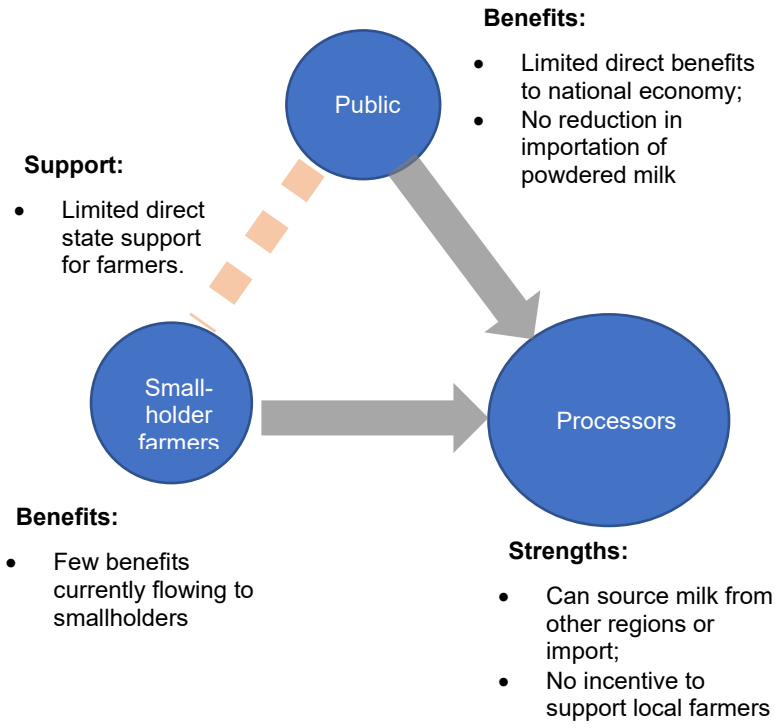


Figure 16. KPS Bogor relationship model

Case study: Nestlé, East Java

Nestlé commenced dairy operations in Indonesia in 1970 in West Java. A factory was built and opened in 1971 in West Java and another was opened in Kejayan, East Java in 1988. At the time of the study, Nestlé worked in partnership with cooperatives/KUDs with more than 26,000 farmers milking approximately 70,000 cows (Figure 17).

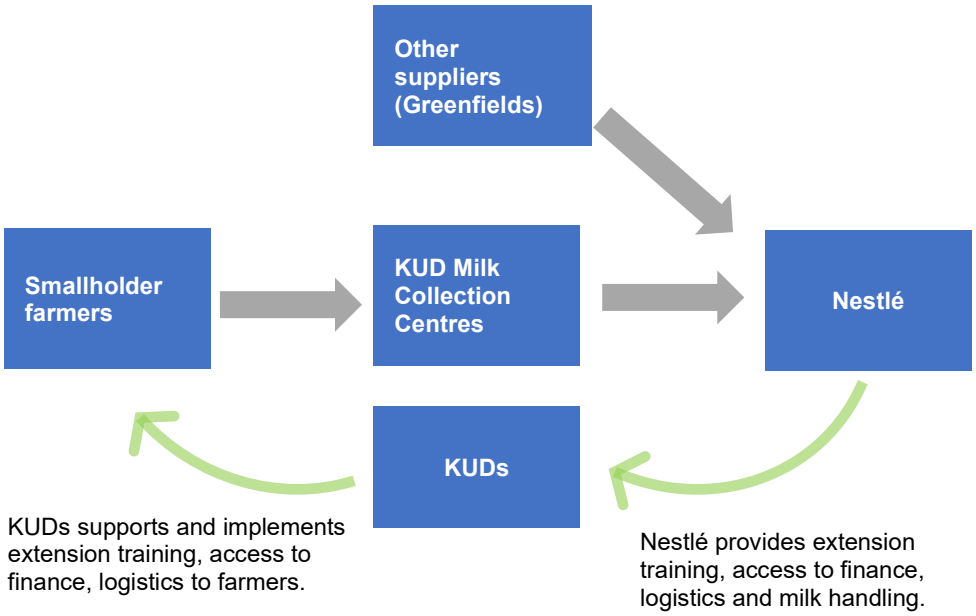


Figure 17. Value chain map for Nestlé, East Java.

Through Nestlé's '*Creating Shared Value'* strategy, farmers focused on increased productivity and quality to meet Nestlé's demands and specifications. Nestlé provided interest-free financing to cooperatives to setup and manage milk collection centres. Specifications such as time between milking and chilling, purity, cleanliness, and handling were strictly adhered to by the cooperatives to ensure consistency in the quality of fresh milk. For consistency to be achieved, Nestlé invested in the purchase of cooling tanks, stainless steel collecting cans, and transportation. Investments further down the value chain were made through the distribution of seeds/nurseries of fodder species to cooperatives, developing fodder farms, and providing water *ad-libitum* to cowsheds. Extension agents from Nestlé ensured compliance by farmers with the recommended practices in feeding, milking, and handling of animals. The approach fostered self-reliance and engagement of farmers, rather than a habit of reliance on welfare payments. Nestlé's investments increased the quality of farmers' milk, strengthened cooperatives, and delivered a reliable source of high-quality milk.

Nestlé purchased milk from multiple KUDs in the vicinity of Kejayan and paid nominally higher prices than cooperatives for the milk. They paid IDR 5,250 per litre (52 cents AUD) for TPC of <500,000, as compared with IDR 4,950 per litre (49 cents AUD) through KPBS Pangalengan, and around IDR 4,700 per litre (47 cents AUD) through KPS Bogor for the same quality milk.

Nestlé's operating model (Figure 18) appears to have had a well-balanced relationship between smallholders and Nestlé, which mitigated both smallholders' and processors' risks in the market.

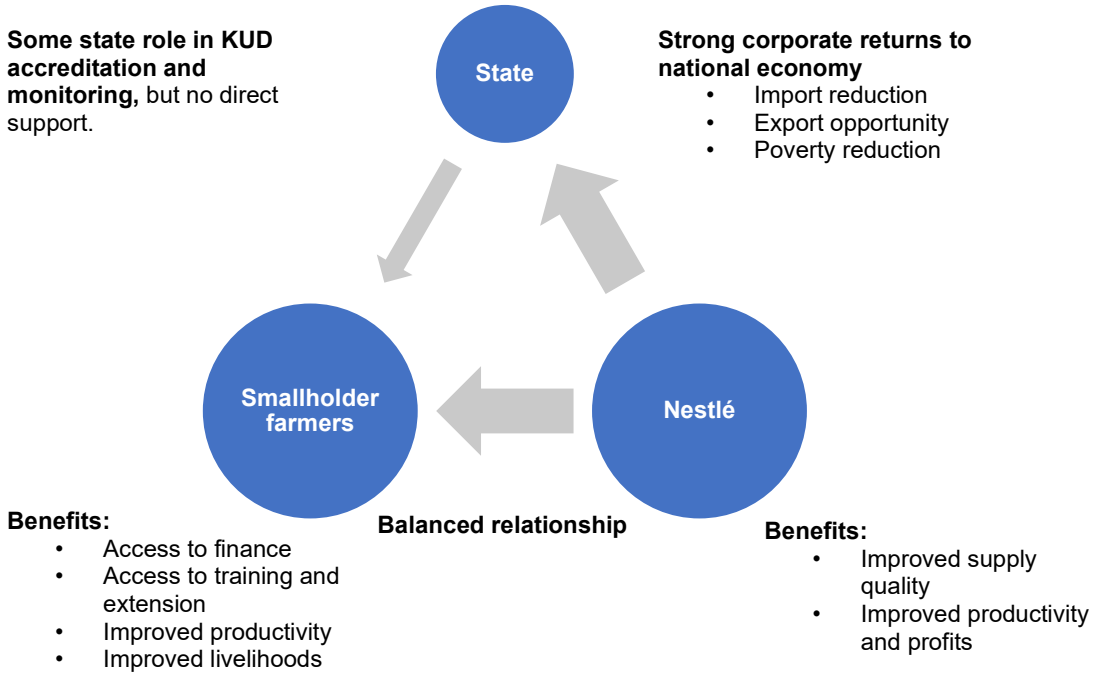


Figure 18. Nestlé East Java relationship model.

The Nestlé, Cimory and KPBS Pangalengan models (outlined in the full report: Annex 5) delivered, to varying degrees, direct benefits to smallholder farmers through Nestlé and Cimory's focus on improving their supply inputs, and through the KPBS working with farmers on better quality milk to increase payments from processors.

In all examples, we see that the benefits accruing to farmers originate from a 'whole of supply chain approach', focused on quality of product. That is, in these cases, the drivers for improvements to milk quality supply lie in securing better quality milk production facilities upstream for farmers. Investment in smallholder capacity results in a chain of higher quality and greater consistency, which and delivers higher, more consistent volumes of fresh milk. These factors are critical to processors, as their profitability relies on the quality and the quantity of their supply, leading to stronger corporate businesses, improved domestic food security, and the potential for increased exports. We have also found through the case studies of the Nestlé, Cimory and Pangalengan models that smallholder farmers also benefit through improved productivity, security of sales and better livelihoods.

Greenfields corporate model

The approach of Nestlé, Cimory, and KPBS Pangalengan can be compared with a corporate model of production, such as Greenfields whose production is not reliant on the capacity of existing smallholder dairy producers in the region. The Greenfields model is not intended to directly support smallholder farmers. However, the development of this type of large-scale enterprise can have a direct and positive impact on the local population through the creation of jobs, supply of inputs such as feed, and the introduction and dissemination of new farming technologies and skills, some of which are passed on directly to smallholder farmers in the immediate area.

Over the longer term, as the industry and economy develop, there is also potential for larger-scale enterprises to offer profit sharing and equity ownership to employees, both of which represent inclusive approaches to industry development. Greenfields also supports the local smallholder network by purchasing lower quality milk from local farms, and using it in their processed product range.

From a national economic perspective, the corporate Greenfields model delivers strong business potential and valuable tax receipts, and therefore benefits the national government. The two approaches to farming and milk supply, smallholder and large-scale production are complementary and necessary for the resilience of the industry more broadly.

The theory of inclusive business approaches is based on the principle that there is significant broader economic benefit in using the productive capacity of smallholder farmers, particularly in developing economies, as this scale of production is widespread throughout developing economies. Wealthier smallholders across a rural economy mean greater incomes for a significant proportion of the population.

6.1.4 Value-chain-approach to addressing milk quality

Milk hygiene and milk quality are significant issues in the Indonesian dairy sector. The national standard for bacterial contamination is a TPC count of 1 million colony forming units per ml (cfu/ml) off sample, which is 20 times higher than Australia's standard (50,000 cfu/ml). Despite microbial contamination being a major issue, many farmers are paid a flat rate for their milk , and therefore, they lack an incentive or do not see a direct benefit from investing time and resources into improving their milk quality. In some cases farmers also do not receive information about their milk quality and therefore they are not aware there is an issue. Additionally, those that may be aware and want to improve their quality do not know what changes they should make on-farm.

In October 2019, ACIAR approved additional funding to support action research to address the issue of microbial contamination (Variation 4). A new activity (Activity 1.7) was developed which entailed designing, implementing, and evaluating an incentive-based approach to improving on-farm hygiene practices leading to improved milk quality and food safety. The study focused on improving on-farm hygiene practices to improve milk quality (measured by TPC) to improve smallholder profitability. There were three components to this activity:

1. A Hazard Analysis and Critical Control Points (HACCP) study
2. Farmer milk quality and hygiene training
3. A quality-based price incentive study

CGFAR-UoA and IPB's Vocational School were the lead collaborators for this activity. Brad Granzin oversaw and advised the HACCP study. Ms. Denise Burrell was contracted to deliver the farmer training with support from Ms. Zita Ritchie and Ms. Vyta W. Hanifah. Additionally, four VLRs played an active role in the farmer training and incentive study.

HACCP Study

Key results from the HACCP study for farm-level (n=26) and cooperative-level sampling are summarised in Figure 19 and Figure 20, respectively.

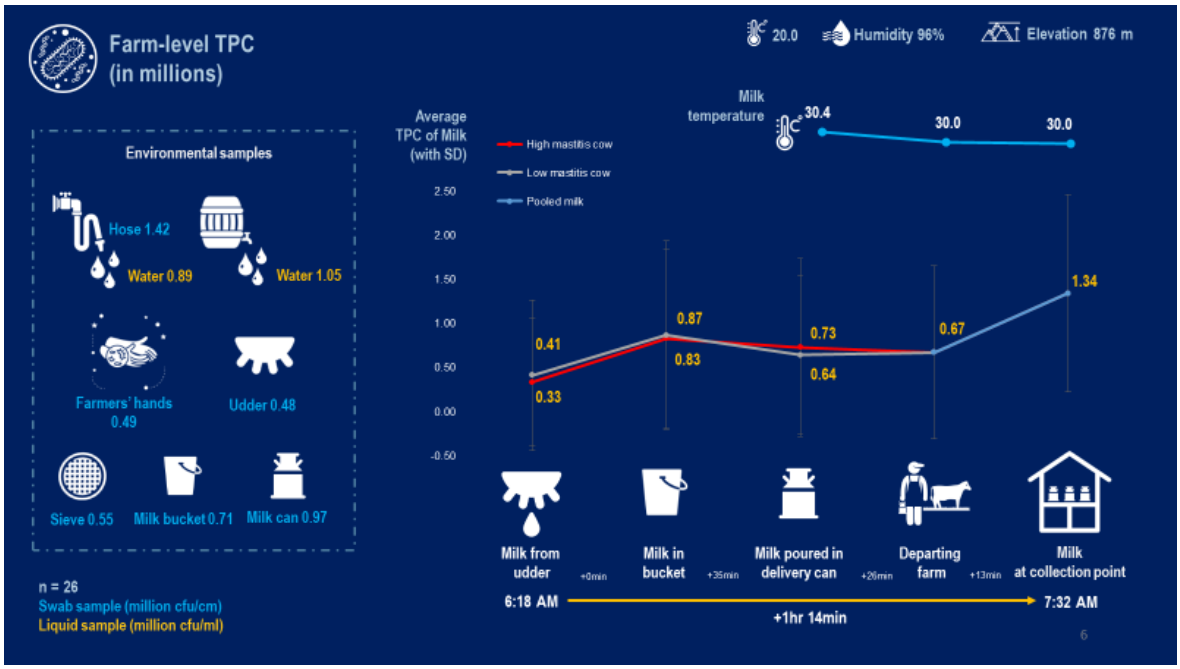


Figure 19. Summary of farm-level results from the HACCP study.

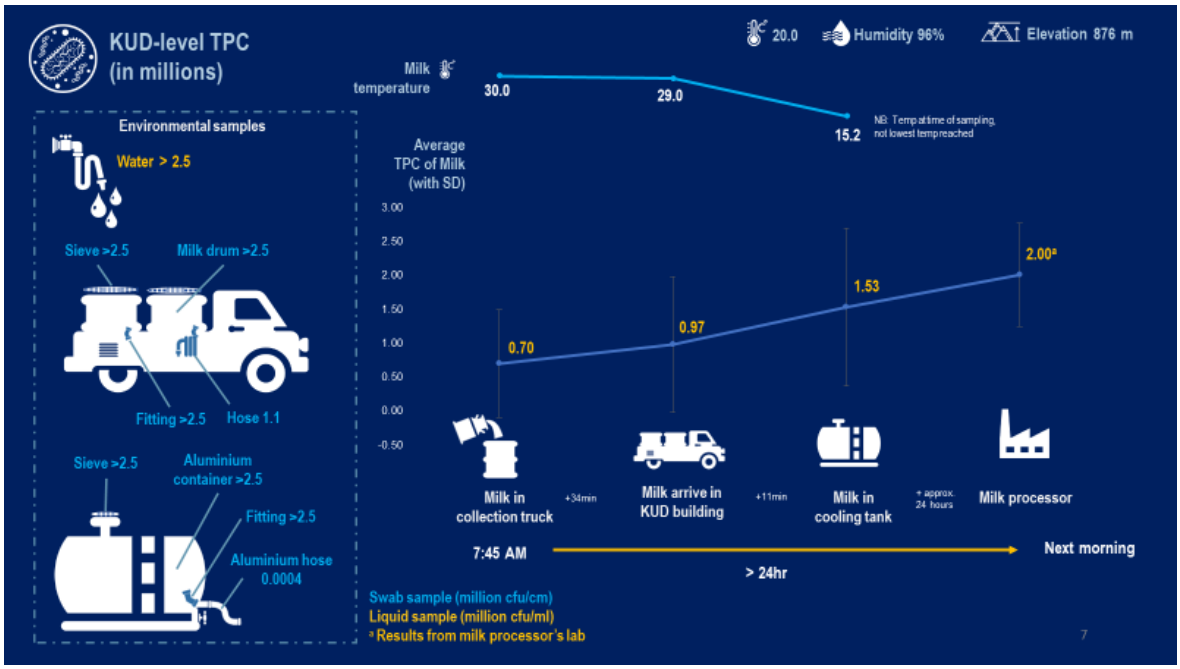


Figure 20. Summary of KUD-level results from the HACCP study.

Farm-level results

The study found that from milking through to the point of collection, the TPC of milk increased (on average) from 440,000 to 1,340,000 cfu/ml and took 1 hour and 14 mins.

There was not a significant difference in the TPC levels of milk from mastitic and non-mastitic cows. There were high levels of environmental contamination on-farm, particularly from water used for cleaning. Running water used for cleaning had a TPC of 890,000 cfu/ml, and water stored in a reservoir (e.g., a concrete trough or plastic drum) was slightly higher at 1,050,000 cfu/ml. This could explain the high TPC levels found in milking equipment that were sampled prior to milking. Milk buckets sampled (before cleaning) had a TPC of 970,000 cfu/cm. Most farmers in the study used plastic milk buckets (69%) and aluminium delivery cans (80%) (Figure 21). This could be improved by using stainless-steel buckets and cans. All farmers participating in this part of the study used cold water

for cleaning their equipment, only 42% used detergents in the cleaning process, and half of the farmers only changed their milk sieves every two to three months.

Figure 21. Left: Farmer milking in plastic bucket. Right: Milk at collection point, in a mix of stainless steel, aluminium and plastic delivery cans. (Photo: IPB)

KUD-level results

Cooperative-level results showed that milk TPC levels increased significantly after leaving the milk collection point and being transported in the KUD truck to the KUD facilities where it was then placed in a cooling tank. For example, the TPC of milk averaged 700,000 cfu/ml at the milk collection point (before being transferred to the KUD milk truck), and by the time it reached the KUD, the TPC for the same milk averaged 970,000 cfu/ml (before being transferred to the cooling tank) and increased again to 1,530,000 cfu/ml once inside the cooling tank. Environmental samples at the KUD showed consistently high levels of contamination happening during transport in the KUD milk trucks, many of which had TPCs greater than 2,500,000 cfu/cm. One of the KUD's three collection trucks utilised plastic drums, which were significantly damaged. The KUD's cleaning practices should be modified to ensure that hot water and appropriate detergents are used in the trucks, cooling tanks and all other facilities.

Figure 22. Left: KUD collection truck utilising plastic drums to collect from farmers in Ciawi. Right: KUD collection truck made from stainless steel.

