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Technology and Knowledge Transfers to Dairy Farms

Private Sector Contribution to Improve Milk Production

by Ibnu Budiman & Aditya Alta

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GLOSSARY

AI:
Artificial Insemination

BSN:
Badan Standardisasi Nasional (National Standardization Agency of Indonesia)

CFU:
Colony-Forming Units

DPR RI:
Dewan Perwakilan Rakyat Republik Indonesia (House of Representatives of the Republic of Indonesia)

EU:
The European Union

FAO:
Food and Agriculture Organization

FFI:
Frisian Flag Indonesia

GDFP:
Good Dairy Farming Practices

Gerbang Patas:
Gerakan Pengembangan Pakan Berkualitas (Quality Feed Movement)

IAARD:
The Organization for Economic Co-operation and Development *(Badan Penelitian dan Pengembangan Pertanian)*

IDX:
Indonesia Stock Exchange

KPBS:
Koperasi Peternakan Bandung Selatan (South Bandung Farm Cooperative)

KPSBU:
Koperasi Peternak Sapi Bandung Utara (North Bandung Cattle Farmers Cooperative)

KPSCU:
Koperasi Peternak Sapi Cianjur Utara (North Cianjur Cattle Farmers Cooperative)

KPSG:
Koperasi Produsen Susu Giri Tani (Giri Tani Milk Producer Cooperative)

MCP:
Milk Collection Points

MCP-M:
Mobile Milk Collection Points

MOA:
Ministry of Agriculture

MOEF:
Ministry of Environment and Forestry

MOEMR:
Ministry of Energy and Mineral Resources

MOF:
Ministry of Finance

OECD:
Organisation for Economic Co-operation and Development

PTPN:
PT Perkebunan Negara (State Plantation Company)

Renstra:
Rencana Strategis (Strategic Plan)

Sikomandan:
Sapi Kerbau Komoditas Andalan Negeri

SNV:
Stichting Nederlandse Vrijwilligers (Foundation of Netherlands Volunteers)

UHT:
Ultra Heat Treatment

EXECUTIVE SUMMARY

Indonesia's fresh milk production is only able to fulfil 22% of national milk demands. With growing milk consumption and the national target of fulfilling at least 60% of national demands from domestic production by 2025, boosting the productivity of dairy farms becomes important. This requires more adoption of productivity-enhancing technologies, techniques, and better farm management practices by dairy farms. However, as dairy farmers are predominantly smallholders, investing in technologies is a challenge due to cost, small production scale, and a lack of information and awareness.

Partnering with the private sector offers a solution, as evidenced by case studies of technology and knowledge transfers from major milk-processing companies such as Cimory, Frisian Flag Indonesia [FFI], and Nestlé), and international development organizations operating in West Java and East Java. An example of collaboration is a support for digitalization in milk collection points (MCP). The system assigns a price that reflects the quality of milk from each farmer, therefore incentivizing investment in technology, equipment upgrading, and better management by farmers to improve milk quality and production. Different contract mechanisms are applied for the technology transfers—some are put alongside a supplier agreement with mandatory supply requirements while the others are delivered as grants and loans tied to a commitment to maintaining quality and standards.

Meanwhile, public efforts for promoting technology adoption are mostly delivered as free technology provision. Provision of subsidized or free technologies is only effective at introducing technology in the short term but it leads to pseudo-adoption behaviors; in the long term, the technologies are often disregarded. Comparisons between government and private technology transfer programs also reveals a disconnect. Government assistance often is delivered as technology or equipment grants implemented through a few vendors. The national programs overlap with local government programs and lack proper monitoring and evaluation or user training. In contrast, programs from the private sector and donors utilize a market-based and commercial or semi-commercial approach, which involves multiple stakeholders, and include standardized training and after-sale services. Public and private programs often overlap and promote conflicting knowledge.

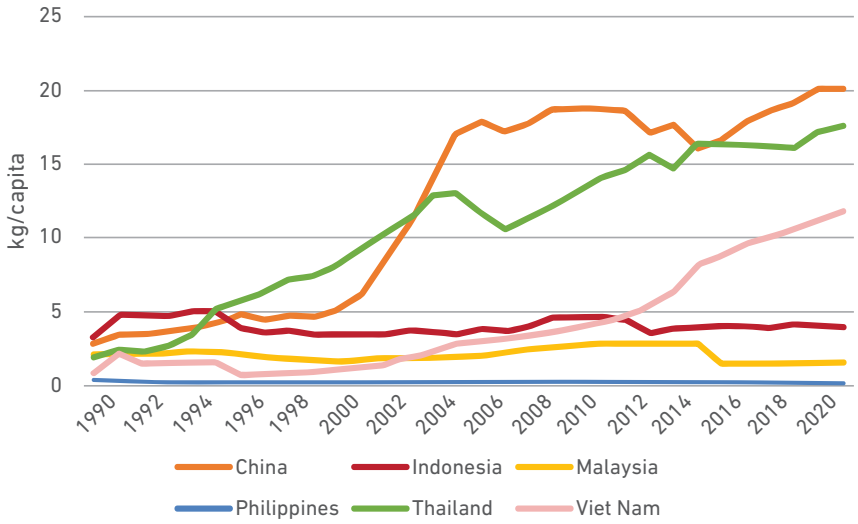
To improve technology adoption by dairy farms, the Ministry of Agriculture (MOA) should acknowledge and facilitate the private sector's role in technology and knowledge transfers. This can be achieved by first providing a stronger legal basis in the next Ministry of Agriculture Strategic Plans (Renstra) and by revising and enforcing MoA 13/2017 on Partnerships in Animal Husbandry Businesses. This would lead to implementing technology and knowledge transfers as a possible partnership scheme between firms and farms. Reducing fragmentation and overlaps can be achieved by mapping existing technology transfers from the private sector, donors, and local governments. The ministry should refrain from delivering similar assistance that has been provided by other stakeholders and aim instead to complement and facilitate them through a market-based approach.

