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Division of Labour Amongst Innovation Intermediaries in Agricultural Innovation Systems: The Case of Indonesia

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Abstract: *Innovation intermediaries are individuals and organisations that enhance connectivity amongst constituencies of national, sectoral, and regional systems of innovation, thereby facilitating knowledge spillover. This paper articulates the whole picture of Indonesia's agricultural innovation system, with a special focus on how different innovation intermediaries play different roles in technology transfer and knowledge dissemination. First, the public sector accounts for more than half of the actors involved in research and extension, but insufficient routes to transfer local needs to the public sector impede efficient feedback. Second, village unit cooperatives are closely associated with extension workers, suggesting the presence of a feedback mechanism, but many of them face serious financial distress. Third, private agricultural research and development and extension are organised and managed efficiently where they involve fewer internal actors working in an environment with minimal bureaucracy. However, a vague regulatory environment makes it difficult for multinational enterprises to hold a positive view towards agricultural research and development and extension from the public sector. Last, the changing governance system and the ensuing shift in political decision-making have introduced uncertainties to the arrangement of actors and resources in the system, which may take some time to resolve.*

***Keywords*:** Agricultural innovation system; ASEAN; division of labour; extension workers; Indonesia; innovation intermediaries; knowledge spillover; technology transfer
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1. Introduction

An improvement in living standards is the ultimate goal of any government. From an economic perspective, total factor productivity (henceforth, productivity) growth is the key driver to improve living standards. Industrial productivity can be improved via productivity growth through innovation by incumbents, resource reallocation through market competition amongst incumbents (e.g. changes in market share), or the entry of efficient newcomers and exit of inefficient incumbents (i.e. entrepreneurship and industrial metabolism). This study defines innovation as 'new' products, processes, and practices created in a society, which are 'disseminated' within the society (Fukugawa, 2018a). The novelty element associated with innovation defined here does not necessarily mean that the innovation must be new to the world. A technology that is widely accepted in one society can be regarded as an innovation in another society where the technology has yet to be introduced, if it brings new solutions to existing problems in that society. Further, innovation is not merely a technological process driven solely by scientific advancement, but also a 'social process' that inevitably hinges on how much seekers of solutions are receptive to the new knowledge embodied in technologies and practices, and how much providers of knowledge are responsive to social needs. In this context, innovation, as defined in this study, encompasses not only technological breakthrough but also institutional efficiency (Lafuente, Szerb, and Acs, 2016).

Looking to developing countries, agriculture tends to be the most important industrial sector. This makes agricultural innovation critical for their long-term economic growth and the improvement in living standards. The promotion of agricultural innovation requires particular attention from policymakers because of the crucial presence of the public sector in agricultural innovation. First, agricultural research takes longer than research in other industrial sectors built on physics and chemistry because it takes more time to repeat experiments which involve a number of growing plants and selecting a few with appropriate characteristics. This implies higher uncertainty in research and development (R&D), and makes it difficult for the private sector to manage a research plan and capture value from innovative investments. It also makes it difficult for the private sector to invest in agricultural research activities. Second, price elasticity of demand for agricultural products, such as staple foods, tends to be small, which implies a steep demand curve. The elasticity of supply to the price of agricultural products also tends to be small, as it is difficult for

agricultural producers to increase production within a short period of time, which implies a steep supply curve. These demand- and supply-side conditions suggest that the impact of innovation, represented as a shift of a supply curve, tends to be absorbed by a great increase in consumers' surplus, leaving a small increase in producers' surplus. Therefore, in agriculture, it is more difficult for private innovators to appropriate the return to R&D than for innovators in other industrial sectors. The appropriation condition can be more difficult considering that the agricultural sector consists of a number of individual farmers who normally do not have complementary assets, such as distribution channels. These supply- and demand-side factors in innovation render the public sector a crucially important source of agricultural research, and thus agricultural innovation.