Farmer milk quality and hygiene training

The TPC levels of milk at the KUD were measured by the processor, Cimory. These TPC levels and the price per kg of milk paid by Cimory to the KUD were provided and plotted from January to March 2020 (Figure 23). The period from 1 January to 4 March was before the farmers received the training, which was part of this activity. After the training the average TPC levels of the KUD decreased, and the milk price received from Cimory increased. The TPC level after training, for the period from 9 to 31 March 2020, was on average 1,670,000 (cfu/ml). This can be compared to the period before training (1 January – 4 March 2021) where the TPC was 1,700,000 (cfu/ml). During this period after training the average price received by the KUD per kg of milk increased to IDR 6,627 (66 cents AUD) and the minimum price received was IDR 6,550 (65 cents AUD). In comparison, the average price for the period before training was IDR 6,311 per kg (63 cents AUD). The average TPC in April 2020, a month after the milk quality training, was 984,643 cfu/ml, which was significantly lower than the average TPC in February and March 2020 (Table 6).

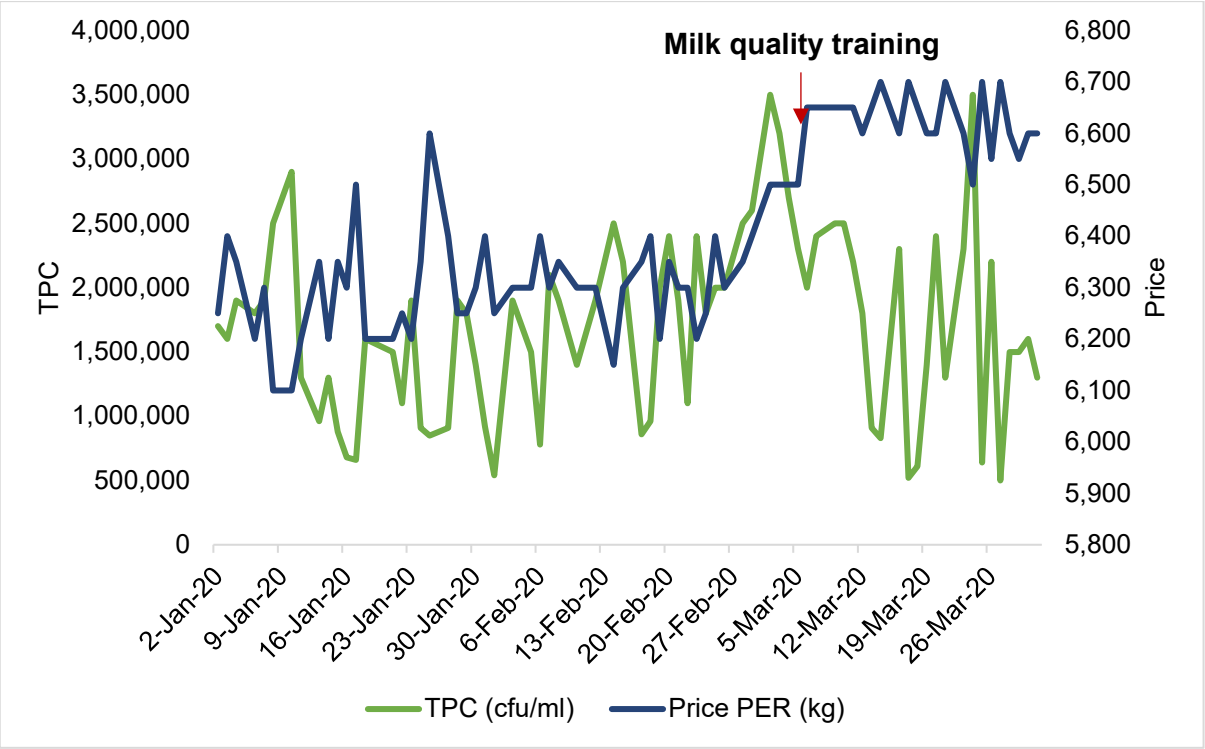


Figure 23. TPC levels and milk price at the KUD level.

Table 6 Monthly average TPC at the KUD level January – May 2020.

Month	Average TPC	SD	ANOVA/Sig.	n
January	1,452,917	572,785	AB	24
February	1,783,636	605,582	B	22
March	1,867,037	875,780	B	27
April	984,643	723,313	A	28
May	1,357,308	929,200	AB	26
Total	1,475,433	817,711	***	127

Months with similar letters are not statistically different at 5% level
SD = Standard deviation
ANOVA = Analysis of variance
Sig. = Significance
n = sample

Quality-based price incentive study

Unfortunately, this study was disrupted during implementation due an outbreak of COVID-19 in the field. The research team was not able to travel to the field to measure TPCs. This also caused delays in the timing of incentives being delivered which likely impacted the farmers' related behaviour. While farm-level results did not show a statistically significant improvement, this could be due to the nature in which farmers were tested and the inability to implement the study for a long enough period for farmers to start to receive their incentive payments. However, TPC levels for all milk delivered by the KUD to Cimory decreased from the baseline sampling period (25-30 January) and the second incentive payment cycle (16-28 February) (Figure 24).

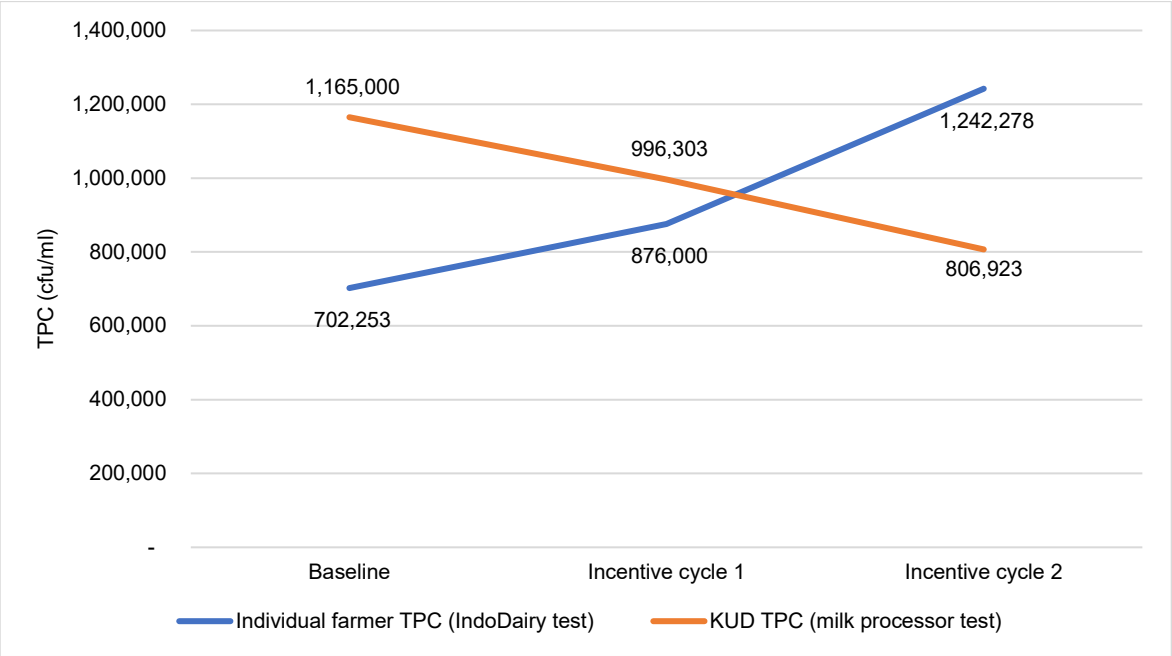


Figure 24. Total plate counts (TPC) levels during the price incentive study. Individual farmer results are from random sampling of farmers during each time period. KUD TPC results was results from the milk processor and reflects all milk delivered to the KUD on each day.

The overall feedback from the KUD board about the incentive study was positive. The board highlighted that the average milk quality of farmers increased during the incentive study, suggesting that higher prices for good quality milk incentivised farmers to improve their milk quality. The incentive study appears to have encouraged participant farmers to change their behaviours. The KUD board indicated their strong intention to continue to implement the individual quality testing to incentivise milk quality of farmers and improve their milk quality.

The KUD stated that with the improvement of quality, the KUD will receive more profit from their milk sales, and these profits will be paid back to farmers as an incentive for good quality milk. However, they highlighted that many developments were still needed, especially investment in infrastructure to implement the new measurement and payment system, including laboratory equipment and training of staff, as well as the development of a robust formula to calculate the price incentive. The KUD also indicated that they believe that with the improved milk quality, new market opportunities will open for the KUD to sell their milk to the local tourism industry.

Information from the WhatsApp Focus Group Discussions (implemented in June to July 2021), highlighted farmers in KUD Giri Tani were continuing to implement improved hygiene practices, including one producing milk with low TPC. ‘Farmer 2’ in the Cisarua Focus Group (CS_F2) said:

> *3 weeks ago, Cimory took a milk sample from my farm, the result was good. Thank God, the TPC of my milk was 70,000 cfu/ml. This is what makes the quality of our milk better…*

This statement was followed by several photos that this farmer shared (see Figure 25).

More information is available in Annex 6.

Figure 25. Farmer participant of the WhatsApp Focus Group in Cisarua shared photos illustrating milk hygiene practices they continued to implement after the project activities. Left to right: (a) Wiping udder before milking; (b) using milk sieves; and (c) washing the shed before milking.

6.2 Objective 2

6.2.1 IndoDairy Smallholder Household Survey (ISHS)

The baseline household survey of 600 dairy farming households was conducted in West Java, Indonesia during August and September 2017. The households participating in the surveyed were members of one of the five KUDs that partnered with the project. The data collected as part of the ISHS was analysed and a series of 21 factsheets (available in Annex 7) was published in Bahasa and English and disseminated to key stakeholders. The ISHS Factsheet series provided an overview of many aspects of dairy smallholders in West Java, Indonesia. Comparisons of key household and farm characteristics were made across districts, KUDs and profit quartiles.

The information gained from the ISHS allowed the research team and interested stakeholders to better understand the current socio-demographic and farm characteristics of dairy farming households in West Java, as well as issues limiting smallholder profitability. This insight helped the research team to better understand barriers to adoption of technologies and management practices and helped the team identify opportunities to improve adoption rates and address issues with dairy production and management, ultimately with the aim of improving smallholder livelihoods.

6.2.2 Adoption of Multiple Dairy Farming Technologies – Issues and Opportunities for Smallholder Dairy Farmers in West Java, Indonesia

Dr. Rida Akzar completed his PhD in June 2021 at CGFAR-UoA, under the supervision of Prof. Umberger and Dr. Peralta.[6] His PhD research utilised the ISHS and value chain data and aimed to understand the heterogeneity (i.e., diversity) in technology adoption

[6] Published article from Dr. Akzar's PhD research: https://doi.org/10.1002/agr.21782

decisions, multi-level barriers (at the farm and institutional levels) to adoption, and the relationship between adoption of different technologies and on-farm productivity.

The PhD research found that the adoption of multiple dairy farming technologies (versus single technologies) can significantly increase milk production, especially when high protein concentrate technology is included in the technology bundle. However, the high costs of adoption and the limited availability of high protein concentrate have prevented farmers from adopting this technology.

The research supported the notion that smallholder dairy farmers' awareness of technologies and the stages they reach in the adoption of technologies are varied, and that farmers are faced with multiple varied constraints at both the farm and institutional levels. These constraints limit farmers' adoption of technologies to varying degrees. Further, in the process of adopting multiple technologies, dairy farmers face different constraints at different stages of adoption. These constraints include lack of awareness, lack of access to information, capital, and improved skills to properly adopt technologies. Farm-level constraints limit farmers' awareness of technologies and farmers' ability to adopt technologies, even if they are aware of them.

Additionally, the research found that Indonesian smallholder dairy farmers are challenged by weak institutions (e.g., KUDs and other service providers) that fail to provide adequate services to address market failures such as information asymmetry (related to milk and input quality) and the high transaction costs to acquire farm inputs. For example, in theory, the role of the cooperatives (KUDs) is to address some of these market failures by providing their farmer members with services such as providing individualised information on milk quality, guidance on how they can improve quality, supplying high quality affordable farm inputs, and delivering extension services which improve on-farm practices. However, the research found that in many cases, KUDs were unable to efficiently address market failures due to their limited internal capacity (e.g., human and financial) and the complexity of the markets in which they operate.

Weak institutions result in an environment where farmers lack incentives (e.g., information on milk quality and corresponding price incentives for high quality milk) to adopt technologies that provide benefits to the entire dairy value chain and limit farmers' access to affordable technology inputs and information. These institutional constraints limit farmers' adoption of productivity-enhancing technologies (e.g., mastitis testing, feeding high protein concentrate). This suggests that interventions that focus on addressing adoption constraints at the farm level are not enough to incentivise continuous adoption. Improvements beyond farm (e.g., at the cooperative level) are needed as well.

Adequate milk quality standards and their effective enforcement to reduce information asymmetry, investments in infrastructure to reduce transaction costs in input markets, building the capacity of extension workers with up-to-date information, and the design and implementation of effective dissemination programs which meet the unique needs of heterogenous farmers may be beyond what the KUDs can do alone. Milk processing companies could partner with the KUDs to improve the services provided. For example, companies could invest their resources (knowledge and capital) in capacity-building programs for farmers and extension staff and assist the KUDs in developing milk quality assessment programs which also provide information on quality back to farmers. Additionally, they could help farmers access high quality and affordable dairy farm inputs.

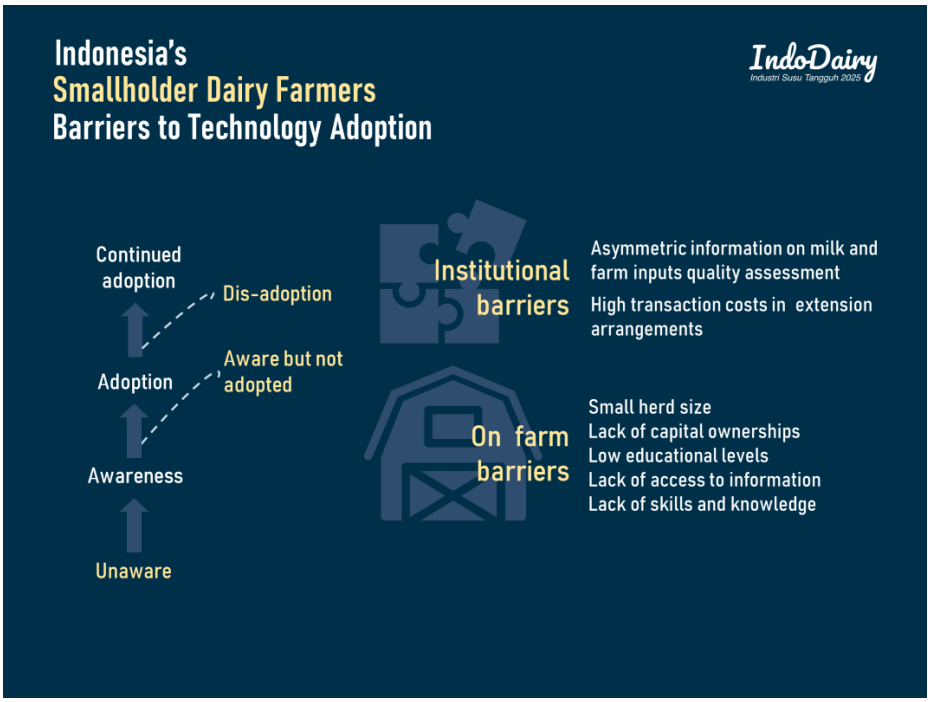


Figure 26. Summary of barriers to technology adoption for smallholder dairy farmers.

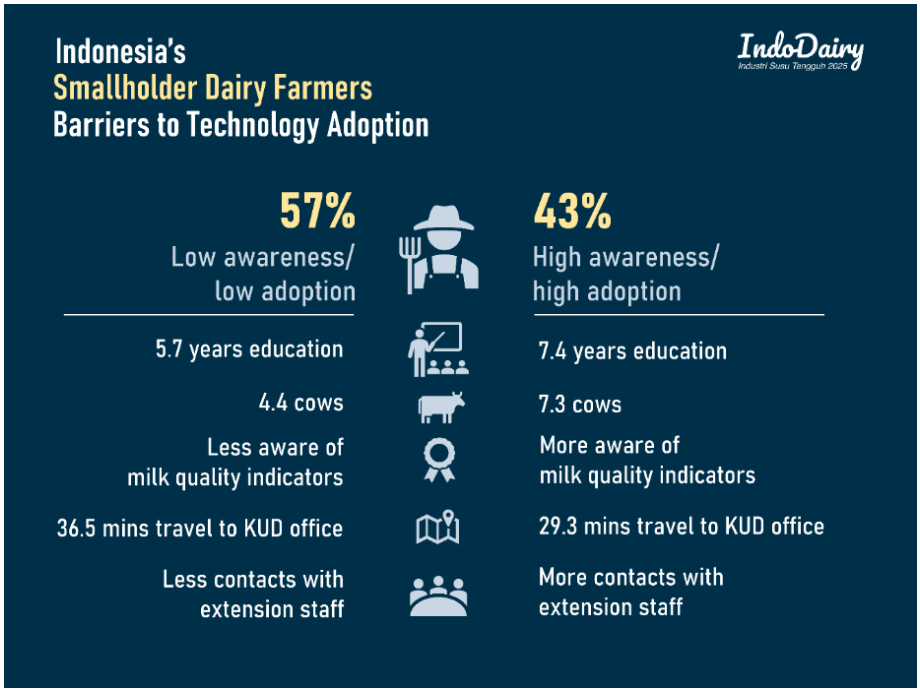


Figure 27. Summary of cluster analysis of farmers in the Indonesian Smallholder Household Survey (ISHS).

Objective 3

6.2.3 Review of Indonesian and international extension approaches

Reviews of existing technical material and successful extension methods both in Indonesia and internationally were undertaken to help inform project design and pilot delivery.

Review of extension methodologies (used internationally)

The approach taken in the review was to explore and analyse a range resource culminating in the identification of best-bet extension methodologies for the project. The review commenced with analysis of extension methodologies to establish relevant frameworks, theories and principles. The review also considered the technical focus, audience characteristics, value chain and delivery support of previous extension projects and programs to enable a customised extension approach. This report is available in Annex 8.

Literature review of dairy extension in Indonesia

A review was undertaken of dairy extension programs in Indonesia, including those offered by government and universities. The primary focus of the review was on dairy extension materials. Other relevant extension materials were also considered in the review (e.g., beef production). This report is available in Annex 9.

6.2.4 ICARD feed study

ICARD team members co-authored papers which summarised the data from the ICARD-led feed technology study. An overview of their work is provided below.