OVERVIEW OF INDONESIA'S DAIRY SECTOR AND MILK CONSUMPTION

> Developing dairy cattle farms to increase milk production becomes necessary to meet growing demands.

Demands for milk in Indonesia reach 4.3 million tonnes per year. Meanwhile, domestic production is only able to meet about 22% of milk demands (MOA, 2021), with the rest being fulfilled by imports mainly from New Zealand, Australia, Europe, and the United States. At 4.61 kilograms per capita in 2021, Indonesian consumption of fresh dairy products[1] is much lower than Thailand, Viet Nam, and China, and only slightly better than Malaysia and the Philippines (Figure 1). However, milk consumption is expected to grow rapidly at 12% annually due to the growing middle class (Setyowati, 2020; Susanty et al., 2019). Therefore, developing dairy cattle farms to increase milk production becomes necessary to meet the growing demands. .

Figure 1.
Fresh Dairy Products Consumption Per Capita, 1990-2021



Source: Organisation for Economic Co-operation and Development (OECD)/Food and Agriculture Organization (FAO), 2022

According to the MOA and Statistics Indonesia, Indonesia's dairy cattle population was 578,579 in 2021 (Statistics Indonesia, 2021). The annual cattle population shows an increasing trend while milk productivity struggled to increase (Table 1). Milk production centres are concentrated in East Java, Central Java, and West Java. These three provinces make up about 97% of the cattle population nationally (Statistics Indonesia, 2021).

[1] Fresh dairy products cover all dairy products and milk which are not included in processed products. They include fermented and pasteurized products and exclude processed dairy products such as butter, cheese, skim milk powder, and whole milk powder (OECD/FAO, 2022).

Meanwhile, milk production is mostly conducted by smallholders, with farms maintaining three to five cattle making up about 90% of milk production (Septanti et al., 2020). Indonesian dairy farms produce an average of 10-15 litres of milk per cow each day and have a high stocking density per unit of land (de Vries et al., 2019; Eade & Williams, 1995) For comparison, dairy farms in the European Union (EU) produce an average of more than 20 litres of milk per cow every day (Kimura & Sauer, 2015).

Table 1.
Population of Dairy Cattle in Indonesia from 2016-2021

Year	Population	Population growth (%)	Milk production (tonne)	Production growth (%)	Productivity (tonne/cow)
2016	533,933		912,735		1.71
2017	540,441	1.22	928,108	1.68	1.72
2018	581,822	7.66	951,004	2.47	1.63
2019	565,001	-2.89	944,537	-0.68	1.67
2020	568,265	0.58	947,685	0.33	1.67
2021	578,579	1.76	962,676	1.66	1.66

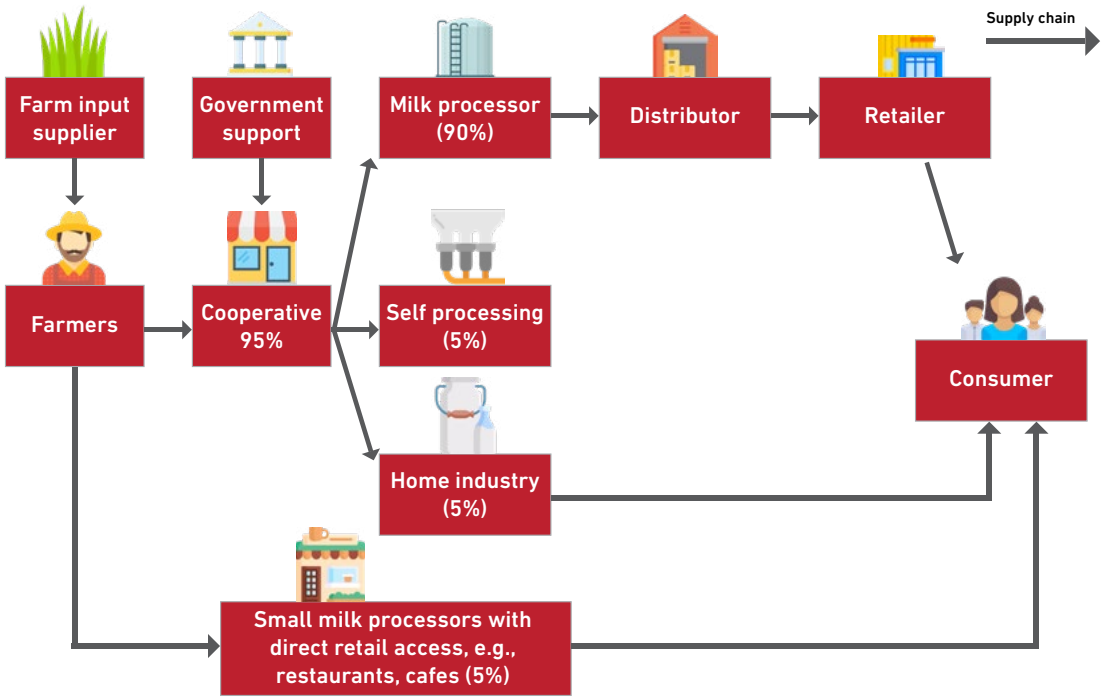
Source: Statistics Indonesia, 2021

Indonesia's dairy supply chain typically consists of three to five stages before milk arrives for the end consumers (Figure 2). Milk production starts at the farms, where the smallholder farmers typically organize themselves into groups, 95% of which supply milk to dairy cooperatives. The remaining 5% are supplied directly to small-scale milk processors that also act as distributors and retailers. Ninety percent of milk from the cooperatives goes to milk processors. These are typically dairy companies that process fresh milk to improve its quality, safety, and shelf life through pasteurization or Ultra Heat Treatment (UHT) process, or through manufacturing it into derivative products such as yogurt and cheese. Other than the companies, a small percentage of cooperatives self-process their milk or sell it to home processors. Agreements and contracts exist between smallholder farmers and the cooperatives, and between cooperatives and dairy companies. Products from milk processors are finally sold by retailers to be purchased by the end consumers.