Combined with the above-mentioned uniqueness of agricultural innovation, the 'diffusion' element associated with innovation defined in this study implies that the efficient transfer of research outcomes from the public sector is critical. In other words, public research institutes, including national universities, have to be responsive to social demand and, at least to some extent, select research topics ready for industrial application. This makes the 'intermediation function' important not only in disseminating outputs from public research institutes, but also in promoting the public sector's understanding of social needs. 'Innovation intermediaries' are individuals and organisations that connect the constituencies of national, sectoral, and regional innovation systems, which otherwise would have been fragmented. They enhance knowledge spillover, and thus innovation (Stankiewicz, 1995; Howells, 2006). Previous studies on the agricultural innovation system (AIS) view innovation intermediaries as an essential structural element of the AIS (Klerkx, Van Mierlo, and Leeuwis, 2012). This is because the AIS concept places a high value on institutional support for interactions amongst system constituencies, which is distinct from a linear model of technology diffusion that considers spillover from public knowledge taking place in a unilateral (i.e. from research institutes to extension stations), automatic, and exogenous manner. In contrast, the AIS sees that interactions amongst system constituencies (e.g. research institutes and extension stations) promote agricultural innovation, and such interactions can be enhanced through better rules and institutions (Klerkx, Van Mierlo, and Leeuwis, 2012; World Bank, 2012). A typical example of such an institutional device is innovation intermediaries.

Innovation intermediaries can be observed at any level of the economy (micro, meso, and macro) and governance (national and regional), and any type of sector

(public and private) and organisation (policy-led and voluntary). For the micro-level example, innovation intermediaries refer to individuals who can identify external sources of knowledge, translate the knowledge into terms that can be shared within their community, and eventually link previously unconnected economic agents. Cohen and Levinthal (1990) described such an individual as a 'gatekeeper' who possesses the 'knowledge of who knows what, who can help with what problem, or who can exploit new information' (Cohen and Levinthal, 1990: 133). Previous studies on sociology and organisation theory refer to such human capital using different terms, such as 'knowledge gatekeepers' (Lewin, 1947; Allen and Cohen, 1969); 'network entrepreneurs' (Burt, 2001); 'knowledge transformers' (Harada, 2003); and 'boundary spanners' (Aldrich and Herker, 1977; Adams, 1980; Tushman and Scanlan, 1981). A number of studies that addressed university–industry collaborations, taking examples of technology transfer organisations, liaison offices, incubators, and science parks, viewed such individuals as critical in bridging different realms, such as universities representing open science and industry pursuing proprietary technology (Westhead and Batstone, 1999; Santoro and Chakrabarti, 2002; Balconi, Breschi, and Lissoni, 2004; Fukugawa, 2006; Fukugawa, 2018b). For the meso-level example, a number of developed countries have established innovation intermediaries as a part of regional innovation policy for small and medium-sized enterprises (SMEs). Examples include *Kosetsushi* (local public technology centres) in Japan (Fukugawa and Goto, 2016; Fukugawa, 2016); the Manufacturing Extension Partnership (Office of Technology Assessment, United States (US) Congress, 1990) in the US; the Industrial Research Assistance Program in Canada; the Netherlands Organisation for Applied Scientific Research (TNO); the Steinbeis Foundation in Germany; the Emilia-Romagna Regional Development Agency (ERVET) in Italy; and Technology and Innovation Centres in the United Kingdom (Shapira, Youtie, and Kay, 2011). These innovation intermediaries fulfil different functions in regional innovation systems according to the needs of small local firms.

Innovation intermediaries become more important when considering the AIS in developing countries. First, as previously stated, agriculture tends to be the most important industrial sector in developing countries. Second, it is critical for welfare improvement in developing countries to diffuse existing knowledge efficiently rather than to explore cutting-edge technologies. This makes the intermediation function, in terms of the dissemination of outputs from public research institutes, significant in developing countries. Third, the intermediary function becomes more important in the

AIS as the information gap widens between the seeker and provider of solutions. The information gap is determined by the time required for the seeker to evaluate the outcome of technology transfer and the necessity of face-to-face communication between the user and provider of knowledge (Izushi, 2003; 2005). This implies that the information gap is a function of the cognitive distance between the two. In developing countries, the need to fill the cognitive distance and knowledge disparity (Han, Han, and Brass, 2014) between the seekers and providers of solutions tends to be greater. This is because capability-related systemic failures (Klerkx, Van Mierlo, and Leeuwis, 2012) tend to be more serious in developing countries. In other words, it is likely that less knowledge or mindset are shared amongst AIS constituencies for institutional reasons, such as immature education systems. Collectively, characteristics of the agricultural sector make innovation intermediaries more valuable in the AIS of developing countries.