The reproductive performance of dairy cattle in smallholder farmers

The ICARD study first collected information on the reproductive performance of dairy cattle in the five KUD locations (Bogor, Cisarua, Cianjur, Garut and Pangalengan), conducted in January 2018 - May 2019. Data was collected through direct observation in the field and information reported by farmers. The parameters observed were Body Weight (BW), Body Condition Score (BCS), parity, Calving Interval (CI), Service per Conception (S/C), and Age of First Calving (AFC). The mean BW of cattle varied significantly between KUDs ($P < 0.05$), the highest BW was in Pangalengan (502.36 ± 5.96 kg) and the lowest was in Cisarua (415.19 ± 9.21 kg). The average BCS was 2.76 ± 0.30. The mean overall age was 56.20 ± 25.71 month, however, this also varied significantly by KUD location ($P < 0.05$). The mean parity for all KUDs was 2.87 ± 1.65. The average AFC for all KUDs was 26.80 ± 2.27 months, however, there were significant differences between KUDs, with Bogor having the lowest and Cisarua and having the highest AFC. The mean CI in this study was considered good, with an average for all KUDs of 13.14 ± 1.73 months. The highest CI was in Bogor (13.53 months), while the lowest was in Garut (12.04 months). The overall average S/C was 1.25 ± 0.30. The S/C in KUD Cianjur was signficantly higher than in the other 4 KUDs. The overall reproductive performance of cows was considered to be good. The differences in the reproductive performance of cows between KUD locations may be due to differences in mating management.

The conference paper is available in Annex 14. It was presented at the International Seminar on Livestock Production and Veterinary Technology: “Technology Innovations and Collaborations in Livestock Production for Sustainable Food Systems”, 6-7 September 2021.

Introduction of 16% crude protein concentrate and Ca-FA feed to increase milk production for dairy cows on smallholder farms in Bogor Regency

This study aimed to improve the quality of feed to increase milk production of dairy cows at smallholder farms in Bogor Regency. The treatment for feed quality improvement consisted of G1: 16% crude protein (CP) concentrate + calcium fatty acid (Ca-FA); G2: 16% CP concentrate + without Ca-FA; G3: 12–14% CP concentrate + Ca-FA; G4: 12–14% CP concentrate + without Ca-FA (as a control), respectively. Experimental feeding was carried out for 3 months. The results showed that feeding of 16% protein concentrate and Ca-FA had a significant effect ($P<0.05$) on milk production versus the control (G1 = 13.76 L, G2 = 10.16 L, G3 = 16.29 L vs G4 = 7.67 L), and increased consumption of dry

matter, protein, fat, and feed energy, respectively. Ca-FA supplementation had a significant effect (P<0.05) on Ca and P consumption only in cows which received G3. Feeding of 16% CP concentrate increased protein intake so that the protein content of the ration increased to G1 = 14.25%; G2 = 13.98% vs G3 = 12.87%; G4 = 12.37%. The study found that diet improvement through the feeding of 16% CP concentrate and Ca-FA significantly increased milk production.

The paper was presented at the 3rd International Conference of Animal Science and Technology, held 3-4 November 2020 in Makassar, Indonesia. The conference paper is available here: https://iopscience.iop.org/article/10.1088/1755-1315/788/1/012044

6.2.5 Extension study results

Service Provider training

Five service provider workshops were delivered to a core group of approximately 20 dairy advisors including the VLRs (Table 7).

Table 7. List of service provider workshops delivered under Objective 3.

No.	Topic	Date	Number of participants	Facilitators
1	Dairy cow nutrition	2-5 October 2018	20	Dr. Brad Granzin
2	Extension methods	5-6 March 2019	15	Ms. Zita Ritchie and Ms. Vyta W. Hanifah
3	Dairy reproduction and farm business management	8-11 April 2019	23	Dr. Phil Chamberlin Dr. Endang Romjali Ms. Zita Ritchie
4	Milk quality and hygiene	25-27 June 2019	18	Ms. Denise Burrell
5	North Sumatra Dairy Service provider workshop	20-23 January 2020	20	Dr Brad Granzin Ms. Zita Ritchie

Delivery of the extension methods workshop was crucial for upskilling VLRs and extension staff to deliver DGs and FFs in West Java. Topics covered in the training included extension methods and techniques, the adult learning cycle, participatory evaluation and how to manage challenging group dynamics. Participants, including lecturers from Bogor Agricultural University (IPB), said the training improved their understanding of teaching styles and facilitation in the university. Participants also said that the training enabled them to more confidently deliver training to larger groups and improved their ability to communicate one-on-one with farmers.

Knowledge of the participants was measured before and after the training. For the dairy reproduction workshop held in April 2019, participants' average knowledge in this subject area increased by 25%. Knowledge about farm business management increased by 24%.

In June 2019, the workshop held on milk quality and hygiene resulted in an increase in knowledge about the topic by 34% for service providers. The application of the Surf test[7] for subclinical mastitis was well received by service providers, and many service providers said they began to use their training to demonstrate and share with their farmer groups.

In January 2020, a four-day workshop was held in North Sumatra for 20 dairy service providers and researchers. The workshop covered the four technical dairy topics. The

[7] *The SURF-field test is a simple rapid test for detecting subclinical mastitis using household washing detergents. It was developed in Pakistan for smallholder farmers, replacing the conventional test which has high cost reagents.*

evaluation showed the largest increase in knowledge occurred on the topics of milk quality and hygiene best practices and managing mastitis.

These workshop activities helped to contribute to a network of skilled dairy service providers in North Sumatra and more particularly in West Java who are able to support further training and extension activities. For example, they were able to participate as trainers in the IndoDairy DGs and FFs.

Figure 28. North Sumatra dairy service providers participating in the workshop from 20-23 January 2020.

Figure 29. Dairy reproduction workshop with Dr Phil Chamberlain in Bogor, April 2019.

Discussion Groups (DGs)

Across all five regions, 184 farmers participated in the DGs. Six topics were prioritised by each group and the delivery of topics was led by the group facilitator, who was the VLR. Some groups requested very specific content such as managing mastitis or preventing fly bites, and a couple of meetings combined topics (e.g., animal health and farm business management). Some groups covered a topic more than once, such as in Cianjur where two nutrition sessions were delivered (one on forage management and another on concentrates). The full summary of topics delivered can be seen in Appendix 2.

Out of the 13 groups, roughly one-third of participants were women, totalling 53 women (29%) and 131 men (71%) (Table 8). KPS Bogor was the only women's group, which was trialled as an alternative extension strategy to encourage greater female participation. On average, farmers attended five out of six scheduled meetings. For more than two-thirds of the farmers, it was their first time participating in a DG, and almost all participants said the DGs had helped them to make improvements on their farm (Figure 30).

Table 8. Breakdown of male and female participants in the discussion groups across the five cooperatives.

Cooperative	District	Men	Women	Total
KPS Bogor	Bogor	0	16	16
KUD Giri Tani	Bogor	27	12	39
KPS Cianjur Utara	Cianjur	39	5	44
KPBS Pangalengan	Bandung	35	5	40
KPGS Cikajang	Garut	30	15	45
Grand Total		**131**	**53**	**184**

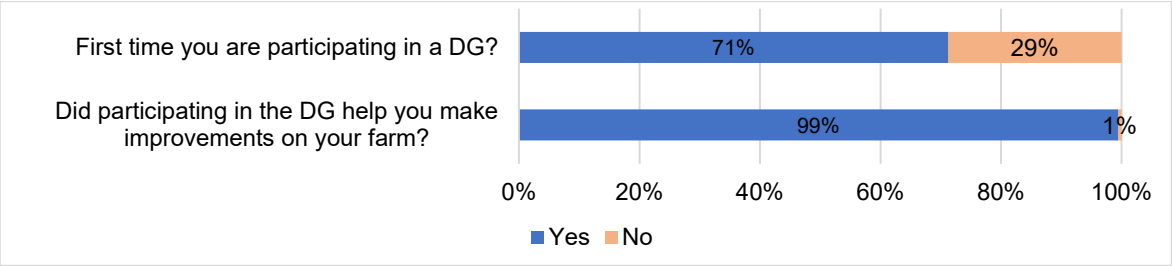


Figure 30. Farmer responses if they had participated in a DG previously and if they had made improvements as a result (n = 184).

Results from participating farmers' responses to the knowledge, attitude, and practice (KAP) and other meeting questionnaires completed as part of the DGs show that there was an increase in knowledge, attitudes and adoption of certain practices. The analysis also showed that there was a reduction in barriers to adoption of certain practices across different technical areas of feeding and nutrition, animal husbandry and reproduction, milk quality and business management. The following sections provide an overview of the broad changes in knowledge, attitudes, adoption, and barriers to adoption across the eight practices. A detailed summary of each practice can be found in Annex 11.

1. *Change in knowledge*

Farmer self-assessment of knowledge was measured on a scale of 1 (no knowledge of subject matter) to 5 (very good knowledge). Questionnaires were answered by farmers after each DG. A total of 926 farmer responses were analysed. On average, before attending the DGs, farmers' self-assessed knowledge score was 2.5. After they attended DG sessions, their self-assessed knowledge score increased by 23% to 3.6 (Figure 31). The breakdown of self-assessed knowledge score for each topic can be seen in Figure 32, where knowledge scores increased between 16% and 28%.

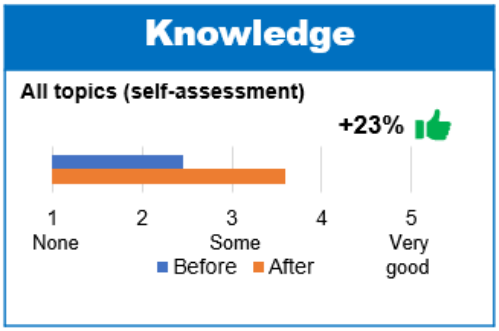


Figure 31. Overall knowledge self-assessed knowledge change for all six discussion group meetings and all farmers (total of 926 farmer responses).

In the KAP survey, quiz-style knowledge questions were asked before and after farmers' involvement in the DG program. An example of the type of quiz questions asked included 'How much crude protein (%) does your feed need to have for a lactating dairy cow?' and 'How much concentrate should a calf eat by the time it is weaned?'. Farmers were required to provide an answer without being shown correct answers. The enumerator would select all correct answers the farmer provided, which would go to an overall score. If a farmer did not give any correct answers, the enumerator would record 'Don't know'.

Overall, there was an increase in level of knowledge for the nine questions covering the four main technical topics. The full set of knowledge questions can be seen below in Figure 32. The increase in knowledge across these technical areas has contributed to a change in attitudes towards practices, as well as changes in adoption at the farm level for participating farmers.

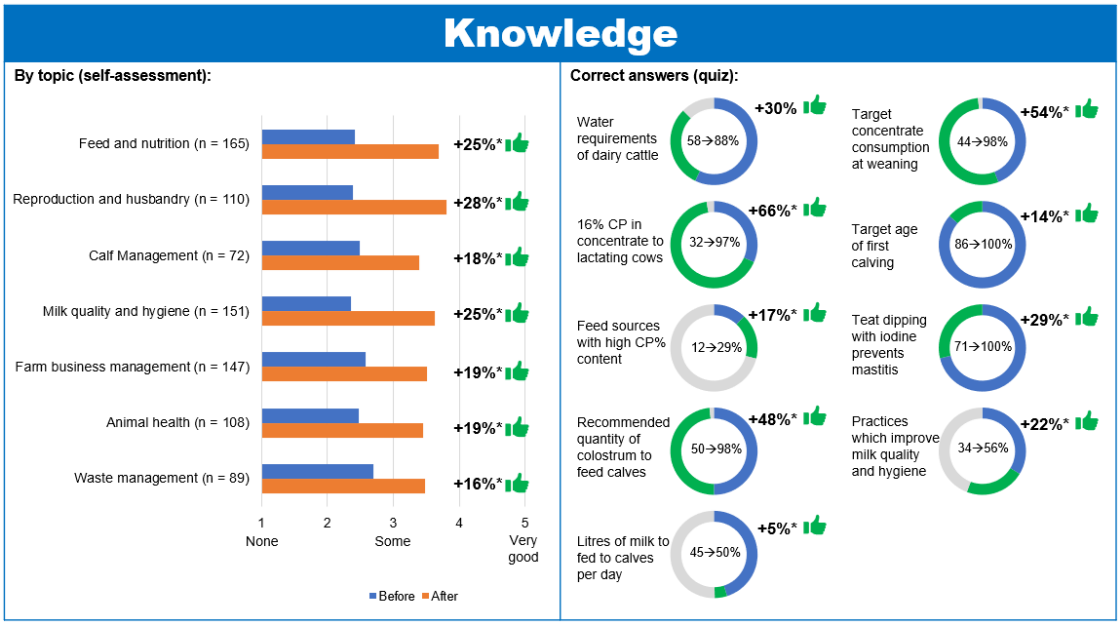


Figure 32. Change in knowledge on specific topics by the end of the study. Left chart shows the self-assessed knowledge change across topics presented in the DGs. The right chart shows specific increase in correct answers given to the quiz questions asked in the KAP surveys.

2. *Change in attitudes and intentions towards dairy farm practices*

Results from the KAP survey measured changes in attitudes regarding whether a practice would help to improve the farm generally, increase profits and was easy to apply. This was scored by farmers between 1 (strongly disagree) and 7 (strongly agree).

Overall, farmers attitudes towards the eight core practices mostly improved, including being important to improving their farms (average rating increased between 0 and 8%); increasing farm profits (increased between 1 and 8%); and being easy to do (increased between 4 and 17%). For example, farmer attitudes toward teat dipping improved, where there was a 4% increase in the view that it would help to improve the farm generally, would increase profits (increase of 6%) and was easy to do (11%) as seen in Figure 33. The change in attitudes mostly improved across the eight practices that were surveyed, and the full breakdown in attitude change can be viewed in Annex 11.

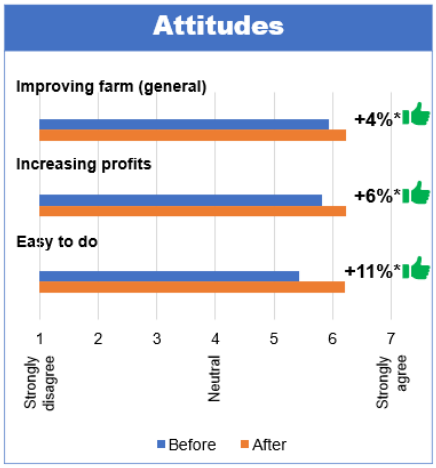


Figure 33. Change in farmers' attitudes towards teat dipping with iodine after milking (n = 184). * indicates significant difference ($p < 0.05$).

As a result of the DGs, the summary of meeting questionnaires showed that participating famers said they intended to change practices, with 92% of farmers responding that they were very likely or definitely likely to do things differently, with a further 74% saying they were likely to make changes immediately (Figure 34).

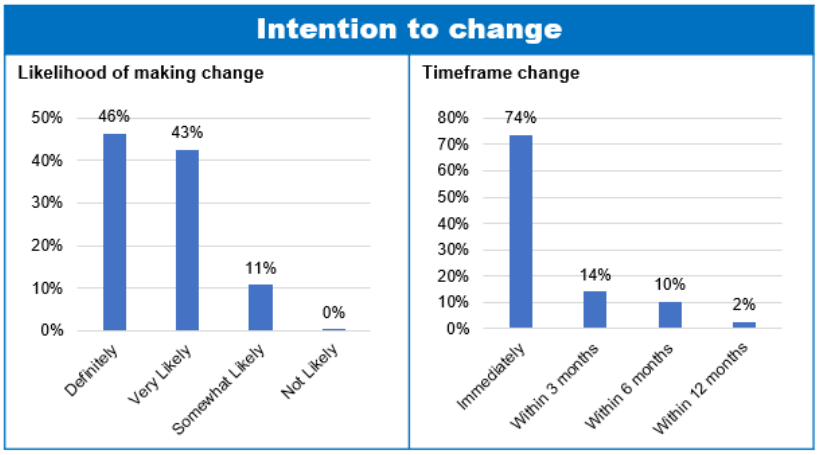


Figure 34. Proportion of farmers who intend to make changes to farming practices after participating in DG meeting (total of 926 farmer responses after 104 meetings). Left: Likelihood of changing practice as a result of recommendations during the meeting; Right: the timeframe intended to implement the change.

3. Changes in farming practices

In the KAP survey, eight practices were assessed to measure change in adoption as a result of the DGs. Results showed an increase in adoption for six out of the eight practices with varying levels of adoption observed across the four main technical areas (Figure 35). While no change in adoption occurred for *ad libitum* feeding to calves, over a longer time we may see an increase in the adoption of these two practices as they require investment, additional labour, or in some cases the farmer may not have had a calf at the time of surveying. The 2% decrease in *ad libitum* water adoption, although unexpected, was not significant and can be explained by the change in responses to the barriers to adoption.

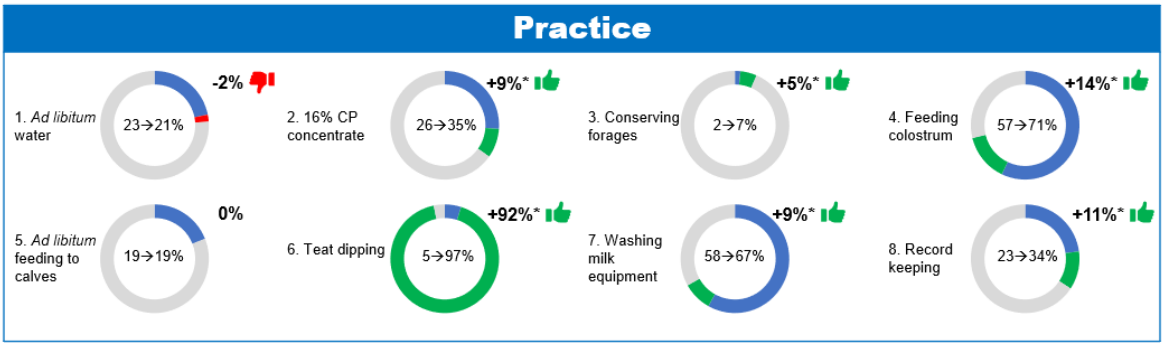


Figure 35. Change in adoption of eight farm practices for farmers involved in the DGs.

Qualitative data was captured during the participatory evaluation sessions with farmer groups in each region after all of the DG meetings Figure 37. The information captured during these sessions reflected the results found in the KAP survey.

The key practices identified by farmers in the participatory evaluation session were:

- Teat dipping – frequently reported across all 5 KUDs
- Carrying out the Surf test was widely adopted by farmers to detect subclinical mastitis.
- Improved feeding practices, such as increasing feed intake in Cianjur.
- Feeding 16% CP concentrate was a practice that most farmers intended to apply in the future. However, the main limitation was that high-quality concentrate was not available through the KUD, particularly in Cianjur and Cisarua.
- Many farmers intended to make silage and would like to have an *ad libitum* water trough in future. However, current barriers of cost to upgrade the water system and difficulties, such as access to a mechanical chopper and other equipment needed for ensiling have limited the uptake of these technologies.

The endline survey, which was conducted in December 2021, identified the technology adoption status of farmers who were involved in the DGs (n=164) (Figure 36). Washing milking equipment to improve milk hygiene was highly adopted as was teat dipping where almost half of the participants still maintained the practice. The adoption rates of the other technologies remained low due to barriers of cost and/or complexity of adoption. More analysis and discussion about the adoption of technologies using the endline dataset is available in section 7.3.4 of this report (for the full impact assessment see Annex 12).