In addition to the core milk supply chain, input suppliers and the government contribute to the dairy industry through the provision of feed, equipment, and veterinary care for cattle. As will be discussed, technology transfer and capacity building for farmers are also provided by some dairy companies as part of contract arrangements .

> Technology transfer and capacity building for farmers are provided by some dairy companies as part of contract arrangements.

Figure 2.
Dairy Supply Chain in Indonesia Between Different Stakeholders



Source: IndoDairy, 2020

CHALLENGES IN IMPROVING FARMS' MILK PRODUCTION AND TECHNOLOGY ADOPTION

The Indonesian government aims to increase domestic milk production up to 2.40 million tonnes by 2028 (MOA, 2021). By 2025, domestic production is expected to cover 60% of national consumption. To that end, the dairy cattle population is expected to grow up to 1.80 million, or triple the population today, with targeted daily productivity of 20 litres per cow, or an increase of more than 30% from current productivity (Directorate General of Animal Husbandry and Health, 2021). Achieving these targets requires investing in productivity-enhancing technologies and techniques. However, farmers face immense challenges in technology adoption.

The first challenge relates to profitability. A survey of dairy farms in West Java by IndoDairy (2020) categorized farms into equal-size profit quartiles and found that annual profits differ significantly between IDR 2.54 million for farms in the first quartile (least profitable) and IDR 47.90 million for farms in the fourth quartile (most profitable). However, annual revenues only increased by 12% between the first- and fourth-quartile farms. This indicates that profitability tends to be achieved with cost cutting rather than through higher revenues. This situation reduces the likelihood for dairy farmers to increase revenues by investing in productivity-enhancing technology and technique. IndoDairy (2020) found that more than 90% of the farmers did not use complex technologies like cooling milk in water tanks and automatic milking machines.

> "Profitability tends to be achieved with cost cutting rather than through higher revenues. This situation reduces the likelihood for dairy farmers to increase revenues by investing in productivity-enhancing technology and technique."

Second, low technology adoption has been related to low awareness. Almost 70% of farmers were unaware of the best practices and technologies for ensuring dairy productivity and quality like mastitis tests, improved feed (high protein concentrates, feeding legume forages), record keeping, and application of the breeding plan (IndoDairy, 2020). Farmers' lack of knowledge of these processes and technologies reduces the likelihood of adopting new technology.

The majority of farmers only finished elementary school, manage less than ten dairy cows, live far from the cooperative and farmer group leader, and receive few visits from dairy extension officers (Akzar, 2021). Limited resources in knowledge and capital hinder the production of high-quality milk that is bought at a higher price by dairy cooperatives and companies. Fresh milk produced by domestic farmers usually has a bacterial count much higher than the Indonesian National Standard for fresh cow milk, set at 1 million colony-forming units (CFU) per mililitre (Anugrah et al., 2021; National Standardization Agency of Indonesia [BSN], 2011).

However, even when farmers receive knowledge transfer from extension programs, their impact is often limited due to conflicting and non-culturally sensitive information (Bößner et al., 2019; Budiman, 2021; Budiman & Smits, 2020). Further, awareness does not always guarantee long-term adoption. A survey of 600 dairy farms in West Java found many cases of disadoption, where farmers stopped using technologies and good farming practices such as teat dipper, record keeping, milk quality testing, application of the breeding plan, and mastitis testing (IndoDairy, 2020).[2] Reasons for disadoption include a perceived lack of quick financial benefits (revenues do not immediately increase after costly technology adoption), lack of technical or knowledge support to use the technology, technology promoters or providers discontinuing support, and pseudo-adoption behaviour (IndoDairy, 2020). The latter refers to adoption motivated by the provision of free technologies and additional benefits such as training and access to credits, instead of a genuine need to increase productivity. Pseudo-adopters often stop using the technology once the free and additional benefits end (Kiptot et al., 2007).

These challenges show the need for an alternative strategy to encourage sustainable adoption of technology beyond relying on farmers' capital expenditure, improvements in awareness, and technological assistance. Firm-farm partnerships and contract farming arrangements provide an opportunity for such a strategy. Compared to farmers, milk processors often have better access to technology due to larger capital, lower transaction costs, and better knowledge of consumer preferences to inform the appropriate technology use (Burkitbayeva et al., 2020). As will be discussed below, partnerships between dairy companies and farmers often have a technology transfer component to enable farmers to improve production and fulfil contractual obligations. Policy to increase milk production through technology should be reformed and designed around facilitating these mutually beneficial partnerships.

[2] These technologies and practices affect cattle health and growth (calving interval), and help detect sub-clinical mastitis, low-quality diets, and high bacteria concentration in milk. These in turn impact milk production quality and quantity and, indirectly, farm revenues.

CASE STUDIES: PRIVATE SECTOR'S ROLE IN TECHNOLOGY TRANSFERS IN WEST JAVA AND EAST JAVA

West Java and East Java are the top dairy-producing areas in Indonesia. Together they account for 87% of fresh milk production in 2021 (Statistics Indonesia, 2022). In both provinces, large dairy companies such as Cimory, FFI, and Nestlé have been supporting technology adoption and transfers among dairy farmers and cooperatives (Trobos, 2018).