Figure 37. The final evaluation session with DG in Cisarua, KUD Giri Tani with Rizky Febrianggia (VLR) facilitating.

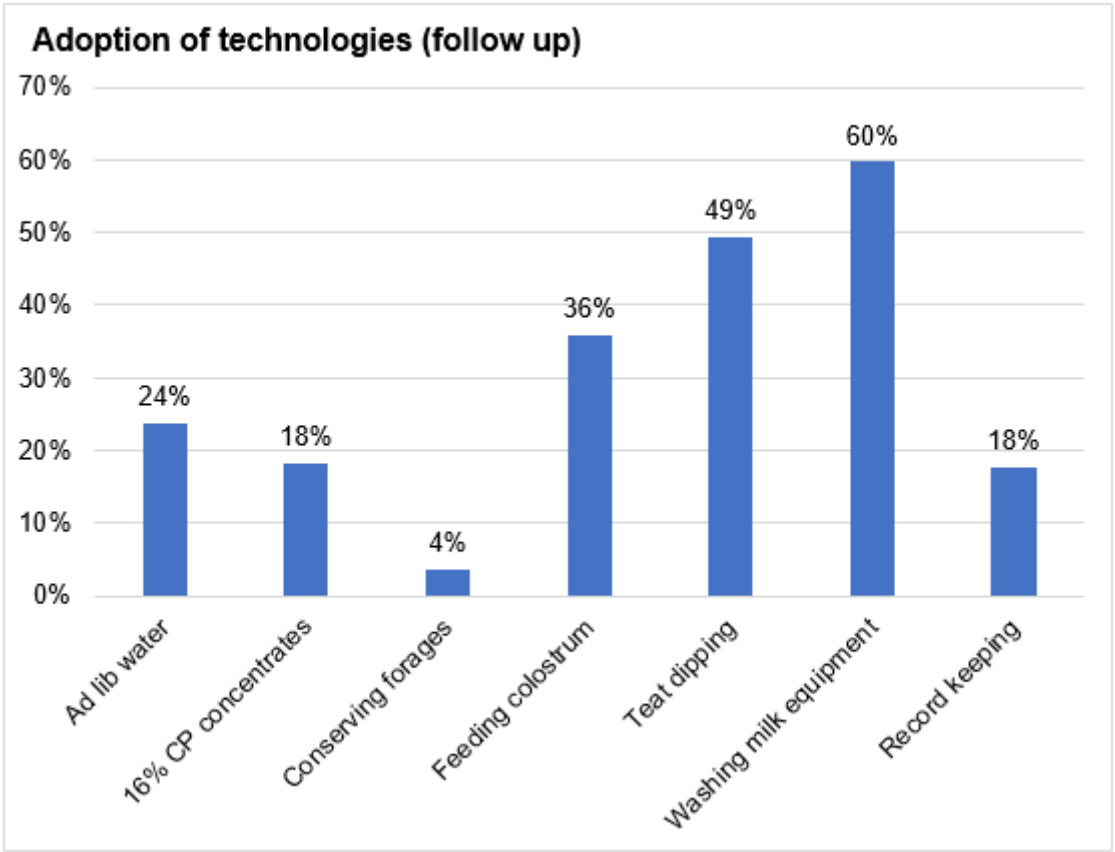


Figure 36. Adoption rates of technologies at the endline survey (2021).

4. Barriers to adoption

A number of barriers to adoption were identified for each of the eight practices (Figure 38). The lack of information about certain practices was not a barrier for any farmers after the DGs, with the largest changes occurring for information about conserving forages and *ad libitum* feeding to calves. This result shows the effectiveness of the DGs of providing

targeted and relevant information to help farmers make informed decisions about the practices on their farm.

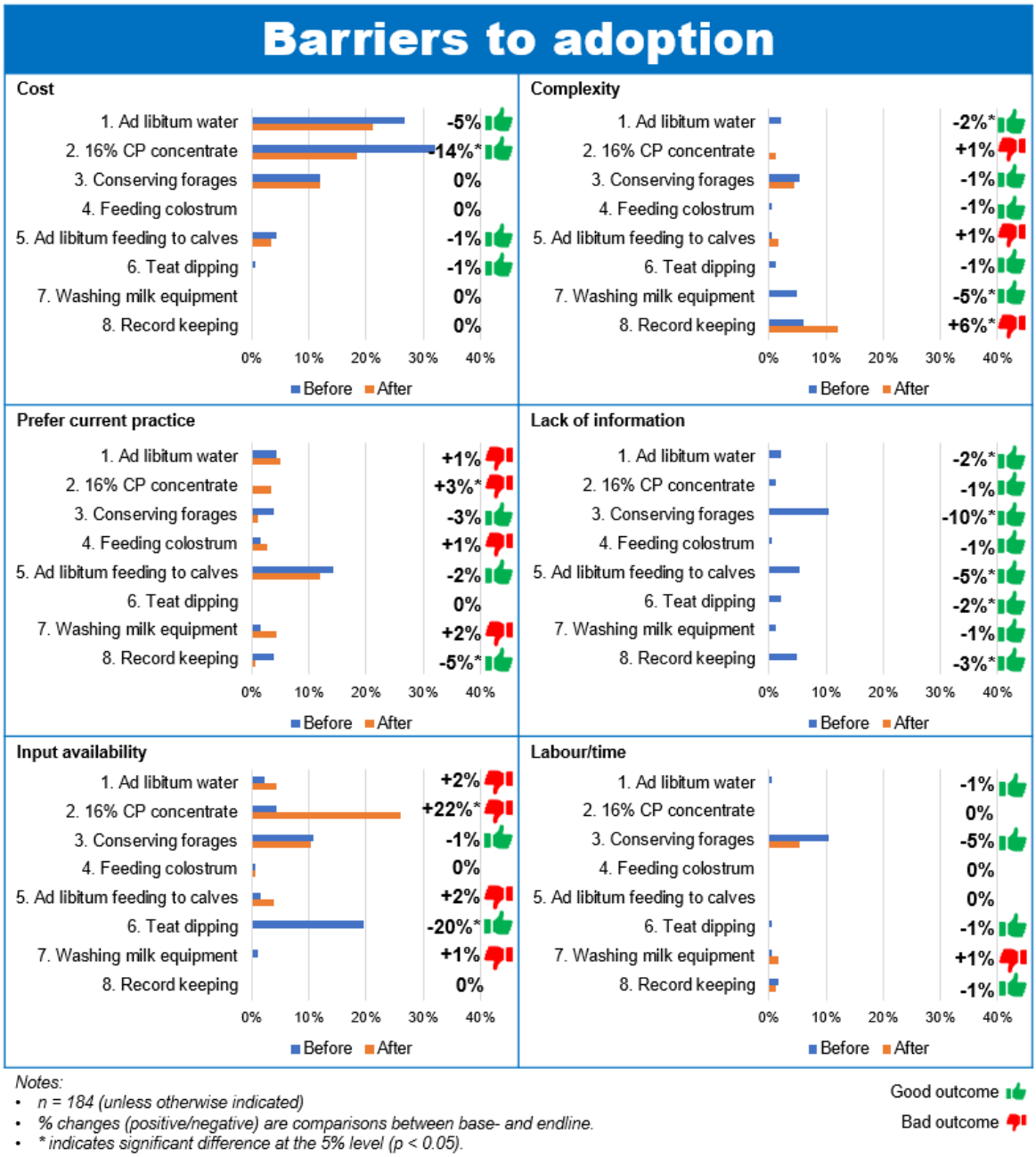


Figure 38. Change in barriers to adoption facing farmers for the eight practices.

Focus Farms (FFs)

Background

Two FFs were piloted in Cijeruk, Bogor over a 10-month period. The FF concept is a shift away from the conventional approaches employed by research and development centres in Indonesia, who typically use demonstration farms. A demonstration farm is a farm used primarily to research or demonstrate various agricultural techniques or technologies, where institutional research objectives determine the activities on the farm (a top-down approach). In contrast, an FF is a commercial farm, which aims to assist the farmer to achieve their stated goals, whereby changes are driven by the farmer with the support and guidance from an advisory group.

In Australia, an FF is usually facilitated over a two-year period to allow adequate time to develop strategies and actions, implement changes and see the results on farm and to the overall business performance. Given the success of the FF approach in Australia, the FF methodology was tested for the first time in West Java, Bogor to see the response from farmers and advisors, and compare it to the DGs that were delivered concurrently. Due to limited time available in the IndoDairy project, the FFs were trialled as a pilot over a shorter period (10 months).

Two farmers (Figure 39) were chosen in Cijeruk, Bogor: 1) Pak Yunus, a younger farmer with one milking cow and 2) Pak Ma'mur with a larger farm operation with approximately 20 milking cows, who also had a milk vat and collection for other farmers as part of his group (outside of the KUD KPS Bogor). These two farmers were selected through an expression of interest based on the criteria of their vision to improve their farm, open to providing farm financial data and sharing their learnings with the advisory group. One farmer (Pak Yunus) was part of the cooperative, while Pak Ma'mur was selling his milk privately through a separately established group. Both farmers were willing and motivated to participate, with clear goals discussed during the first planning session. An advisory group was formed for each farmer, which consisted of 8-10 farmers and advisors. Over time the attendance of the advisory group was variable, especially from advisors who often were unable to attend each meeting.

Figure 39. Focus Farmers Pak Ma'mur with wife Ibu Ening (left photo) and Pak Yunus with his family (right photo).

Feedback from FF advisory group

The FF advisory group evaluated the information discussed and the experience of being involved in the FFs, giving it an overall rating of 4.4 out of 5 (rating between 1 - no value and 5 - excellent value). All participants said they would recommend the opportunity of being involved in a FF to others. Overall, 75% of participants said they gained a good understanding about the business of the farmer, with the remaining 25% saying they gained a partial understanding about the farm business.

For knowledge, 81% of the participants said they gained new knowledge and 19% partially gained new knowledge. Pak Endang, a support farmer, started feeding molasses and soybean on his farm after seeing the benefit through the feeding trial on Pak Yunus's farm. He said, *'Feeding molasses and soybean meal showed a great result as milk production increased 1-2 litre/cow/day'*. Other farmers reported the usefulness of learning about new forages, harvesting times, making silage and the importance of feed quality, especially in early lactation.

A summary of the farmer profiles, goals and main project activities are provided in Table 9.

Summary of Focus Famer profiles and results

Table 9. Focus farmer profile for Pak Ma'mur and Pak Yunus

	Pak Ma'mur	Pak Yunus
Farm goals (longer term)	1. Build an Agro Tourism facility as a way of utilising owned land assets and increasing sales of dairy products (long term goal) and; 2. Increasing milk production from 10 litres to 20 litres/cow/day.	1. Increase the dairy herd from 1 cow to 15 cows over the next 10 years and; 2. Increase milk production to over 15 litres/cow/day (shorter term). 3. Successfully submit cow to AI (after a few failed inseminations).
Key activity and intervention areas for the Focus Farm	Focus on improving forage production and utilisation as a means to increase milk production.	Improve milk production and profit by increasing home grown forage availability and quality, rather than relying on roadside grass.
Farmer profile – July 2019	• Average number of milking cows: 15 • Average milk production: (litres/day/cow): 10 • Current milk fat: 3.9% • Current milk protein: 3.2% • Average milk price per litre (8 months): IDR 5,038 (50 cents AUD) • Farmer Group: Mandiri Sejahtera, Cijeruk, Bogor	• Number of milking cows: 1 • Average milk production: (litres/day/cow): 11 • Current milk fat: 3.6% • Current milk protein: 3.1% • Average milk price per litre (8 months): IDR 5,477 (54 cents AUD) • Farmer Group: Kania Group, Cijeruk, Bogor
Key activities	• To improve the fertility of the soil, fertiliser was applied through compost and inorganic fertilisers. • Trialling new forage varieties such as biograss grass (an improved variety of elephant grass from Biogen, a government research institute) and a legume called Clitoria. Some treatments of urea were also applied to improve forage yields and quality. • A feeding trial to increase the overall crude protein and soluble carbohydrate content of the diet by supplementing with soybean meal and molasses for 21 days for six lactating cows. • Making silage from biograss and elephant grass using molasses and an inoculant. Silage quality was measured.	• Planting forages including elephant grass and odot with a treatment of urea on half of the plot. Clitoria seeds were also planted in between some of the rows as a legume. • Soybean and molasses were added to the cow's diet for 2 months to help to increase milk production, body condition and heats. • Making odot silage from the forage planted.

Key impacts	• Improved understanding of farm business analysis, silage making and different forage varieties e.g., Biograss with higher protein content (18% CP at 91 days of growth) • Feeding soybean meal and molasses results showed the greatest response in early-mid lactation cows with an average increase in milk production for the six cows of 1.7 litres per day. Therefore adding soybean meal and molasses is an effective way to increase milk production by adding extra protein and increasing the sugar content in the diet to increase dry matter intake. Pak Ma'mur said, "Soybean meal and molasses showed to increase milk production across the six cows but the best response was seen in the early lactation cows. This helped me to pay more attention to the cows in the early lactation with an opportunity to feed them the better quality feed available". More information can be found here: https://www.adelaide.edu.au/global-food/news/list/2020/04/05/focus-farmer-pak-mamur	• Supplementary feeding increased milk production by 2-3litres/cow/day. • The cow was also successfully submitted to AI after soybean supplementation, and was 4 months pregnant as of March 2020. • Growing odot as a forage has been successful. Odot was also trialled for making silage, which showed a higher CP percentage and digestibility than elephant grass fed fresh or as silage. More information can be found here: https://www.adelaide.edu.au/global-food/news/list/2020/04/01/focus-farmer-pak-yunus
Farm business analysis	• Average net profit IDR 2,337 per litre (24 cents AUD) • Net profit removing livestock sales IDR 303 per litre (3 cents AUD) • Farm profit was largely driven by livestock sales, where some animals were sold during the time of the FF. • There was no obvious change in farm profit during the time of engagement with the FF and would need a longer time period.	• Average net profit IDR 1,459 per litre (15 cents AUD) • Profit per litre at the start of the FF was IDR 1,271 per litre (13 cents AUD) (July 2019) and increased to IDR 1,468 per litre (15 cents) (Feb 2020) at the end of the 8 months for the one cow. A full year's analysis would be needed to see a change over a longer period.
Farmer testimonials	"From the Focus Farm, I have learned a lot about forage management and gained a lot of information about the condition of my cows. I've also gained new relationships and a lot of new knowledge about my business analysis, quality of milk, and managing the land using soil tests, compost and trialling new types of grass such as biograss which I now know about and its nutritional value. Thank you IndoDairy for allowing me to learn a lot during this Focus Farm activity and the team for their support."	"The involvement in IndoDairy helped me become aware of things that I didn't know about. Feeding soybean meal and molasses made me aware of how to improve cow condition for better reproduction, and the benefits of giving forage or supplementary feed. Hopefully in the future I can pay more attention to feeding the cow better such as providing soybean meal and molasses. Thank you so much IndoDairy and the team - it has taught me a lot about the current science."

Profitability comparison of the FFs

Figure 40. Left – Focus Farm Discussion group meeting at Pak Ma'mur's farm. Right – Ploughing the land at Pak Yunus's block prior to planting odot and elephant grass.

Comparing these figures with the analysis of 600 households in the IndoDairy Smallholder Household Survey (ISHS) (Annex 7) under Objective 2, shows that the two FFs sit in the bottom half of the sampled population with regards to profitability. In the ISHS factsheet series, a comparison of profitability quartiles was conducted (see Factsheet 13 in the series) and the average profitability of Quartile 1 (Q1) (lowest profitability) was – IDR 100 per litre (1 cent AUD), and the average for Quartile 2 (low to mid-profitability) was IDR 1,940 per litre (19 cents AUD). The profit calculations from the ISHS do not include livestock sales or purchases. This reflects the type of smallholder farmers the IndoDairy project has been engaging with and is representative of the type of farmers in the region. Removing the livestock sales from Pak Ma'mur resulted in a net profit of IDR 303 per litre (3 cents AUD), showing that he sits within Q1 farmers, and derives a much lower profit from milk sales alone. However, the short feeding intervention of molasses (0.5kg) and soybean (1kg) for six cows over 21 days resulted in an average of 1.7 litres extra milk per cow/day, leading to an increase in profit of IDR 1,182 /cow/day (12 cents AUD). A full-year business analysis would better reflect the calendar year of activities on the farm and average profit on the farm, as well as the value of this feed intervention over a longer period.

Future considerations of the FF method

Although the FF is a group extension approach it differs from implementing DGs. FFs are more resource intensive to establish and deliver, as they require advanced levels of expertise from a technical advisor/s and a whole farm perspective. Depending on the on-farm interventions imposed (aligning with goals of the farmer) it needs to have a very high chance of success and to show impact within the lifespan of the FF. Consequently, FFs are not a methodology for high risk interventions.

The strengths of FFs are that they allow concepts to be explored in more detail using an actual farm to demonstrate concepts. This provides an opportunity for other farmers to see firsthand new technologies or practices implemented rather than general concepts through the DG method. For both farmers, specific interventions were designed to suit their specific needs resulting in small changes and impacts on farm, which other farmers were able to learn from.

The short time available for the pilot (only 10 months) was a major constraint, as this limited what interventions could be tested. Ideally, two-years is needed to evaluate impact. Farmers have suggested that in the future, meetings run over a longer duration, with greater farmer participation at meetings. One farmer suggested bi-monthly meetings, showing the FF activity was well received. Inclusion of more practicals in the meetings was also suggested to improve learning.

Feedback from the advisory group suggested providing clearer guidelines about their role in FF meetings. One advisor noted that the Australian team had more of a lead role in meetings, which is important to address if this activity is run in future in other regions. The

set up and involvement of the advisory group is critical for success of the FF, where it is important for the advisors to learn and build their network as compensation for their participation.

The FF concept is a shift from the conventional demonstration approaches. Participating researchers in the advisory group mention a greater need for technology dissemination in the FF, highlighting the existing focus on traditional technology dissemination compared to implementing innovative extension methods in Indonesia.

The FF method is not as easy to scale out compared to DGs, with further investigation needed prior to expanding, as well as sufficient resources available for technical support. The success depends on the willingness of farmers to participate and commit to the process, as well as an adequately supported advisory group for technical oversight. Evaluation of participants and impacts on the two FFs in Cijeruk show proof of concept that a FF can work effectively in Indonesia, however a recommendation would be to trial the FFs over a longer timeframe (two years) for improved engagement from advisors and for sustained impact.

For more information about the extension study results see Annex 11.

6.2.6 Endline survey and focus groups

The endline survey was a 480-household panel dataset (2017 and 2021) and the research team also conducted WhatsApp Focus Group Discussions (WFGDs) where farmer participants were able to share their feedback, including with photos and videos. While the project activities covered a wide range of practices and technologies, there were six technologies that were consistently the focus and therefore measured across the project interventions: two milk hygiene practices (teat dipping after milking, mastitis testing); three dairy nutrition practices (high protein concentrates, forage conservation, and ad libitum drinking water availability); and one business management practice (record keeping).

Results from quantitative analysis identified significant changes in short- and medium-term outcomes. Initial descriptive comparisons between baseline and endline of the project beneficiaries and non-beneficiaries highlight interesting changes. This is followed by a multivariate analysis, which controls for multiple confounding factors. To complement the quantitative results, the qualitative impact stories shared by farmers are presented to provide more insights on the project impacts. Additionally, a specific module was included to capture how COVID-19 has impacted farmers.

Overall trend between 2017 and 2021

Both beneficiaries and non-beneficiaries experienced improvements in food security, with an increase of 13-14% household categorised as food secure. The proportion of household income from dairy farming increased by 7% and 9% for beneficiaries and non-beneficiaries respectively. However, milk productivity decreased by 4% for beneficiaries and 12% for non-beneficiaries. Awareness of all six technologies increased (between 10% and 33%). There was a high level of attrition of dairy farmers (30%). This was more noticeable among the non-beneficiary group.

Effect of the COVID-19 pandemic

Restrictions as a result of the COVID-19 pandemic, limited households' activities outside of home, including smallholder dairy farmers' access to inputs, markets and services (e.g., extension and veterinary). The major effect of the restriction was on farmers' access to receive technical support and increases in feed input prices (such as wheat pollard and by-product feeds). One example of this was that tofu waste became scarce when restaurants closed and the consumption, and as a result production, of tofu decreased.

Differences between beneficiaries and non-beneficiaries

Behaviour change – Participants in the project intervention (beneficiaries) were significantly more likely than non-beneficiaries to adopt teat dipping after milking (by 31%); mastitis testing (by 23%); and unlimited access to drinking water (by 17%). When considering the six technologies in combination, project beneficiaries would on average adopt 0.61 more technologies (or ~ 1 technology) compared to the non-beneficiaries. There was no statistical difference in adoption of high protein concentrates, forage conservation and recording keeping. Farmers reported several external barriers to adoption of these technologies, including cost, availability of inputs and complexity.

Production outcomes – Although there was an overall decrease in milk productivity for both beneficiary and non-beneficiary farmers, we found that beneficiaries were able to mitigate this to a greater extent. The multivariate analysis found beneficiaries had, on average, 1.24 litres per cow day higher productivity compared to non-beneficiaries (P-value < 0.01). Therefore, without the IndoDairy project interventions, the beneficiary group would have produced, on average, 1.24 litres per cow per day less milk.

Livelihood impacts – We did not observe any statistical difference between beneficiaries and non-beneficiaries in livelihood indicators such as food security, food consumption and profitability. Interestingly, farmers' participation in the project intervention improved women's participation in dairy farm decision-making by 15% (p-value < 0.01).

Potential long-term impacts

Although the long-term impact indicators including profitability, food consumption and food security were not significantly improved, this is not surprising given the relatively short amount of time between when the intervention concluded and when the impact study was conducted. Additionally, the external factors affecting farmers as a result of COVID-19 and other factors (e.g., production costs and access to services), as well as the poor record keeping (which makes assessing profitability challenging) may have affected the impact analysis. However, the higher milk productivity for beneficiaries does translate to a tangible economic impact for smallholder farmers. An average 1.24 litres more milk per cow per day (9% of the average milk productivity) translates to approximately 1,043 litres per farm per year, which represents IDR 6 million.

Qualitative impact stories

Farmers expressed that their participation in the project intervention has improved their awareness and knowledge on good dairy farming practices. Improvements in milk production and quality were gained by farmers after consistently adopting good dairy farming practices which they have learnt from the project.

Reporting on the short-run and potential long-run impacts, including the qualitative responses, can be found in Annex 12.

Dairy farmer attrition

Prior to the implementation of the endline survey, the project identified that 30% of dairy farmers who were involved in the project (total 686 farmers) have left the dairy farming business. Thirty-six (36) randomly selected ex-dairy farmers distributed across five cooperatives were surveyed in October 2021 to understand the reasons for ceasing their dairy business. The main reasons for the departure from the diary sector were: the households were no longer dairy farming as the household member responsible for the dairy business passed away or retired and no other family members was available to continue the business; death or reduced production of animals; and the household needing cash. The full report developed by the ICASEPS team can be found in Annex 13.

7 Impacts

7.1 Scientific impacts – now and in 5 years

The milk quality study (under Objective 1) has generated new knowledge in relation to the potential benefits gained by all chain participants from providing price incentives to improve smallholder milk quality. The new knowledge shows using a value chain approach to address a common quality issue can be an effective driver of behavioural change. In this example, bacterial contamination was identified as a critical issue facing local dairy production with significant contributors at the farm-level as well as the cooperative. Through partnerships, and support from the processor as well as the cooperative (KUD), the individual testing and price premiums had benefits along the chain.

Although these impacts have not been realised at the time of reporting, we believe within five years the conceptual framework used to understand the complex process of technology adoption by smallholder farmers will be used by other researchers and will enhance how researchers consider their measurement methods and analytical techniques. In addition, the new knowledge from the thesis will also have the potential to divert the attention from understanding the farm-level issues to address adoption barriers to focus more on the issues that are beyond farm (i.e. institutional arrangements to ensure incentives from adoption and availability and affordability of quality inputs).

New knowledge has been generated through the activities implemented as part of Objective 3. The extension design and implementation of the DGs led to an increase in knowledge across the technical areas, change in attitudes, as well as increased adoption on farm of six out of the eight practices. This pilot demonstrated the positive impact and value that an extension program can have when it designed in a participatory way to meet the needs of participants. The Objective 3 activities demonstrated that participatory extension approaches have the potential to drive sustainable on-farm change provided they address the local needs and challenges of farmers. Therefore, to empower farmers and allow them to shape their training priorities and technical needs, future extension programs should consider inclusive, ground-up extension design approaches, rather than traditional top-down dissemination approaches.

Due to the outbreak of foot-and-mouth disease (FMD) in Indonesia, as of June 2022, GKSI (‘*Gabungan Koperasi Susu Indonesia’* - Indonesian Association of Dairy Cooperatives) reported 14,226 dairy cows (out of a total 75,714) were suspected to have been infected by FMD. The value chain mapping conducted in West Java by the IndoDairy project team has been used by the government to model the potential impacts of the disease in the region. While FMD is likely to have a significant negative impact on smallholders’ milk productivity and in-turn their livelihoods, the research conducted as part of IndoDairy has helped local authorities respond to the outbreak.

7.2 Capacity impacts – now and in 5 years

Capacity building has been a major focus of the IndoDairy project with a focus on the capacity of farmers, extension officers, researchers and the project’s Village Level Researchers (VLRs). Capacity impacts are outlined below.

1. Farmers

The findings from the extension study showed significant improvements in farmers’ knowledge and attitudes regarding multiple technologies, the interventions translated into

behaviour change for some practices. Comparing changes between 2017 and 2021 for both beneficiary and non-beneficiary farmers we observed improved knowledge across the six core technologies the project addressed. The rate of behaviour change differed for each technology and this was discussed further in the Economic impacts section.

The potential future impacts (within the next 5 years) to farmers' capacity are likely to improve significantly as a result of the improved capacity of service providers, including KUD extension staff and VLRs who have used the resources and extension approaches with other resources. These are discussed more in the following paragraphs.

2. Village Level Researchers (VLRs)

A large success of the delivery of Objective 3 has been due to the project's investment in the capacity of the five village level researchers (VLRs), who were all recent Animal Husbandry graduates recruited to the project in June 2018. The five VLRs – three male and two female - played a critical role in supporting the delivery of Objective 3 extension activities in the field, including the nutrition dissemination study, data collection, and facilitating discussion groups (DGs) and Focus Farms (FFs) in Years 3 and 4.

The VLRs were provided with technical training alongside dairy service providers, as well as training on innovative participatory extension methods and facilitation skills to better deliver the DGs and FF activities in the field. Ongoing mentoring was provided to develop the VLR's soft skills including English and technical writing, producing factsheets, oral presentations, video-making, facilitation, data collection and analysis (including the use of CommCare), time management and teamwork.

Additionally, the capacity impacts of the VLRs, as well as Indonesian government researchers Dr. Endang Romjali and Ms. Vyta W. Hanifah, were further reinforced by an ACIAR-funded grant which allowed them to travel to experience and learn from Australia's tropical and subtropical dairy industry in Queensland (ACIAR contract number: C001445).

Figure 41. IndoDairy team during the field trip to Queensland's dairy industry in 2019. Back row: (from left) Dr. Endang Romjali (ICARD), Dr. Todd Sanderson (ACIAR), Ms. Zita Ritchie (UoA), Dr. Brad Granzin (ADC), Mr. Jack Hetherington (UoA), Mr. Rizky Febrianggia (VLR). Front row: Mr. Rio M Fauzan (VLR Team Leader), Ms. Attin Syahnurotin (VLR), Ms. Eulis Diah Sri Rahayu (VLR), Ms. Vyta W. Hanifah (ICATAD), Mr. Muhammad Fauzi (VLR). Photo: ACIAR/Patrick Cape.

During latter stages of the project, the VLRs demonstrated impressive initiative including leading the milk quality feedback reports provided to farmers and hosting an online webinar series between November and December 2020 when field activities were postponed due to COVID.

After their project roles concluded, all VLRs were recruited into roles to support the development of the Indonesian dairy sector. Mr. Fauzan, Mr. Febrianggia and Ms. Syahnurotin were employed on an Asian Development Bank (ADB) project which aims to training 1,000 women dairy farmers between 2020-22 in the West Java region. More information about the ADB project can be found here. Mr. Fauzi has gone onto obtain a role as a Dairy Field Facilitator with the Netherlands Development Organisation (SNV) and Friesland Campina. This programme also aims to train 1,000 women dairy farmers in West and East Java. Ms. Eulis Diah Sri Rahayu is currently completing a Master's of Animal Science at Wageningen University and Research (WUR).

Overall, the VLRs were passionate about continuing future careers in the dairy industry in Indonesia after being involved in the IndoDairy project, which is a positive unintended outcome of the project.

"From the IndoDairy project I've learnt so much about how to deliver practicals and demonstrations, as well as how to present through learning the methods of extension. For my future work, I will use these extension learnings to deliver information and prepare materials needed by the farmers."

Ms. Attin Syahnurotin, VLR from Cijeruk and Women's discussion group facilitator.

"When I began my role with IndoDairy I was only an enumerator who could collect data. But under your leadership and guidance I was able to grow into the role of a VLR and a person who could contribute to dairy farming practices, farmer livelihoods and assist farmers and the KUD to perform well on their businesses. Now I have big dreams to improve dairy sector and to be a professional in this industry. Every single thing I gained from IndoDairy will be a promising asset for me; the networking, skills, and experience."

The VLR team leader, Mr. Rio M. Fauzan.

3. Dairy Service Providers

Capacity building occurred across the dairy service sector in West Java and North Sumatra under Objective 3. Training for service providers were targeted towards the four key technical areas, addressing dairy cow nutrition, reproduction and calf rearing, milk quality and hygiene, and farm business management. An additional workshop on extension techniques was delivered and the participants for these workshops consisted of the same core group of individuals ranging between 15 and 25 participants per workshop, including the VLRs, KUD staff and researchers from ICARD and IPB. Ongoing mentoring in the field occurred for KUD staff involved in the DGs, as well as service providers involved in the FF advisory meetings throughout 2019 and into 2020.

Ongoing mentoring of milk cooperative staff involved in the DGs, has resulted in wider dissemination of technical information and training with farmers. Mr. Yan Yan and Mr. Ade (Figure 42) are extension officers in KPBS Pangalengan, West Java who have adopted new extension techniques after being involved in the IndoDairy DGs. The training and extension materials provided on calf management were useful for their farmers as they had never been delivered before in Pangalengan. After being involved in the discussion groups, Yan Yan said, *"Now I have delivered the topic on calf management to an additional 340 farmers who are currently under my supervision"*. This was also extended by another five extension staff in the KUD, reaching a total of 2,000 additional farmers in the Pangalengan region.

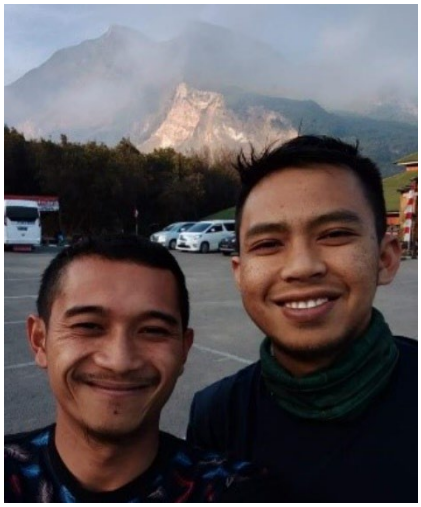


Figure 42 Mr. Yan and Mr. Ade, extension officers from KPBS Pangalengan.

During the WhatsApp Focus Group Discussions (WFGDs) conducted in June and July 2021, extension staff reported they had continued to introduce and encourage farmers to implement the following practices:

a) Farm business management - recording expenses and income
b) Reducing mastitis through improving air circulation, barn size and allowing the barn to dry properly.
c) Cleaning the udder before milk, with one clean towel per cow, and milking mastitic cows last.
d) Monitoring the health and nutrition of the cow by inspecting the manure.
e) Extension about calf rearing
    i) Post-birth: providing colostrum as soon as possible to the calf with minimum 4 litres within the first 12 hours.
    ii) Providing concentrate to calf in their early ages to accelerate growth.
    iii) Providing feed and water separately to calves.
    iv) Body scoring calf: Knowing the right time when the calf can be weaned.

4. Institutional capacity impacts - Indonesian researchers and dairy cooperatives

Training provided to ICASEPS researchers in 2017 on the use of the data collection application CommCare. Through the training and continued use of CommCare in project activities encouraged the team to use CommCare and other data collection applications in other areas of ICASEPS's research.

Research and extension staff from government and universities have played a critical role in the project, where they have also had the opportunity to participate in training to build their skills and knowledge in dairy management. Representatives from IPB, ICARD, and the Indonesian Center for Agriculture Technology Assessment and Development

(ICATAD) were regular participants across all of the training workshops, as well as extension field activities.

Additionally, Ms. Vyta W. Hanifah went on to provide training for researchers and extension staff at ICATAD. Ms. Hanifah, as the focal point in Indonesia for delivery of Objective 3 extension activities used the learnings from the training in extension and facilitation more widely within her organisation, across a range of sectors including crops, horticulture and livestock. After completing the IndoDairy training in March 2019 on extension and facilitation methods she conducted a workshop for 13 colleagues titled 'Facilitation techniques for enhancing extension skills', to build capacity in this area. Since this time, Vyta has incorporated participatory extension and evaluation methods into her work within the organisation on other projects, primarily a project funded by the World Bank called SMARTD (Sustainable Management of Agricultural Research and Technology Dissemination) and with groups of university students that she manages. This additional work shows the far-reaching impacts of the training and workshops provided under Objective 3 of the IndoDairy project.

Figure 43. Farmer group leader (right), Pak Dedi, receiving the milk quality award for the Ciharus farmer group from the KUD representative (left) in Cikajang, West Java.

Institutional changes were also seen at the milk cooperative level, where KPGS Cikajang in Garut District provided teat dips and iodine to all the farmers in their cooperative (approximately 1,500 farmers) after seeing the improvement in milk quality from farmers involved in the DGs. A farmer group from the same KUD also celebrated receiving third place in the milk quality awards against 32 other farmer groups in the milk cooperative.

"This prestigious award was achieved by the Ciharus group after decades of waiting. Thank you IndoDairy for facilitating our discussion group to increase our knowledge and skills which contributed to winning this award", said DG farmer, Pak Dedi (pictured right).

Case studies, highlighting selected farmers, service provider and institutional impacts can be seen at https://www.adelaide.edu.au/global-food/research/international-development/indodairy under News and updates.

Further institutional capacity impacts were seen in KUD Giri Tani (Bogor District), who received training and equipment to conduct individual farmer TPC testing as part of the price incentive study (Act 1.7.4). These impacts have the potential to significantly improve the livelihoods as farmers could receive up to a 20% bonus on the base milk price.

Prof. Daryanto and Dr. Sahara from the IPB team published a book titled 'The Voice of Youth: The Future of Dairy Industry in Indonesia' in 2022, which included 44 articles written by young Indonesian students, researchers and professions (between 15 and 34 years old). The topics covered value chain, blockchain, and partnerships; certification, food safety, and challenges in the industry; and policies and prospects of dairy industry development in Indonesia. The book was launched at the End of Project Review in April 2022 (see Annex 16).

7.3 Community impacts – now and in 5 years

7.3.1 Economic impacts

The overall results show that the participation of farmers in IndoDairy project intervention has had positive and significant impacts on farmers' technology adoption behaviour and milk production. The participatory extension approach (i.e. discussion groups and focus

farms) taken by the project found to work well according to farmers, where it has improved farmers awareness and knowledge on good dairy farming practices.

Behaviour change

Participants in the project interventions (project beneficiaries) were significantly more likely (31% higher) than non-participants to adopt teat dipping after milking; mastitis testing (23%); and unlimited access to drinking water (17%). When considering the six technologies in combination, project beneficiaries adopted 0.61 more technologies (or ~ 1 technology) than the non-beneficiaries. There were no statistical differences between groups in the adoption of high protein concentrates, forage conservation and record keeping. Cost, availability of inputs and complexity were reported as barriers to adoption.

Interestingly, a significantly higher proportion of beneficiaries were categorised as “new adopters”, in other words, they adopted the technologies after their participation in the intervention programs (previously they were not aware or aware but had never adopted the technologies) (see Annex 12 Table A2-4). This suggests that the project has contributed to helping farmers “climb the adoption ladder”.

Farmers’ adoption of technologies also depends on how the service providers and others in the supply chain respond to changes. As a result of the project interventions, which included the KUDs, one of the KUDs now provides and supplies teat dipping cups and iodine solution to their members. They reported that they decided to do this after seeing improvements in milk quality of farmers who participated in the extension study. This has resulted in the continuous adoption of teat dipping after milking. The baseline survey found that many farmers who initially adopted teat dipping had dis-adopted it due to limited availability of inputs. Therefore, the involvement of the KUD has helped ensure sustained adoption of this practice.

Another lesson learned from the project impact study is that adoption rates are more likely to increase with technologies that are simple, affordable, and suitable to farmers’ unique conditions. For example, the project introduced the SURF test, a mastitis test that uses household detergent as the reagent. Household detergent is relatively inexpensive and easy to find. This is an alternative to the California Mastitis Test (CMT) that is more expensive. In addition, the practice of unlimited access to drinking water requires investment in infrastructure which could be considered as capital-intensive for some farmers. Therefore, was not surprising that the increase in adoption rate of unlimited access to water was not as high as teat dipping after milking.

Although there were increased rates in awareness, the adoption of high protein concentrates, forage conservation and record keeping remained low even after interventions. The impact study revealed that high protein concentrates were considered by farmers to be too costly. The cooperatives also indicated that it was too costly to produce concentrates due to the increasing price of the raw materials (i.e., pollard). The COVID-19 lockdown exacerbated issues related to the supply of raw materials for mixing concentrates, making the price even higher. Forage conservation was also not widely adopted due to its high cost and complexity. The adoption of record keeping was also considered by farmers to be too complex. Farmers reported that they were not able to interpret the data they collected so that it could be used for farm business decision-making. Additional work could help farmers understand how to use the data to make decisions.