> In the top dairy-producing areas, large dairy companies have been supporting technology adoption and transfers among dairy farmers and cooperatives.

FFI is one of the biggest milk off-takers in Greater Bandung. It is part of the Frisian Flag group which has been producing milk since 1922. Today, it works with 20 cooperatives and 20,000 farmers in Sumatra and Java (Elsa, 2021), and has the second largest UHT milk market share in Indonesia behind Ultra Milk (Indonesia Stock Exchange [IDX], 2019). FFI has been working with cooperatives to increase the milk quality standard from dairy farms (Bagus, 2021). The company maintains an annual contract farming agreement with the South Bandung Farm Cooperative (*Koperasi Peternakan Bandung Selatan* or KPBS) with 2400 farmers and the North Bandung Cattle Farmers Cooperative (*Koperasi Peternak Sapi Bandung Utara* or KPSBU) with 4,200 farmer members. Both are among the oldest cooperatives in Indonesia (Sembada et al., 2020). Each cooperative produces around 30 tonnes of milk every day. Cooperatives buy the best quality milk from farmers at IDR 5,800-6,000 per litre (*Koperasi Peternakan Bandung Selatan* [KPBS] Pangalengan & *Koperasi Peternak Sapi Bandung Utara* [KPSBU] Lembang, personal communication, 2022) and sell it to FFI at around IDR 7,000 per litre (Trobos, 2018).

Cimory processes fresh milk into pasteurized and UHT milk and yogurt. It accounts for 53% of the market share for yogurt in the country (Qolbi, 2021). Cimory works with 25 suppliers (cooperatives and farmers groups) in West Java, East Java, and Lampung. It is the main dairy off-taker for farmer cooperatives in Bogor and Cianjur, such as the Giri Tani Milk Producer Cooperative (*Koperasi Produsen Susu Giri Tani* or KPSG) and the North Cianjur Cattle Farmers Cooperative (*Koperasi Peternak Sapi Cianjur Utara* or KPSCU). Each cooperative supplies around 2.50 tonnes of milk per day to Cimory. Each of them maintains a contract with Cimory, renewable every five-year term. In the last few years, Cimory buys fresh milk from cooperatives at IDR 7000 per litre (Cimory, personal communication, 2022). Cooperatives buy the best quality milk from farmers at IDR 5,500 per litre (*Koperasi Peternak Sapi Cianjur Utara* [KPSCU], personal communication, 2022).

Nestlé Indonesia is the major milk processor in East Java. It is a market leader for milk powder (IDX, 2019; SWA, 2009) producing UHT milk, dairy products, and other food and beverage products. Established in 1971, Nestlé Indonesia operates three factories, each located in Lampung, West Java, and East Java, with a new factory in Batang, Central Java, under construction at the time of writing. In East Java, Nestlé works with 27,000 farmers in 42 cooperatives from 16 districts. These cooperatives have 500 milk collection points (MCPs) distributed in different villages to cut

transport time for farmers and increase milk quality. Farmers sell fresh milk at IDR 5,100 - 5,900 per litre to the cooperatives (Nestlé, personal communication, 2022). Nestlé buys more than 750,000 litres of fresh milk per day from the cooperatives. Nestlé Indonesia applies fixed-price fresh milk contracts with their cooperative partners, supplemented by an annual agreement from the suppliers to follow milk safety and quality standards.

In addition to the companies, farmers in West Java also received technology and knowledge transfers from international development organizations and projects, such as IndoDairy, Foundation of Netherlands Volunteers (SNV), and Mercy Corps.[3]

The following sections describe the technologies, knowledge, and skills transfer in the private sector programs in West Java and East Java, including the contract and financing arrangement accompanying the transfer.

Improving Milk Production, Quality, and Prices with Digital Milk Collection Points

An emerging type of technology transfer is the digitalization of MCP, found in Bandung (West Java) and East Java and implemented by FFI and Nestlé. An MCP is a place, usually located in milk-producing villages and managed by a cooperative, where farmers deposit fresh milk before it is collected by the milk processor. A modern, digitalized MCP is equipped with a barcode system that identifies the individual farmers, testing, and measurement facilities to determine milk quality and weight, and cooling tanks to preserve quality. MCPs help dairy farms address milk quality issues through adequate cooling and better integration into the milk supply chain. Further, with the barcode system, digital MCPs can quickly determine the quality and quantity of milk deposited and assign this information to the producing farmer. Based on this assessment, each farmer receives a price that properly reflects their milk quality.

Before the first digital MCP was established with FFI support in Pangalengan, Bandung District, in 2015, the price was assigned for each farmer group instead of the individual farmer. Quality testing and milk pricing were conducted every ten days, not instantly, and milk price would reflect the quality found on the day of testing (Anugrah et al., 2021). Digital MCPs thus provide an incentive for each farmer to improve production and quality to be rewarded with better prices. More farmers in the KPBS are encouraged to upgrade their farming practices due to the pricing system, for example by investing in milking machines (KPBS Pangalengan, personal communication, 2022). The average number of microorganisms in milk extracted with a milking machine is significantly lower compared to hand milking (Filipovic & Kokaj, 2009). The system also enables milk quality and productivity tracking and helps cooperatives and companies identify farms with quality and production issues, investigate the issues, and offer technical or management recommendations.

> “Digital MCPs provide an indirect incentive for each farmer to improve production and quality to be rewarded with better prices.”