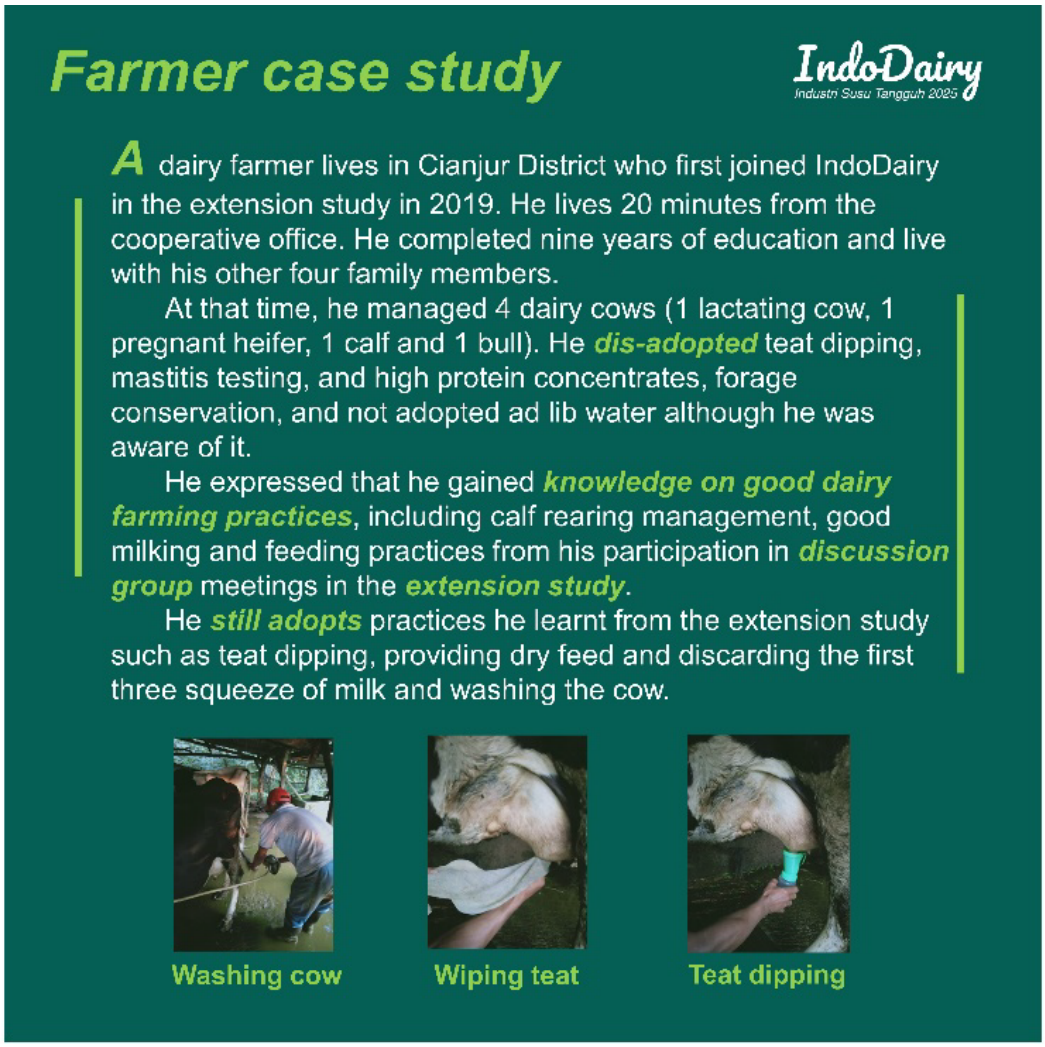


Figure 44. Farmer case study from WFGDs

Milk productivity, quality and income

Although there was an overall decrease in milk productivity for beneficiary and non-beneficiary farmers, the results of the impact study revealed that beneficiaries were able to mitigate this to a greater extent. The analysis of the impact study data (multivariate analysis) revealed that beneficiaries had, on average, 1.24 litres per cow day higher productivity compared to non-beneficiaries (P-value < 0.01). Stated differently, without the IndoDairy project interventions, the beneficiary group would have produced, on average, 1.24 litres per cow per day less milk.

Although we do not know for certain why beneficiaries' productivity was significantly higher than non-beneficiaries, the higher rates of adoption among beneficiaries of technologies and management practices that can lead to increased production may have contributed. Insight from the qualitative part of the impact study (i.e., interviews with farmers), suggests the project interventions helped them to increase productivity per cow and improve milk quality (e.g., see quotes in the boxes on the following pages).

The higher milk productivity for beneficiaries translates to a tangible economic impact for smallholder farmers. An average of 1.24 litres more milk per cow per day (9% of the average milk productivity) translates to approximately 1,043 litres per farm per year (9% increase), which represents IDR 6 million additional gross revenue (approx. AUD 599). This is 6% increase relative to the average household's total income from the dairy enterprise.

"Before, I used 12% concentrate. Now I'm using 16% and there is an improvement on the results and the work at the farm become slightly easy. An average of 18 litres now. Previously only 15 litres"

Farmer 6 in the Garut WhatsApp Focus Group

Photos shared by the farmer participant show wiping the cow's udder (1 cloth, 1 cow), washing the barn before milking and using a milk sieve).

Farmer 2 in the Cisarua WhatsApp Focus Group

Additional insight gained from farmers during the qualitative part of the impact study suggests that non-IndoDairy programs which intended to increase smallholders' milk production by increasing their dairy herd populations were not successful. Farmers reported that this was because the carrying capacity of most farmers was limited due to their ability to provide forage, access concentrates, and hire additional labour. From the perspective of these smallholder farmers, focusing on improving milk production per cow and milk quality, rather than increasing dairy cow population, should be prioritised when considering programs to improve smallholder milk production and improve livelihoods.

Pak Yunus, the FF from Cijeruk showed increased profit since being involved in the FF by increasing milk production per cow by utilising higher quality feed. Profit per litre increased from IDR 1,271 per litre (13 cents AUD) (July 2019) to IDR 1,468 per litre (15 cents AUD) (Feb 2020) at the end of the 8 months for the one cow. Although this only reflects a small snapshot in time, the process of building financial literacy with famers through regular farm business analysis enables profits to be monitored and improved.

At the KUD level, KUD Giri Tani have reported being able to negotiate a higher milk price with their buyers which has had a positive economic impact for the cooperative, and the farmers that supply KUD Giri Tani. This was brought about by an overall improvement of milk quality (fat, protein components and total plate count-TPC) where the KUD management have looked favourably on the work carried by the IndoDairy project with farmers around nutrition and improvement in milk quality. The results from the endline survey indicate that, overall, farmers' average milk price has increased too.

Additional economic impacts can be expected for smallholders if the individual price incentives for higher milk quality continue. Historically, farmers received a flat rate for their milk: IDR 5,000 per litre (50 cents AUD). During the price incentive study, farmers could receive a premium of up to an addition IDR 1,000 per litre (10 cents AUD). The KUD board have indicated that they will continue to implement the price incentives for farmers. Further, proper management of milk quality and hygiene can contribute to improved milk production as sub-clinical mastitis can result in a decrease in milk production.

7.3.2 Social impacts

The project did not observe any statistically significant difference between beneficiaries and non-beneficiaries in livelihood indicators such as food security and food consumption. This is perhaps not surprising considering the relatively short amount of time between the endline study and the conclusion of the interventions.

However, the quantitative analysis found that farmers' participation in the project intervention significantly improved women's participation in dairy farm decision-making by 15% (p-value < 0.01). Women are often underrepresented in formal dairy training compared to men. Therefore, future work should consider expanding women-centred extension activities to further empower women dairy farmers.

The Women's Discussion Group (WDG) that was trialled to target women aimed to create a space where their unique needs and challenges could be addressed openly and directly. This was the first time a dairy women's group had been held in Cijeruk. This activity was well supported by women, however attendance at meetings was variable due to several competing priorities that women faced in their households. Their interests were more on milk quality, mastitis and business management and some of the women were already helping with record keeping at the farm.

Although the IndoDairy project was only able to support one group of women farmers in Cijeruk, Bogor, it's proof-of-concept has been realised with significant scale, including through further dissemination of the resources and capacity building material developed by the project. As mentioned in the Capacity Building Impacts section, two projects targeting 2,000 women farmers across West and East Java have subsequently been implemented with the IndoDairy VLRs as facilitators of activities. The first project was funded by ADB in partnership with Cimory. The second was a collaboration between SNV and Frisian Flag Indonesia (FFI). The ADB project utilised training resources developed by the IndoDairy team.

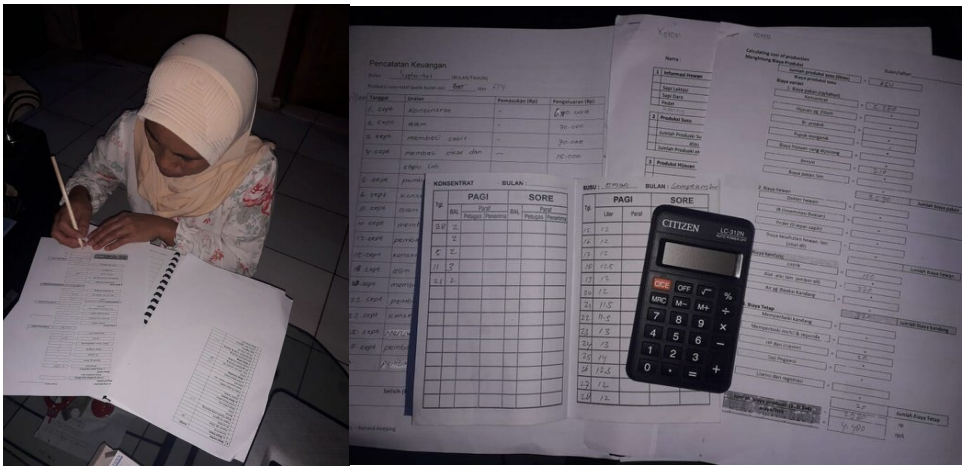
Additionally, The IndoDairy WDG activity was nominated for the Gender Competition Assessment by the Ministry of Women's Empowerment and Children Protection (MWECP). Ms. Vyta W. Hanifah and Ms. Attin Syahnurotin (VLR) were heavily involved in the facilitation of this group.

Future projects could build on the success of the WDG, and trial more in-depth Whole of Family Extension Approaches (WFEA) such in the ACIAR-funded Pakistan Dairy-Beef project (project number: LPS/2016/011) and the Papua New Guinea Family Farm Teams project (ASEM/2014/095), to ensure capacity is built across the whole household.

Farm business management and understanding of how to calculate farm profit was chosen as a discussion topic for one WDG. One member, Bu Kokom, was very enthusiastic about how to calculate farm profit. Before joining the discussion group she was collecting some farm records, but it was only limited to the amount of concentrate she fed the cows. Bu Kokom acknowledged, "For the farm I only recorded milk production and the amount of concentrate and I didn't know about the usefulness of other records to calculate profit. After joining the WDG discussion I learned how to calculate profit from understanding sources of income and also the production costs incurred".

"Since this topic I have recorded costs and income in the book provided for two months, which has helped me to analyse the profit. So now I know how much my profit is per litre. My hope going forward is that I will be more diligent in keeping records after the group has finished", said Ibu Kokom.

"I learnt that great dairy farmers are those who make money (profit) by implementing the best technical skills on the farm", she recalled from the information discussed during the group.



Ibu Kokom learning how to calculate profit in the group meeting.

7.3.3 Environmental impacts

Although not a central focus of the project, environmental awareness and practice was integrated within other topic areas. Some farmer groups (in Cisarua and Pangalengan) selected specific topics on waste management, where efficient use of fertiliser was discussed, as well as the value and importance of reusing effluent on farm for productivity gains, as well as reducing any negative environmental impacts. Additionally, ICASEPS research promoted the adoption of biogas to policy makers.

More broadly, the project has potentially contributed to a reduction in greenhouse gas emissions through on-farm efficiency gains, such as increasing milk production per cow. An example of this is through improved feeding and nutrition of cattle (such as improved fodder management and feeding better quality concentrate), which can reduce methane by 2.5-15% (Knapp *et al.* 2014). Increasing cow efficiency through improved feeding and milk production per unit of input, can lead to a reduction in methane emissions per litre of milk.

7.3.4 Risks to community impacts

COVID-19 remains an ongoing issue in West Java and Indonesia more broadly. This will continue to have a direct and indirect to the communities and households IndoDairy engaged.

A significant finding from the project was the high-level of attrition among dairy farmers. Interestingly, 30% of farmers surveyed by the project in 2017 have ceased their dairy businesses at some stage since 2017. While the dairy farmers that exited the industry were skewed towards non-beneficiaries of the IndoDairy project, this exit creates issues for other agents in the dairy value chain. Former dairy farmers' reasons for exiting included the household member responsible for the dairy business passing away or retiring (and no other family members were available to continue the business); death of dairy cows or other animal health issues; and the household needing cash and therefore deciding to sell the cattle.

Meeting Indonesia's growing domestic demand for milk will not be achieved by increasing productivity of smallholders alone. Further development of medium, large, and mega farms, like Cimory and Greenfields, have significantly contributed to increasing the domestic supply of quality fresh milk in Indonesia.

The ICASEPS team in the policy workshops, policy reviews, and policy dialogues with stakeholders recommended to the Government to not hinder the development of big and mega dairy farms in Indonesia. Rather, they recommended that the Government should support and facilitate the development of smallholder, medium-scale, large-scale, and mega-dairy farms simultaneously. Large-scale and mega-dairy farms must be directed outside Java, while small- and medium-scale farming can still be carried out in Java in suitable agro-ecological areas. Regulations should be directed to promote and support mutually beneficial multi-stakeholder partnerships, particularly between smallholders and milk processors, to increase productivity and improve the quality of fresh milk. Partnerships between smallholder and mega-dairy farms which deliver mutual benefits should be encouraged.

7.4 Communication and dissemination activities

Communication and dissemination activities were conducted to ensure outcomes and impacts can be further realised in the future. This included providing farmers with training new knowledge, and direct feedback leading to behaviour change, and engaging with policy and industry throughout the project to ensure project activities are relevant and findings are directly shared and communicated. The paragraphs below document specific activities targeting farmers, policy makers and industry.

Farmers

The VLRs played a vital role in ensuring communication and dissemination activities occurred with farmers. They were critical to the extension activities, including DGs and FF meetings (Act 3.3). During the price incentive study (Act 1.7.4), the VLRs prepared individual reports to farmers with the results of individual farmers' milk quality (e.g., TPCs) and the provided individualised feedback to farmers with information on how they could improve their milk hygiene (see Figure 45 and Figure 46).

Grade
C

REPORT LETTER
IndoDairy Incentive Study
Laboratory Result for Individual FarmerTPC
First Cycle 1-15 Februari 2021

Name	XXXXXXXX
Group	XXXXXXXX
Total Production (Litre) 1-15 Feb	258 Litre
TPC result (cfu/ml)	730,000 cfu/ml
Water content	5%
Milk Quality Grade	C
Incentive IndoDairy (Rp/Litre)	Rp 500
Total Incentive IndoDairy (Rp)	Rp 129,000

Feedback
Based on the result of milk quality test on the laboratory, your TPC was 730.000 cfu/ml, which is Grade C (500,000 – 1,000,000 cfu/ml). Therefore, you still need to improve the milk quality as follows:

- Ensure all of the milking equipment is clean and dry.
- Udder and teats should be clean and dry.
- Wash hand before milking.
- Discard the first three streaks of milk.
- Deliver milk immediately once finish milking.
- Use milk sieves to filter milk before storing to the milk can.
- Wash and the clean milk can in advance after delivery, and dry under the sun light.

Note:
- Do not wash the equipment immediately before milking, it can leave the water on the surface and make the milk contaminated by the water.
- Use hot water and detergent to clean the milk can to have best result of hygiene equipment.

Cisarua, February 2021

IndoDairy

Figure 45. Example report provided to farmers during the price incentive study (translated to English).

Figure 46. VLRs sharing TPC reports to farmers during the price incentive study.

During the endline survey, CGFAR-UoA researchers prepared individual farm business reports for all participants (n=480). These reports summarised each farm household's financial and production information, including costs, revenue, and profit for all the periods that data was collected. The reports provided benchmarks for each KUD. These reports were delivered by the ICASEPS team and enumerators between November and December 2021 (see Figure 47).

Figure 47. Farmer beneficiary (left) being presented an individual farm business report by an enumerator during the IndoDairy endline survey (December 2021).

Industry and policy-makers

Several extension resources to support the IndoDairy activities have been published as part of Objective 3. These resources are available both in Bahasa Indonesian and English and can be located here: https://www.adelaide.edu.au/global-food/research/international-development/indodairy#extension-and-training-resources

The list of resources includes:

- IndoDairy Farming Factsheets
- Extension newsletters
- Focus Farmer profiles and updates
- Voices from the field video
- Outcomes of the participatory extension study animated video
- Outcomes of the Focus Farm activity video.
- Four-part webinar series.

During delivery of the extension activities, KUD representatives were engaged in the planning and delivery of the DGs and FFs. They were also involved in the planning and evaluation sessions with farmer groups where the results and impacts of the DGs were disseminated to each KUD during the evaluation session, this allowed them to see the impact of the project in their area. Findings from the FFs in Cijeruk were shared among the other four regions. This activity raised awareness of the extension pilot and other farmers showed interest in having an FF in their region. Supporting extension materials

were also shared with industry and policy makers, these materials included the IndoDairy farming factsheets, newsletters, and FF updates. Additionally, in June 2022, high-level reports comparing the baseline and endline results were provided to each KUD.

Policy makers were engaged throughout the project including during working groups, roundtable discussions, and one-on-one meetings. ICASEPS and IPB regularly engaged with representatives from the Coordinating Ministry for Economic Affairs, the Ministry of Agriculture (MoA), the Ministry of Trade, the Ministry Cooperative and Small to Medium Enterprise, the Directorate General of Livestock and Animal Health Services (DGLAHS), the Indonesian Association of Dairy Cooperatives (GKSI – '*Gabungan Koperasi Susu Indonesia'*) and collaborating KUDs.