[3] IndoDairy is a research and development project funded by the Australian Center for International Agricultural Research (ACIAR) and implemented by the University of Adelaide, the MOA's Centre for Animal Research and Development (*Pusat Penelitian dan Pengembangan Peternakan*) and Centre for Agricultural Socio-Economic Policy Studies (*Pusat Sosial Ekonomi dan Kebijakan Pertanian* or PSEKP), and IPB University. SNV is a Dutch international development organization. Mercy Corps is a global non-governmental humanitarian aid organization.

In the KPBS area in Pangalengan, 9 out of 20 MCPs have been digitalized with FFI support. The digital MCPs provide benefits to more than 1,000 farmer members. Establishment costs for all the digital MCPs are split between KPBS (70%) and FFI (30%), except for one MCP that is fully funded by FFI. One of the digital MCP is also financially supported by the Ministry of Industry (KPBS Pangalengan, personal communication, 2022). Understanding the benefits of digital MCPs, KPBS is trying to expand digitalization to all their 20 MCPs. Due to the high cost of building a digital MCP like those designed by FFI, KPBS has been working with Padjadjaran University to develop a simpler system with an integration to a mobile application. The system, known as mobile MCP (MCP-M), is operational in 11 MCPs. Compared to the FFI-supported digital MCP, MCP-M collects data for each farmer group, not the individual farmer. MCP-M collects and digitalises information on feed distribution, veterinarian services, and farmer profile (including information on income and savings).

Extension Services, Capacity Building, and Other Technologies

Extension services and capacity-building programs are important to ensure sustainable technology adoption by farmers as many technologies are knowledge-intensive. All the companies and development projects have provided different kinds of knowledge and skills transfer.

FFI's free extension services and training are generally delivered in the training-of-trainers format, designed to allow training participants to disseminate the knowledge to more farmers. In West Java, the extension services and training have been provided to cooperative board members, 420 KPSBU members, and around 500 KPBS members. The materials cover not only technical knowledge on cattle rearing and milk production but also business management and marketing. FFI also has specific capacity-building programs, such as Farmer2Farmer and Young Farmer Academy. Farmer2Farmer is a study visit and knowledge exchange program where local farmers are sent to the Netherlands, and Dutch farmers are sent to Indonesian farms, to exchange knowledge. Young Farmer Academy consists of courses and intensive training delivered to young farmers covering technical knowledge, business and financial management, and young farmer organization.

In our observation and interviews with the West Java cooperatives, farmers demonstrated a willingness to improve farm and business management, adopt new technologies, and upgrade existing equipment after the training. Some farmers showed interest in investing in machinery, supported by the KPSBU through 0% interest loans. In 2021, more than 20 farmer members applied and 15 obtained the loan for automatic milking machines, among other machines (KPSBU Lembang, personal communication, 2022). Due to the high cost, automatic milking machines tend to be adopted by larger farms with more than 20 cattle.

Cimory provides extension services and training for their partner cooperatives, such as in cowhouse hygiene, milk quality maintenance, milking techniques, feed and drinking space management, and implements weekly and monthly random monitoring of farmers.

Companies also provide programs with a gender aspect. FFI in collaboration with IndoDairy

implemented the Womanpreneur program, designed to support the role of women in a farming household to increase their work efficiency, milk production, income, and financial management. Similarly, Cimory has the 1,000 Srikandi program where 1,000 female farmers, farmer's wives, or daughters in West Java took a three-day training covering good dairy farming practices (GDFP) in farm management (feeding management, lactation cycle, calf rearing, animal health and reproduction, milk quality), as well as financial literacy, entrepreneurship, and digital literacy.

Dairy companies also design several extension programs around their commercial farms that are positioned as a model for independent farmers. FFI has the Dairy Village, a modern, integrated dairy farm in Subang with capital investment from FFI and the government of the Netherlands, and operated by FFI and KPSBU on land owned by the state plantation company *PT Perkebunan Negara* (PTPN) VIII. The Dairy Village serves as a production centre and learning space that integrates FFI best practices, where KPSBU farmer members can learn about technologies and practices such as milking machines, feed management and preservation, waste and water management, disease detection and treatment, calf management, and other good agricultural practices (Dairy Village, personal communication, 2022). Moreover, the Dairy Village invites KPSBU farmers to join as members, where they can supply and raise cattle for the farm. Farmer members receive wages and are offered certain benefits, including bank loans for purchasing cattle and the right to own Dairy Village stocks for up to 25% (Maulana, 2018). Similar programs are implemented by the other companies—Nestlé with Rearing Farms in some cooperatives with a program focused on optimizing land use for productivity, and Cimory with study visits to the company's farms.

Capacity building programs implemented by the international development projects include training on cowhouse hygiene, feed management, cow health (mastitis), milk production, and milk quality (IndoDairy); a training and a pilot project on implementing feed innovation, improving animal health, and water management (SNV); and training on cowhouse management, feeding, and home industry (Mercy Corps).

Other technologies provided to farmers in West Java and East Java are detailed in Table 2.

Table 2.
Technology and Equipment Provided to Farmers

No.	Provider	Technologies/equipment provided
1.	Cimory	Milking machines, milk cans, stainless steel milking equipment, and cow drinking water facilities.
2.	Frisian Flag Indonesia	Milking machines and barn renovation are implemented through the Farmer2Farmer scheme.
3.	Nestlé	Cooling units, MCP infrastructure, transporting tanks, feed, grass chopper machine, barn cooling pad for animal welfare, cow drinking water facilities, milking machines, and others.
4.	IndoDairy	Teat dipper, milk filter, calf bottles, milk cans, biogas, feed (silage) and chopper, check-up incubator for milk bacteria testing, calf bottle, mastitis test.
5.	SNV	An app for monitoring milk supply from farmers to cooperatives and managing production and price data. Developed in partnership with IPB University.
6.	Mercy Corps	Modern cowhouse, cattle feed chopper, standardized home industry.

Source: Authors' interviews

Contract Arrangement, Financing, and Incentives

Different contract arrangements are applied by the dairy companies. Cimory and FFI utilise supplier contract schemes with the cooperatives, where farmers as cooperative members must exclusively supply good quality fresh milk to the companies. Technology supports are put outside of the contract as grants or credits and equipped with intensive monitoring and maintenance. Meanwhile, Nestlé uses a supplier contract scheme without an exclusive mandatory supply. The contract is reciprocated with a commitment from farmers to improve milk safety and quality with the transferred technology and knowledge. These supports are provided by Nestlé as grants or subsidised soft loans and implemented through the cooperatives. To receive support, farmers must write a proposal detailing their farm profile and milk production, which is then reviewed by the cooperative and assessed by Nestlé. All technology supports provided by Nestlé become farmer's assets. They are free to use the technologies for supplying milk to other buyers as long as they continue to meet milk safety and quality standards from Nestlé. Nestlé encouraged cooperatives to conduct monitoring and evaluation on farmer's use of the transferred technology.

Supports are not always received directly by farmers; they are also mediated by cooperatives. Some cooperatives use the support and earnings from the supply chain to provide affordable technologies to their members, such as artificial insemination, medicines, veterinary services, feed and concentrates, and milk cans. Some provide loans to the farmer members to invest in technologies and, in the case of KPSCU, lend cattle to farmers. The profit is fully obtained by the farmers. Once the cattle give birth, the calves are then lent to other farmers. This program has been done for the last decade.

"Some cooperatives use the support and earnings from the supply chain to provide affordable technologies to their members, such as artificial insemination, medicines, veterinary services, feed and concentrates, and milk cans."

In addition, companies also provide incentives for their suppliers. Cimory, for example, provides awards and cash rewards annually to cooperatives that deliver the high quality and quantities of fresh milk. International development projects sometimes provide rewards, like one of the Mercy Corps training programs that awarded ten cows to the best participating farmers.

GOVERNMENT POLICIES AFFECTING TECHNOLOGY ADOPTION BY DAIRY FARMS

Policies and regulations with relevance to technology adoption and firm-farm linkages discussed here include:

- Strategic Plans (*Rencana Strategis or Renstra*) of MOA and Directorate General of Animal Husbandry and Health, 2020-2024
- MOA Regulation No.13/2017 on Partnerships in Animal Husbandry Businesses
- MOA Regulation No. 26/2017 on Milk Delivery and Distribution (as amended in MOA Regulation No. 30/2018 and MOA Regulation No. 33/2018)
- Presidential Regulation No. 10/2021 on Investment Sectors

The current MOA Renstra mentions technology transfer and partnership among the strategies for increasing agricultural production. The *Renstra* of Directorate General of Animal Husbandry and Health further calls for regulatory simplification for programs on artificial insemination, feeding, and smallholder farmers, which may facilitate technology adoption and partnerships.

> "The MOA Renstra lacks connection with the relevant regulations and does not sufficiently acknowledge the need for technological development and sustainable adoption."

However, the *Renstra* lacks connection with the relevant regulations and does not sufficiently acknowledge the need for technological development and sustainable adoption. Instead, the plan focuses on public research and assistance programs. Indicators for technological adoption in the MOA Renstra are limited to farmers' satisfaction in using technologies developed by public research, and there is no indicator of the impact of technology on milk production. This shows that the MOA is currently not focusing on technology adoption and how it can be facilitated through collaboration with the private sector and other non-state actors. Private sector involvement is only mentioned loosely with no reference made to partnerships for incentivizing technology and knowledge transfers or providing legal protection, access to information, market, capital, and infrastructure for smallholder businesses. With the government's frequent call for "industrial revolution 4.0" in all sectors, including agriculture, the lack of a strategic approach to collaboration and partnership with the private sector in technological development and adoption by farmers is noticeably omitted.

Regulations on partnership include MOA Regulation No.13/2017 on Partnerships in Animal Husbandry Businesses, which provides a legal basis for partnerships between farmers, between farmers and companies, and between government agencies and companies. However, the transfer of technology is only mentioned as part of partnerships between government agencies and companies (Article 9), again indicating the focus on public research and development.

More specific regulations on partnerships in the dairy sector are found in MOA Regulation No. 26/2017 on Milk Delivery and Distribution and its amendments in MOA Regulation No.30/2018 and MOA Regulation No. 33/2018. Fresh milk pricing is set to follow the market mechanism by considering production cost, quality, and microbial contamination (Article 19). No price

control from the government (for example, through a Maximum Retail Price) enables buyers to incentivize better quality and higher production from farmers through better pricing. However, to increase the utilization of domestic fresh milk, Article 23 of MOA Regulation No. 26/2017 made it mandatory for dairy businesses to partner with dairy farmers and cooperatives for processing (Article 24) or promoting domestic fresh milk (Article 28). This article and the other associated articles were revised in MOA Regulation No. 30/2018 and MOA Regulation No. 33/2018. The amended articles drop the mandatory requirement for dairy businesses to form a partnership with farmers and cooperatives. According to the MOA, the change must take place to follow the WTO policy of non-discrimination and improve competition (The House of Representatives [DPR RI], 2018). While it exposes domestic farmers to competition from imported milk, it also encourages technology adoption as there is an increasing need for technology transfer to bolster production quality and efficiency.

Dairy cattle farming and breeding and fresh milk and cream processing industries are included among the priority investment sectors under Presidential Regulation No. 10/2021 on Investment Sectors. Income tax allowance is provided to encourage investment in these sectors. For investment in dairy cattle farming and breeding, the incentives require investors to partner with farmers and be integrated or partnering with a milk processor.