ICASEPS conducted a series of policy discussions with dairy industry stakeholders, including:

- Discussions were held with DGLAHS and the Centre for Data and Agricultural Information on 16-17 July 2020. At this meeting, the ISHS findings were presented. ICASEPS proposed that milk be included as an essential and important food for Indonesia. They highlighted that the domestic dairy sector contributed significantly to health and economic indicators that are pro-growth, pro-job, pro-poor, pro-health, pro-village, and pro-environment. In this meeting, ICASEPS also discussed the blueprint of the development of National Dairy Industries.
- Stakeholder discussions with DGLAHS were held on 18 August 2020. In 2020 the MoA introduced SIKOMANDAN (*'Sapi Kerbau Komoditas Andalan Negeri'* - Buffalo Cattle *Commodity* Mainstay of the Country), a live cattle program that was designed to improve the breeding quality of dairy cattle in Indonesia. To improve the quality of genetics, the MoA implemented "heredity selection (uji zuriat)" for dairy cattle at the national level.
- A discussion was held with the Directorate General of Agricultural Infrastructure and Facilities (DGAIF) on 16 November 2020 to address issues related to access of clean water to help farmers to implement good husbandry practices.
- A meeting was held with DGLAHS on 7 December 2020 regarding future planning to increase the national dairy cattle population by increasing participation in AI, growing the number of locally-bred dairy cows and importing dairy cow breeds (heifers or calves) with high milk productivity from dairy-producing countries.
- Other discussions were held relating to initiatives to protect small-scale dairy farming through the launch of a Cattle Farming Insurance ('*Asuransi Usaha Ternak Sapi'* - AUTS) program and a financing system for dairy farmers, People's Business Credit (*'Kredit Usaha Rakyat'* KUR) products. These programs were in addition to the existing credit programs facilitated by dairy cooperatives.
- Discussions were held with the Secretary General of MoA on 13 April 2021 related to the results of the IndoDairy research collaboration and its policy implications for the development of dairy cattle in Indonesia.
- Throughout the project, meetings were held with KUD leadership to discuss various policy issues relevant to the dairy sector.

Scientific

Multiple scientific publications have been published by IndoDairy collaborators using data collected by the project and more generally about the Indonesian dairy sector. A full list is provided in Section 8.4. We expect that there will be additional scientific publications (e.g., journal articles) forthcoming over the next two years as there are manuscripts that are under review in international journals and still being drafted.

8 Conclusions and recommendations

8.1 Conclusions

Objective 1: Dairy value chains, policies, and business models

Value chains

West Java has a well-established dairy sector but several persistent issues along the value chain remain. Inconsistent supply and quality of key *inputs* including feed resources such as concentrate, raw feed ingredients, and forages continue to be a significant challenge for smallholder dairy farmers. The dairy sector must compete with other agricultural sectors for these inputs, and it is difficult for smallholders to compete. Increased development in the region is putting pressure on land availability, especially on land to grow forages.

Challenges at the *farm-level* include the limited capacity of farmers, small herd sizes, milk quality and hygiene, and low milk productivity. Challenges at the *cooperative-level* include technical skills (milk quality and milk supply) and managerial skills (human resources development and organizational management). Challenges faced by *milk processors* include inconsistent supply from cooperatives with respect to both the quantity and quality of milk provided by smallholders and competition from other processors. Challenges at the *retail-level* include the drinking habits of consumers who do not understand differences between reconstituted milk products and fresh milk, and logistical issues in sourcing fresh milk.

The dairy value chain in North Sumatra is less developed compared to West Java. There are no dairy cooperatives in North Sumatra and at the time of the study, there was only one small milk processor. Therefore, smallholder dairy farmers were mainly selling milk directly to consumers. Therefore, in addition to the issues faced by smallholders in West Java, smallholder dairy farmers in North Sumatra also lacked a processor or cooperative that was willing to collect their milk.

Policies affecting the dairy sector

Additional and ongoing government investment in extension services, policy and dairy infrastructure is critical to maintain a dairy sector in Indonesia and maintain a balance between smallholders and private firms. There are opportunities for private processors in need of domestic supplies of fresh milk to invest in smallholder cooperatives. An example of this was seen in case study of Nestlé's smallholder-inclusive business model in East Java, which demonstrated positive benefits for both smallholders and the processor. Further research is needed to understand the key factors driving these successful smallholder-inclusive business models and if they can be replicated in other locations.

Improving milk quality

Efforts to improve milk quality at the smallholder farmer level required practice change throughout the supply chain, including farmers, the dairy cooperative, and the processor. Results from the Hazard Analysis and Critical Control Points (HACCP) study indicated there are high levels of bacterial contamination on-farm, including water used to clean milking equipment, such as farmers' milk buckets, delivery cans, and sieves. Likewise, the cooperative's milk collection trucks and cooling tank had high levels of bacterial contamination. Improvements are needed throughout the chain, including the hygiene of water sources and cooperative hygiene practices (e.g., using hot water and detergent to wash equipment). However, the project activities showed that training alone is not sufficient to change behaviour in relation to milk hygiene practices. Results of the price incentive study suggest that price incentives may motivate farmers to adopt technologies and management practices that improve milk quality. These individual price incentives for

improved milk quality can play an important role in driving sustained behaviour change at both the farm and the KUD-levels. There was significant positive feedback from the participating farmers, the KUD board and the milk processor (Cimory) suggesting a strong willingness to continue efforts to address quality issues through price incentives. A follow-up study should be conducted over an extended period time and scaled-out to more cooperatives to further explore this opportunity to improve milk quality. Investment is also need in stainless steel milk buckets (for farmers) and milk collection containers/tanks for all cooperative milk collection truck. Facilities to heat water would also help reduce bacterial contamination.

Objective 2: barriers for smallholder technology adoption

Analysis of data from the IndoDairy Smallholder Household Survey (ISHS) revealed that, on average, farmers managed less than three lactating cows per farm and received IDR 1,967 net profit per litre of milk (20 cents AUD). Profit per litre was consistent between districts.

Smallholder farmers' adoption decisions are influenced by differences in farmers' socioeconomic characteristics, access to agricultural services, and the characteristics of the technologies. Farmers face multi-level barriers to adoption, including at the farm-level (e.g., lack of individual awareness and knowledge, limited capital, and poor access to finance) and at the institutional level (e.g., a lack of milk and feed quality standards, inconsistent quality feed and poor access to other inputs, and lack of information and market signals to incentivise farmers to change their practices to improve milk quality).

The project findings suggest that to increase adoption rates of key technologies and management practices and drive improvements in both milk quality and quantity, interventions must address the specific constraints faced by different typologies of farmers (segments). Different business models for service provision can greatly assist in overcoming constraints such as knowledge, availability of inputs, costs and motivate smallholder farmers to change behaviour. Specific examples are provided in Section 8.2 Recommendations (below). Additionally, KUD leaders and staff need training to improve the KUD's skills in relevant technical areas, marketing, finance, and management.

Objective 3: Pilots to improve technology adoption

Feed study

The results of the feed study show that the adoption of concentrate with 16% crude protein and *Kalem* improved the nutritional intake of dairy cows, including protein and energy. Cows that received the nutritional supplements had a higher milk production per cow compared to the control group. Despite the improvements in milk production, adoption of these feed technologies remains low among smallholders. This is likely due to poor access to these supplements and farmers' concerns about the cost and the quality of the inputs.

Extension study

Changes in farm practices were observed through the implementation of innovative participatory extension approaches through DGs and FFs. Significant increases in knowledge and attitudes related to all practices were measured at the end of the study. There were also some notable behaviour changes, including a 92% increase in the adoption of teat dipping and a modest increase in other practices, such as feeding colostrum to calves, record keeping, feeding high quality concentrates, washing milk equipment, and conserving forages. There is a time/timing element that may have limited the adoption of some practices due to the short time between the training and the end of the study. For instance, installing *ad libitum* water troughs requires renovating the farming infrastructure, which cannot occur quickly due to limited resources. Another example is a practice related to feeding calves *ad libitum* (i.e., unrestricted access to water and food). Many farmers may not have had a calf by the time the study concluded, therefore, they

were not able to adopt these practices. However, despite modest changes in behaviour for these practices, we observed the *intention* to adopt increase by 25% and 34%, respectively.

Since the Extension study there have been several outcomes where the resources/approaches utilised in the project were adopted by other programs. Firstly, the training materials developed by the project were adopted by KPBS Pangalengan extension officers and delivered to 2,000 farmers. Secondly, after seeing improvements in milk quality from farmer groups that were participating in the Extension study, KPGS Cikajang provided teat dipping cups and iodine-solution to their 1,500 members. The Women's Discussion Group approach trialled in Bogor by the IndoDairy has since been implemented by two separate development programs funded by the Asia Development Bank and the Netherlands Development Agency collectively targeting 2,000 women farmers in West Java. These programs employed the IndoDairy VLRs to deliver the training.

Assessment the short-term and potential long-term impacts from project activities

The impact evaluation of the IndoDairy project provides strong evidence of the project's positive and significant effects on short-term outcomes (farmers awareness about technologies), medium-term outcomes (farmers' adoption behaviour and milk production), and long-term impacts with respect to participation of women in dairy farm decision-making. These positive impacts are the result of successful farm-level interventions, including the innovative participatory extension approaches through farmer discussion groups and focus farms which were complemented with the positive responses from markets to provide necessary inputs.

Participation in project interventions increased awareness of beneficiaries about *teat dipping* and *mastitis testing* by 15% and 26%, respectively. Additionally, the beneficiaries were significantly more likely to adopt: *teat dipping after milking* (by 31%); *mastitis testing* (by 23%); *unlimited access to drinking water* (by 17%). When considering the six technologies in combination, project beneficiaries adopted, on average, 0.61 more technologies (or ~ 1 technology) compared to non-beneficiaries.

The beneficiaries' *milk productivity* was, on average, 1.24 litres per cow day higher compared to non-beneficiaries. Without the IndoDairy project interventions, the beneficiary group would have produced, on average,1.24 litres per cow per day less milk. The higher milk productivity for beneficiaries does translate to a tangible economic impact for smallholder farmers. An average of 1.24 litres more milk per cow per day (9% of the average milk per cow per day) translates to approximately 1,043 litres farm per year (9% increase), which represents IDR 6 million (AUD 599). This is 6% increase relative to the average household's total income from the dairy enterprise.[8]

Farmers' participation in the project intervention increased *women involvement in decision-making*. This is likely the result of the participatory extension approaches and the successful pilot of the Women's Discussion Group (WDG) in one of the study sites. The WDG has been since adopted by development programs targeting 2,000 women in Java, Indonesia.

Some indicators demonstrate no evidence of effects from the project which is important lessons for future work. The adoption of high protein concentrates, forage conservation, and recording keeping remains low; with reported external barriers to adoption such as cost, availability of inputs and complexity. Long-term livelihood indicators such as food security, food consumption, and profitability did not change significantly. This can be expected given the relatively short amount of time since the intervention concluded, the

[8] *Based on an average herd size of 2.8 cows, a 305-day lactation and average milk price IDR 5,771 per litre, and average milk production per cow 13.3 litres/cow/day*

external factors affecting farmers (e.g., production costs and access to services), and poor record keeping which makes assessing profitability challenging.

Restrictions as a result of the COVID-19 pandemic limited households' activities outside the home, including smallholder dairy farmers' access to inputs, markets, and services (e.g., extension and veterinary). COVID-19 restrictions impacted farmers' access to technical support, and restrictions also resulted in increased feed input prices (such as wheat pollard and by-product feeds).

The results from the impact assessment demonstrate that the project had positive and significant short-term and medium-term impacts, with a statistically significant increase in the adoption of some technologies and in milk productivity, and an increase in women's participation in dairy farm decision-making. Based on feedback from farmers, it appears that the participatory extension approach (i.e., discussion groups and focus farms) was useful, and the results of the impact assessment found that it improved farmers' awareness and knowledge of good dairy farming practices.

To fully understand the extent of the livelihood impacts, ACIAR should consider undertaking an impact assessment at a later stage (e.g., five years after the project completion). Future work should consider scaling up the interventions which have improved adoption, as well as considering external (institutional) barriers to adoption that persist.

8.2 Recommendations

Future work needs to address the following issues and opportunities for the Indonesian smallholder dairy sector:

1. Improving smallholder farmers' access to consistently high-quality dairy feed inputs (forages and high protein concentrates). There are opportunities to develop small-to-medium sized enterprises focused on provision of high-quality feed inputs for smallholder dairy farmers. There is also a need for education, policy, and regulation to ensure feed quality.

2. Promoting and supporting participatory extension approaches to overcome key barriers to sustainable adoption of technology are critical. These approaches need to include gender-inclusive farmer discussion groups and focus farms, to enhance smallholder farmers' likely adoption. The unique needs of farmers should be identified before developing extension activities. Extension and knowledge sharing activities should be "demand-driven" by the farmers and other key stakeholders (e.g., cooperatives and processors).

3. Investing in human and physical capital to improve access to milk quality testing to assess milk quality for individual farms and reduce information asymmetry in the supply chain. It is important that farmers receive information on their milk quality and information on how to address any quality issues. Premiums paid for higher quality milk can incentivise practice change and improve milk quality and hygiene.

4. Supporting dairy cooperatives, as the established primary input and service providers for smallholder dairy farmers, by improving their business, leadership, innovation, and entrepreneurship skills to overcome post-farm gate (institutional) barriers.

5. Promoting inclusive business models for dairy input and service provision. Inclusive business models could involve young entrepreneurs and partnerships with milk processing companies.

The 2022 outbreak of foot-and-mouth disease (FMD) in Java has the potential to significantly impact to smallholder dairy farmers in the region and poses a risk to Australia's biosecurity. ACIAR should consider work to minimise the negative impacts of this outbreak.

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Aringsih E., Purwantini T.B. & Erwidodo. 'Promoting 'Clean and Healthy' Smallholder Dairy Farming Practices in West Java'.
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Technical reports and other resources

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- GFAR-UoA (2022), 'Impact Evaluation report'. (Annex 12)
- ICASEPS (2021), 'Analysis of farmers' decision to exit dairy farming' (Annex 13)

Training and extensions resources

- 'IndoDairy 'Essential Farming Facts''. Training factsheets, presentations and posters. (Annex 10: in English and Indonesian)
- 'How to Establish A Focus Farm: A Hand-book' (Annex 15: in English and Indonesian)

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- IndoDairy - Indo Livestock Expo (2019): https://www.adelaide.edu.au/global-food/news/list/2019/07/11/indo-livestock-expo
- IndoDairy - Policy Roundtable Discussion (2018): https://www.adelaide.edu.au/global-food/news/list/2018/10/11/policy-roundtable-discussion
- IndoDairy - Heifer Importation Workshop (2017): https://www.adelaide.edu.au/global-food/news/list/2017/09/11/dairy-heifer-importation-workshop
- IndoDairy - Policy Working Group Meeting (2017): https://www.adelaide.edu.au/global-food/news/list/2017/02/15/policy-working-group
- IndoDairy - The IndoDairy inception workshop kick starts the project (2016): https://www.adelaide.edu.au/global-food/news/list/2016/11/20/inception-workshop

Videos

- IndoDairy - Voices from the field (2019): https://youtu.be/0KWqDlSmYxo
- IndoDairy - Focus Farm highlights (2020): https://youtu.be/bq6qGNFIWaM
- University of Adelaide - Animated video of the Extension study outcomes (2020): English (https://youtu.be/-vAZsC9j70o) and Bahasa (https://youtu.be/W5qijXmv3oA)
- The Bureau of Foreign Cooperation, Ministry of Agriculture, Indonesia - IndoDairy (2019): https://youtu.be/t_t5Jkc27C0
- ACIAR - IndoDairy visit to Queensland (2019): https://youtu.be/OPjW18ImVVo
- Rida Akzar – *'More Milk Money'* Visualise Your Thesis submission (2019): https://youtu.be/X4dO4LmQc4k

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9 Appendixes

9.1 Appendix 1: Summary of Project Variations and Personnel Changes

Summary of project variations

During the life of the IndoDairy project there were seven variations, including four costed and three no-cost variations. The costed variations were in response to new opportunities that would add-value to project's existing activities. The no-cost variations were executed to extend the project end date and redistribute the funding cashflow in response to change in activity timelines. Figure 48 (below) provides a summary of the variations.

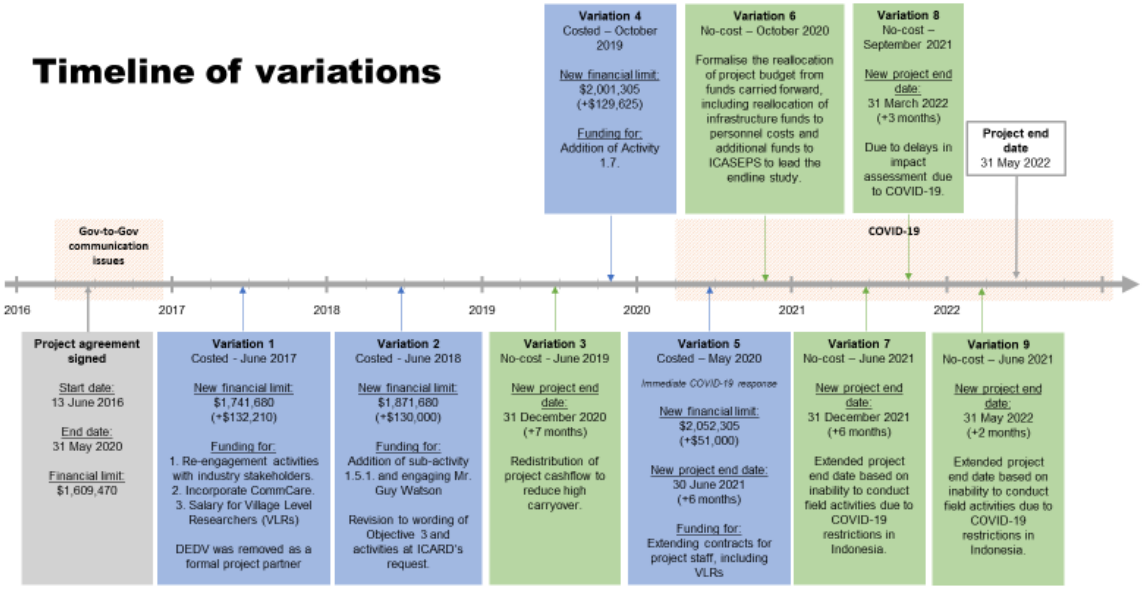

Figure 48. Summary and timeline of IndoDairy project variations.

Changes to project team

During the project lifetime there have been significant change to the project team due to staff changing roles and responsibilities over the life of the project. Figure 49 (below) summarises these changes throughout the project.

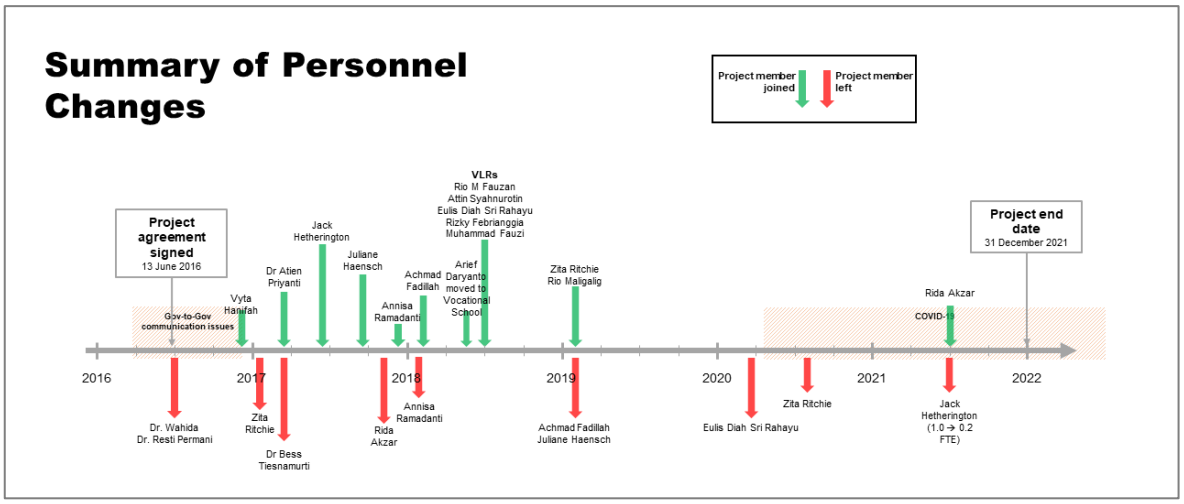

Figure 49. Summary and timeline personnel changes in the IndoDairy project.