GOVERNMENT TECHNOLOGY ASSISTANCE PROGRAMS IN THE DAIRY SECTOR

The Indonesian government's attempt to improve the technology used by farmers is mostly conducted via assistance programs that provide high subsidies and grants for agricultural equipment and technologies. Several examples of assistance programs are as follows:

- *Feeding* – The Indonesian Agency for Agricultural Research and Development (IAARD) has developed high-quality grass for feed and promoted its wider adoption through program such as the Quality Feed Movement (*Gerakan Pengembangan Pakan Berkualitas* or Gerbang Patas). This program provides selected farmer groups with high-quality forage seeds, training, and equipment to grow forage crops.
- *Biogas digesters* – Since 2007, the MOA, Ministry of Environment and Forestry (MOEF), and Ministry of Energy and Mineral Resources (MOEMR) have provided more than 40,000 free biogas digesters to livestock farmers. A biogas digester utilizes bacteria to break down organic waste, such as manure, into biogas for home energy use and bio-fertilizer.
- *Increasing cattle population* – The MOA has implemented several programs for increasing cattle (cows and buffaloes) population and productivity—the latest one is called Sikomandan (*Sapi Kerbau Komoditas Andalan Negeri*) and has been implemented since 2020. This is achieved by increasing the number of superior breeds, improving the quality of calves, and administering progeny testing.[4] The program has incorporated artificial insemination (AI) and disease prevention since 2015 and supported the birth of 276,488 calves from 2018 to 2020. In 2020, 4.60 million AI doses were distributed (MOA, 2020). All supports are provided for free, although some cooperatives have rejected free AI from the government since they provide the same service commercially for their members (KPSCU, personal communication, 2022).
- *Role of local governments* – Some local governments, through the Regional Agriculture Office (*Dinas Pertanian*), provide technology support and training programs similar to those at the national level, though typically at a smaller scale due to budget constraints. Examples of this include provisions of grass choppers, cooling units, and milk management training from the Agriculture Offices in Bogor District and Cianjur (Cianjur Agriculture Office, personal communication, 2022); support for digital MCP development (Budianto, 2021) and biogas digester grants in Bandung; and local versions of Gerbang Patas in several areas. According to some informants from KPSG (personal communication, 2022), eligibility criteria and selection mechanism for these grants are unclear as some machinery and equipment appear to have been provided to farmers or cooperatives with strong connections to the government.

[4] Progeny tests examine the genetic traits of bulls based on their daughter's performance (for example, milk production). The tests are used to identify superior bulls that can be used for producing the next generations of young bulls.

There are several shortcomings with the government's technology and knowledge transfer programs. First, providing subsidized or free technologies is only effective at introducing technology in the short term (Lisson et al., 2010). In the long term, it often leads to pseudo-adoption behaviors , where farmers only adopt the technologies because they are free or to take advantage of its associated benefits like loans (Kiptot et al., 2007). Such programs encourage farmers to wait for technology grants and big subsidies from the government instead of making their own purchases and investment (Budiman, 2021). This is shown in the case of the biogas digester mentioned above. A recent study found that free biogas digesters from the government program crowded out the market and became a hurdle for commercial technology transfers implemented by a donor organization (Budiman & Smits, 2020).

"Providing subsidized or free technologies is only effective at introducing technology in the short term; in the long term, it often leads to pseudo-adoption behaviors."

Second, the studies on Indonesia's biogas programs by Budiman (2021) and Budiman and Smits (2020) reveal a fragmentation in technology transfer programs between those implemented by the government and those from the private sector and development projects, where they follow different, incompatible approaches. National government programs often use a grant approach implemented through a few vendors, overlap with local government programs, and do not provide proper monitoring and evaluation and user training. In contrast, the private sector and donors often have similar programs but with an entirely different approach: utilize a market-based and commercial or semi-commercial approach, involve multiple stakeholders (companies, the government, banks, local construction partners, and cooperatives, in addition to the recipients), and have standardized training and after-sale services (Budiman, 2021). Fragmentation can occur in knowledge transfer programs that runs the risk of promoting conflicting knowledge. Mulatmi et al. (2016) argue that there is a need to improve the connection between extension services from the government and those provided by non-state actors.

Third, programs for increasing cattle populations like Sikomandan are not environmentally sustainable as they promote higher greenhouse gas emissions. Between 2000 to 2020, the livestock sector contributed an average of 26% (24,696 Gg CO2e) of agricultural emissions in Indonesia every year (Ministry of Environment and Forestry [MOEF], 2021). The emissions are produced from enteric fermentation (40%), manure management (29%), feed production (28%), and housing (3%) (de Vries et al., 2017). A sustainable way forward is by improving productivity without increasing the number of cows and by keeping emissions in check. It can be achieved by administering a feeding regime that includes more compound concentrate feed and tofu waste, especially for farms with low and medium milk yields (de Vries et al., 2019). This calls for more attention to feeding support from the government and private sector, without ignoring the trade-offs that may occur due to foraging, such as land-use and biodiversity change and deforestation.

LESSONS LEARNED FROM PRIVATE SECTOR INITIATIVES AND POLICY RECOMMENDATIONS

The private sector's approach is more effective at ensuring technology adoption because they understand the issues that farmers face regarding milk quality and farm management from close, day-to-day interactions. Companies provide tailored extension services, technologies, and approaches to farmers and cooperatives, as shown by FFI and Nestlé with the digital MCP, and Cimory with the 1,000 Srikandi Programme. Nestlé further links technology provision with a commitment from farmers to maintain milk quality and production. This approach has proved able to increase technology adoption and milk production. By working closely with dairy cooperatives in helping farmers afford technologies through loan provision, the partnership approach contributes to maintaining sustainable adoption and prevents disadoption or pseudo-adoption behavior that usually occurs in free technology provisions.

"By working closely with dairy cooperatives in helping farmers afford technologies through loan provision, the partnership approach contributes to maintaining sustainable adoption."

Most of the technologies involved in the partnership schemes are newly introduced to farmers. Most are not accessible to farmers due to cost and information asymmetry, with a few exceptions such as biogas digesters and concentrates which have been commercialized. Transfers of emerging technologies as part of corporate activities and international development programs help develop the market for these technologies.

One technology aspect that still needs attention is feeding. High-yielding cow breeds require quality feeds to increase milk production. Suboptimal feeding may reduce milk production by two litres per cow per day (Ali et al., 2015). FFI, Cimory, and Nestlé provide extension services and support to improve feed quality, but farmers still struggle to find sufficient, high-quality, and affordable feeds. Addressing the feeding issue requires a separate study, but a comprehensive solution should touch on land use and trade policy. According to farmers from West Java cooperatives, they face the challenge of finding forage grass due to the rapid conversion of grassland into buildings and the relatively high cost of feeds (KPSG & KPBS Pangalengan, personal communication, 2022).[5] KPSBU farmers attempt to solve their feeding issue by purchasing maize silage from the maize farmers. This means that cattle feeding is also affected by domestic production of maize and its import policy.

Due to their knowledge-intensive nature, all technologies transferred should come with extension services and training for dairy smallholders. As discussed before, the provision of training that accompanies technology transfer is more often done in private sector programs compared to government programs. Extension services need to transform farmers' perception of the benefits of technology and employ strategies tailored to farmers' socio-cultural and economic situations. Tailored training may involve farmers who were recipients and early adopters of the technologies as teachers who train other farmers—an approach that has been implemented by FFI.

[5] An average of 30 kilograms of grass per day (at IDR 3,000 per kilogram, at the time of writing) are needed for a cow, depending on weight. Farmers also feed cow with concentrates, supplements, and food waste (such as tofu dregs) (KPSG & KPBS Pangalengan, personal communication, 2022).

While extension services and knowledge transfers from companies and development programs are useful, they can be improved by adding training for improving the capacity of farmers and cooperatives in contract negotiation, for example with modules on market information for price negotiation and due diligence. Improved understanding of contract terms from both parties helps reduce transaction costs and provides incentives for high-quality production.

International examples also show the various ways in which smallholders benefit from contract farming through better access to inputs and technology leading to higher and more stable income (Bellemare, 2012; Minten et al., 2009; Rao & Qaim, 2011; Rao et al., 2012t).

To support the development of Indonesia's dairy farming and industry through technological adoption, the following recommendations should be considered by the MOA, especially through the Directorate General of Animal Husbandry and Health:

- *Provide a legal basis and development targets for technology and knowledge transfers that acknowledge and encourage the private sector's role*. This can be done by revising MOA Regulation No.13/2017 on Partnerships in Animal Husbandry Businesses to mention technology and knowledge transfers as a possible partnership scheme between firms and farms. Future Renstra should also lay out a strategy for technology adoption that utilizes a market-oriented approach centred on the participation of all stakeholders, not just government provision of technology from public research and development.
- *Maintain partnerships for domestic milk absorption, between farms and businesses*. The MOA Regulation No. 33/2018 allows companies to utilize technology transfers and better pricing for incentivizing higher milk quality and production. Presidential Regulation No. 10/2021 has further encouraged partnerships through tax allowance for investors who maintain partnership with farmers. The MOA, by coordinating with the Ministry of Finance (MOF), can further encourage technology transfers through incentives for businesses, for example, tax incentives tied to technology provision to local farmers or the amount of domestic fresh milk utilized in production.
- *Reduce fragmentation in technology and knowledge transfer programs by facilitating existing private sector programs and focusing resources on farms or areas that have yet to receive support*. To avoid duplication, the MOA should map existing technology, equipment, and services that have been provided by the private sector and other partners, including local governments. When these are already available, the MOA should refrain from delivering similar assistance and aim instead to complement and facilitate them by opening market access and financial support. The latter is especially important for less-adopted technologies such as milking machines, where a market development strategy is needed. On the other hand, businesses and financial institutions should be involved in implementing and developing technology and knowledge transfers from the government in a market-based approach to creating wider economic opportunities in rural areas.

"To avoid duplication, the MOA should map existing technology, equipment, and services that have been provided by the private sector and other partners, including local governments."

- *Promote the transition from assistance programs that encourage increasing cattle population, such as Sikomandan to sustainable production*. Assistance programs should be designed to improve productivity per cow while keeping emissions in check, which can be achieved through optimal feeding, optimizing land use in mixed crop-livestock farming, and improving barn features to control manure emissions.
- *In the short term, facilitate cooperation with the private sector and implement a market-based approach to address the feed issue*. Farmers and cooperatives may cooperate with the dairy companies to obtain feed support as part of a forward contract arrangement. The government can also expand the Gerbang Patas program to embrace a market-based approach to seed provision and forage cultivation. In the long term, a comprehensive solution should confront the trade-offs with land-use and import policies for forage crops.

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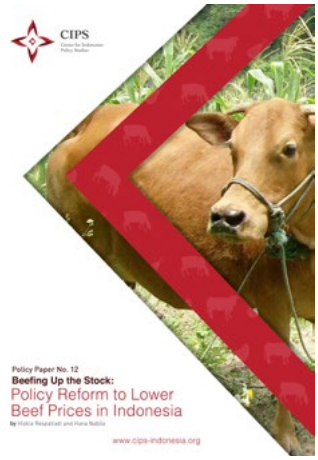

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