Specifically, the reason for changes are as follows:

- **Dr. Wahida, ICASEPS** - As the project was about to commence, Dr. Wahida, ICASEPS took up a role at the Indonesian Embassy in Brussels as Agricultural Attaché.
- **Dr. Risti Permani, UoA** - Also as the project was about to commence, and due to delays in the start date, Dr. Permani (UoA) left the project team to take up a role the ASEAN Secretariat.
- **Ms. Vyta W. Hanifah, ICATAD** – Ms. Hanifah joined the project in November 2016 to support ICARD in analysis of existing extension methods and development of extension programs. She continued to play a critical role in the implementation of the extension study. The project supported her in her application for a John Allwright Fellowship (JAF), which was successful in September 2019. Her enrolment was been deferred (currently until 2022) due to international border restrictions due to COVID-19 and then changes to the Indonesian government system.
- **Ms. Zita Ritchie, DEDV** – Ms. Ritchie's role was to coordinate the extension activities of the project. In January 2017, she took up a role in the United Nation's Food and Agricultural Organisation (FAO) as Food Security Officer in January 2017. Later she re-joined the project in January 2019 as an independent contractor and worked on the project until the completion of the extension study (June 2020).
- **ICARD Director** – In March 2017, Dr. Bess Tiesnamurti's tenure as Director of ICARD concluded. Prof. Atien Priyanti was soon appointed as the new Director, which later concluded in 2020. She was succeeded by Dr. Agus Susanto.
- **Mr. Jack Hetherington, UoA** - Mr. Hetherington was recruited to support project coordination and management following the departure of Dr. Permani and Ms. Ritchie. Mr. Hetherington commenced in a part-time capacity from May 2017, taking on the fulltime position at UoA in August 2017. In June 2021, Mr. Hetherington commenced a PhD at UoA. He maintained a part-time role until the project end date.
- **Indonesian In-country Coordinator** - Mr. Rida Akzar was the initial Indonesian Research Coordinator based in IPB, however, he started his PhD in November 2017. After Rida's departure from IPB, Dr. Arief Daryanto, the Director of Business School at IPB, appointed Ms. Annisa Ramadanti to replace Mr. Akzar, then later Mr. Achmad Fadillah.
- **IPB Vocational School** - In the first half of 2018, Dr. Daryanto was appointed as the Dean of the Vocational School of IPB. During this change, Dr. Daryanto included a number of additional staff to support the coordination of the project

activities including Dr. Pria Sembada, Ms. Yuni Resti, Ms. Atonya Sinaga, and Ms. Silvia Dewi Sagita Andik.

- **Dr. Sahara** (ACIAR JAF Alumni) continued played a strong role in the IPB team as the Head of School of Economics and Management and led several of the activities under Objective 1.
- **Village Level Researchers (VLRs)** - Five VLRs, were recruited in June 2018: Mr. Rio M Fauzan, Ms. Attin Syahnurotin, Ms. Eulis Diah Sri Rahayu, Mr. Rizky Febrianggia and Mr. Muhammad Fauzi. These VLRs were critical to the implementation of the project activities under Objective 3, and without their participation, activities during COVID-19 periods of lockdown would not have been possible. Their initial appointment was for 12 months (June 2019), this was later extended to the project end date of June 2021. Ms. Eulis Diah Sri Rahayu concluded her term as a VLR (based in Garut) in April 2020. Although she had been offered to extend her contract along with the other VLRs, she was successful in gaining a scholarship to pursue a postgraduate program in Wageningen University and Research (WUR), the Netherlands.

9.2 Appendix 2: List of IndoDairy training activities

Activity/Workshop title	Date(s)	Description of participants	Number of participants*	Facilitator(s)
Planning meeting	31 August to 1 September 2016	ACIAR, UoA, IPB, ICARD, ICASEPS	R = 11	ACIAR and UoA
Inception workshop	17 November 2016	Government, Industry, Researchers, and project partners: ACIAR, IPB, ICASEPS, ICARD and UoA.	R = 31 I = 7 SP = 5 PM = 5	IPB, ICASEPS, ICARD, and UoA
Policy Working Group Meeting	21 February 2017	IPB, ICASEPS, ICARD and UoA.	R = 13	IPB, ICASEPS, ICARD, and UoA.
Survey and Sampling Design	22 to 24 February 2017	IPB, ICASEPS, ICARD and UoA.	R =19	ICASEPS
Survey Supervisory Training	29 May 2017	IPB, ICASEPS, ICARD and UoA.	R = 9	ICASEPS
CommCare Training	5 to 9 June 2017	IPB, ICASEPS, ICARD and UoA.	R = 13	AgImpact and UoA
Enumerator Training	24 to 28 July 2017	Enumerators, ICAEPS, UoA, IPB	RS = 16 R = 8	ICASEPS, UoA, and IPB
Heifer Importation Workshop	28 September 2017	44 scientists and service providers reviewing options for increasing dairy heifer importation into Indonesia	R = 21 I = 9 SP = 7 PM = 7	Dr. Brad Granzin, Prof. Arief Daryanto, and Dr. Sahara
Feed Base Extension Design	11 to 12 October 2017	ICARD, IPB, ICASEPS, ADC and UoA	14 = R	ICARD
Facilitating Farm Practice Change — The design and delivery of extension and advisory practice	February to April 2018	Ms. Vyta Hanifah participated in an online training program	R = 1	University of Melbourne
Village Level Researcher (VLR) Induction training	28 to 30 June 2018	5 VLRs, ICARD, ICATAD, ADC and UoA	VLR = 5 R = 9	Dr. Brad Granzin, Dr. Endang Romjali, Ms. Vyta W. Hanifah, and Mr. Jack Hetherington.
Enumerator Training	30 June 2018	5 Enumerators, UoA, ICATAD	RS = 5 R = 3	Mr. Jack Hetherington, Ms. Vyta W. Hanifah, and Dr. Rida Akzar.
Advanced Dairy Cattle Feedbase and Nutrition Workshop	2 to 5 October 2018	20 participants including KUD staff, ICARD and IPB researchers	SP = 7 R = 13	Dr. Brad Granzin
IndoDairy Policy Roundtable Discussion	9 October 2018	40 participants from the Coordinating Ministry for Economic Affairs, Directorate General of Livestock and Animal Health Services, Ministries of Agriculture, Trade, Industry, Cooperatives, Indonesian Association of Dairy Cooperatives (GKSI) and IndoDairy project partners, which include IPB, ICASEPS and ICARD.	R = 22 SP = 6 PM = 12	Prof. Arief Daryanto, Prof. Erwidodo and, Prof. Wendy Umberger

Introductory Training to the Statistical Software: 'R',	10 October 2018	100 undergraduate and postgraduate students, and young lecturers from IPB Faculty of Economics and Management.	US = 70 PS = 18 R = 12	Mr. Jack Hetherington
Annual Meeting	22 January 2019	26 participants (project team)	R = 21 VLR = 5	UoA and IPB
Introduction to Extension and Facilitation Techniques	4 to 5 March 2019	15 participants including VLRs, KUD staff, and researchers from ICARD and IPB	VLR = 5 SP = 5 R = 5	Ms. Zita Ritchie
Introductory Extension Skills: Lessons Learned	12 March 2019	Indonesian researchers and extension staff in ICATAD	R = 12	Ms. Vyta W. Hanifah
Dairy Reproduction and Farm Business Management	8 to 12 April 2019	There were 20 participants including VLRs, KUD staff, ICARD and IPB.	VLR = 5 SP = 5 R = 10	Dr. Philip Chamberlain (Australian Veterinary/Dairy Specialist), Ms. Zita Ritchie, and Dr. Endang Romjali
IPB Summer Course Guest Lecture	9 April 2019	40 vocational students from Indonesia, Australia and the Netherlands	US = 40	Mr. Jack Hetherington
Workshop for Writing Scientific Publication: The Case of Dairy Products	24 June and 2 July 2019	15 participants (researchers and students)	R = 10 PS = 5	Prof. Arief Daryanto, Dr. Sahara, Ms. Syarifah Amaliah, and Dr. Hetty Mulyati
Milk Quality and Dairy Farm Hygiene	25 to 26 June 2019	18 participants including VLRs, KUD staff and ICARD	VLR = 5 SP = 5 R = 8	Ms. Denise Burrell (former Indonesian Country Manager for Fonterra)
Recap session of technical training for service providers	27 June	18 participants including VLRs, KUD staff and ICARD	VLR = 5 SP = 5 R = 8	Dr. Brad Granzin, Ms. Denise Burrell, and Ms. Zita Ritchie
Discussion Groups (DGs), 13 Groups in five KUDs (See Figure 11 for topics covered)	Six sessions covered between July 2019 and March 2020	184 individual farmers, with a total 926 participations across 6 meetings	F = 926	VLRs: Mr. Rio M Fauzan, Ms. Eulis Diah Sri Rahayu, Mr. Muhammad Fauzi, Mr. Rizky Febrianggia, and Ms. Attin Syahnurotin. Supervision and mentoring from Ms. Vyta W Hanifah, Ms. Zita Ritchie, Dr. Brad Granzin, and Mr. Jack Hetherington
Focus Farmers (FF)	Six sessions covered between July 2019 and April 2020	2 FF, 6 support farmers and 7 Advisors	F = 8 SP = 1 R = 6	Ms. A Syahnurotin; supervision by Ms. Vyta W. Hanifah, Ms. Zita Ritchie, and Dr. Brad Granzin
Workshop for Writing Scientific Publication: The Case of Dairy Products	2 July 2019	15 participants (researchers and students)	R = 10 PS = 5	Prof. Arief Daryanto, Dr. Sahara, Ms. Syarifah Amaliah, and Dr. Hetty Mulyati
Indo Livestock Seminar with IndoBeef and IndoDairy, Surabaya, East Java	3 to 5 July 2019	85 participants (government, industry, researchers)	PM = 30 R = 30 I = 25	Prof. Atien Priyanti, Dr. Endang Romjali, and Mr. Jack Hetherington
Enumerator Training	5 to 6 August 2019	8 Enumerators	RS = 8 R = 2	Mr. Jack Hetherington and Ms. Vyta W. Hanifah

Dairy Nutrition Recap session	22 August 2019	5 VLRs	VLR = 5 R = 3	Dr. Brad Granzin, Ms. Zita Ritchie, and Ms. Vyta W. Hanifah
Project annual meeting	28 October 2019	25 participants (project team)	R = 20 VLR = 5	Prof. Wendy Umberger, Mr. Jack Hetherington, and project team.
Queensland Dairy Industry Tour (ACIAR contract no. C001445)	5 to 13 November 2019	12 participants (5 VLRs, 1 ICARD, 1 ICATAD, 3 Australian team, 2 ACIAR)	VLR = 5 R = 7	Dr. Brad Granzin, Mr. Jack. Hetherington, and Ms. Zita Ritchie
Dairy Service Provider workshop in Medan, North Sumatra	20 to 23 January 2020	20 extension and government officers	SP = 18 R = 4	Dr. Brad Granzin, Ms. Zita Ritchie, Dr. Endang Romjali, and Ms. Vyta W. Hanifah
Milk Quality and Hygiene workshop	5 to 7 March 2020	72 farmers and cooperative staff	F = 67 SP = 5	Ms. Denise Burrell, Ms. Zita Ritchie, Ms. Vyta W. Hanifah , and Ms. Yuni Resti
IndoDairy dissemination workshop and discussion forum, Medan, North Sumatra	12-13 March 2020	10 participants (industry and government)	NA	IPB University Team, PT. PIMS, University of North Sumatra and, Medan Polbangtan.
HACCP Study Laboratory Training	16-17 March 2020	10 participants (cooperative staff and VLRs)	VLR = 4 SP = 6	Ms. Yuni Resti
Technical Training of Horticulture, Estate crop, and Livestock for Extension Officers, BPTP	27 April 2020	35 extension officers	SP = 53	Ms. Vyta .W. Hanifah
Webinar: 'Finding Solution Together: Broken food, Agriculture and Fisheries Supply Chain in Time of Covid-19'	20 May 2020	512 participants (government, industry, researchers)	NA	Prof. Arief Daryanto and Dr. Sahara
Webinar: 'New Normal Livestock Industry Strategy'	24 June 2020	458 participants (government, industry, researchers)	NA	Prof. Arief Daryanto, Prof. Bungaran Saragih, Prof. Muladno, Prof. Ali Agus, Don P. Utoyo, Yopi Safari
Webinar: 'Farm from Home', Student Cattle Buffalo Club, Animal Husbandry Faculty, Padjajaran University, Bandung	27 June 2020	65 students	US = 65	Ms. A. Syahnurotin
IndoDairy webinar series 1: Dairy project of Indonesia-Australia: Voices from the field	18 November 2020	119 participants	F = 6 I = 10 PM = 9 R = 19 SP = 12 US = 58 VLR = 5	VLRs: Mr. Rio M Fauzan, Ms. Eulis Diah Sri Rahayu, Mr. Muhammad Fauzi, Mr. Rizky Febrianggia, and Ms. Attin Syahnurotin. Supervision from Ms. Vyta W. Hanifah and Mr. Jack Hetherington
IndoDairy webinar series 2: A participatory extension approach: Increased adoption of technologies	25 November 2020	215 participants	F = 3 I = 10 PM = 10 PS = 1 R = 48 SP = 26 US = 103 VLR = 5	VLRs: Mr. Rio M Fauzan, Mr. Muhammad Fauzi, Mr. Rizky Febrianggia, and Ms. Attin Syahnurotin. Supervision from Ms. Vyta W. Hanifah and Mr. Jack Hetherington

IndoDairy webinar series 3: Improving milk quality at farm level	10 December 2020	114 participants	F = 11 I = 8 PM = 7 R = 17 SP = 17 US = 49 VLR = 5	VLRs: Mr. Rio M Fauzan, Mr. Muhammad Fauzi, Mr. Rizky Febrianggia, and Ms. Attin Syahnurotin. Supervision from Ms. Vyta W. Hanifah and Mr. Jack Hetherington
IndoDairy webinar series 4: How to establish a focus farm	17 December 2020	99 participants	F = 3 I = 2 PM = 2 R = 22 SP = 35 US = 30 VLR = 5	VLRs: Mr. Rio M Fauzan, Mr. Muhammad Fauzi, Mr. Rizky Febrianggia, and Ms. Attin Syahnurotin. Supervision from Ms. Vyta W. Hanifah and Mr. Jack Hetherington
Introductory Extension Skills: Lessons Learned	24 February 2021	Indonesian researchers and extension staff in AIAT South Sulawesi	SP = 5 R = 7	Ms. Vyta W. Hanifah

*Note: Participant categories: Farmers (F); Service providers (SP) – e.g., KUD staff, veterinarians; Industry (I) - e.g., milk processors, input suppliers, etc; Researchers (R), including government and university researchers (e.g., ICARD, ICASEPS, ACIAR, IPB); Village Level Researchers (VLR); Research support (RS) (e.g., enumerators); Undergraduate students (US); Postgraduate students (PS); and Policy makers (PM); unfortunately we do not have the information on the breakdown of the participant categories (NA).

9.3 Appendix 3: List of students involved in the IndoDairy research

No.	Name	Gender	Program/University	Title	Dates

1.	Mr. Rida Akzar	M	PhD program The Centre for Global Food and Resources (CGFAR), The University of Adelaide (UoA)	Heterogeneity in decisions, barriers, and effects in milk production: Adoption of multiple dairy farming technologies by the Indonesian smallholder dairy farmers	November 2017 to June 2021
2.	Mr. Achmad Fadillah	M	PhD program, Wageningen University & Research (co-supervised by Prof. Arief Daryanto)	Monitoring and Surveillance of Milk Quality and Animal Diseases in Indonesian Dairy Herds	Commenced October 2020
3.	Ms. Vyta W. Hanifah	F	PhD program, CGFAR-UoA (ACIAR JAF scholarship)	Evaluating Extension Approaches for Smallholder Dairy Value Chains in West Java, Indonesia	Deferred until July 2022
4.	Ms. Sara Ratna Qanti	F	PhD program, CGFAR-UoA	Intra-household Decision Making in Agricultural Households in West Java, Indonesia.	Commenced February 2019 (expected completion October 2022)
5.	Mr. Dimas Yudo Bramantyos	M	Masters of Global Food and Agricultural Business CGFAR-UoA	Farm business management and financial literacy of smallholder farmers in West Java, Indonesia	Completed November 2019
6.	Ms. Dahlia Readdinillah Aripin	F	Diploma 3 Program IPB University (Vocational School)	Feeding Management of Dairy Cattle at BBPTU HPT Baturraden, Central Java	Completed November 2019
7.	Ms. Cyndi Sukma Rizkhy	F	Diploma 3 Program IPB University (Vocational School)	Milking Management of Dairy Cattle at BBPTU HPT Baturraden, Central Java	Completed November 2019
8.	Ms. Hardine Allida Putri Pranomo	F	Diploma 3 Program IPB University (Vocational School)	Rearing Management of Dairy Cattle at UPTD BPT SP and HPT Cikole Lembang	Completed November 2019
9.	Ms. Herma Mulya Fajriyanti	F	Diploma 3 Program IPB University (Vocational School)	Management of Dairy Cattle Reproduction at UPTD BPT SP and HPT Cikole Lembang	Completed November 2019
10.	Ms. Rahma Safira	F	Diploma 3 Program IPB University (Vocational School)	Rearing Management of Calves and Heifers at BBPTU HPT Baturraden, Central Java	Completed November 2019
11.	Ms. Nugraheni Puspita Sari	F	Master of Management (Faculty of Economics and Management)	Model of Dairy Supply Chain Risk Management in Bogor District	Completed November 2019
12.	Ms. Dewi Karlina Batubara	F	Masters of Global Food and Agricultural Business CGFAR-UoA	Study of Dairy Cooperative Business Models in West Java, Indonesia	Completed November 2018
13.	Mr. Bani Wahyu Nugroho	M	Bachelor of Economics, Faculty of Economics and Management, Bogor Agricultural University (IPB)	The analysis of structure, conduct, performance, and competitiveness of fresh milk industry in Indonesia	Completed November 2018

14.	Mr. Bilfan Nur Aulia Rahman	M	Bachelor of Economics, Faculty of Economics and Management, IPB	The analysis of price asymmetry: the case of Indonesia fresh milk in domestic and international markets	Completed November 2018
15.	Ms. Diani Aliya Sofia	F	Bachelor of Economics, Faculty of Economics and Management, IPB	The analysis of fresh milk price volatility: the case of west Java, Indonesia	Completed November 2018