Innovation intermediaries have different functions. As a consultant, they provide clients with solutions to technological problems in R&D. As a broker, they foster market transactions amongst clients. As a mediator, they foster non-market-based, mutually beneficial collaborations amongst clients. As a resource provider, they secure clients' access to financial, technological, and physical resources to achieve a collaborative outcome (Howard Partners, 2007). In light of the different functions of innovation intermediaries, Intarakumnerd and Chaoroenporn (2013) argued that different types of innovation intermediaries help economic agents tap into different sources of knowledge to improve productivity, which suggests a division of labour amongst innovation intermediaries. For instance, private innovation intermediaries (e.g. trade associations) tend to be important as a broker and in creating 'club goods' that can be used exclusively amongst participants. On the other hand, previous studies provide econometric evidence that public innovation intermediaries established as a part of regional innovation policy had a positive impact on labour productivity growth (Jarmin [1999] examined Manufacturing Extension Partnerships in the US) and innovations (Ponds, van Oort, and Frenken [2010] examined TNO in the Netherlands; Fukugawa [2017] examined *Kosetsushi* in Japan). Thus, public innovation intermediaries tend to be important as a consultant and a resource provider, and to produce public goods that are necessary for the general technological upgrading of all firms in the sector.

Echoing the notion of division of labour amongst innovation intermediaries,

Fukugawa (2018c) examined the determinants and impacts of participation in different interfirm organisations amongst SMEs uniquely developed in Japan. Fukugawa showed that cooperative associations that were promoted by the government and had a legal entity improved the productivity of participants through cost sharing (e.g. joint logistics), while voluntary groups without a legal entity, aiming at information exchange and innovation, improved the productivity of participants through knowledge sharing (e.g. joint R&D). Further, innovative SMEs exploited different innovation intermediaries so that they could extract benefits from each of them. Specifically, innovative SMEs participating in voluntary groups (acting as a mediator) for joint R&D tend to form a cooperative association (acting as a resource provider), which allows them to receive policy loans when they face difficulty in financing innovative activities under voluntary groups. These findings stress the importance of the division of labour between different types of innovation intermediaries.

In the context of AIS innovation intermediaries, previous studies applied the structural-functional approach to various economies, such as China (Yang, Klerkx, and Leeuwis, 2014); Kenya (Kilelu, Klerkx, and Leeuwis, 2013); the Netherlands (Klerkx and Leeuwis, 2009); and New Zealand (Turner et al., 2013). For Association of Southeast Asian Nations (ASEAN) Member States, however, empirical evidence in this field has been scant. This study aims to fill this research gap. Taking the example of Indonesia, a major agricultural power in ASEAN, this paper seeks to provide the whole picture of Indonesia's AIS with a focus on the division of labour amongst innovation intermediaries.

The remainder of this paper is organised as follows. Section 2 reviews previous literature to identify the locus of this research and propose a theoretical framework for empirical analysis. Section 3 describes how we collected information on innovation intermediaries in Indonesia's AIS. Section 4 depicts the whole picture of the AIS and comments on the roles that innovation intermediaries play in knowledge creation and dissemination, thereby illustrating how different innovation intermediaries facilitate the diffusion of new and existing agricultural knowledge amongst local farmers via different routes. Section 5 discusses the implications of the results and refers to the limitations of the present study and agenda for future study.

2. Analytical Framework

To address the research questions articulated in the previous section, this study employs the structural-functional approach to examine the AIS of Indonesia. The structural approach is defined as a static analysis of the presence and interactions amongst actors, and the infrastructures that govern the behaviour of actors in innovation processes (Klerkx, Van Mierlo, and Leeuwis, 2012). This approach addresses the question of the extent to which the AIS supports, or does not support and even constrains, agricultural innovation (Sorensen, 2011).

AIS actors defined by this approach fall into four domains (Arnold and Bell, 2001). First, the research domain includes universities, public research institutes, private R&D departments, and research arms of non-governmental organisations (NGOs), which conduct basic or applied research and generate primarily codified knowledge via publications. Second, the enterprise domain involves supply chain actors, such as input suppliers, farmers, food processors, food service providers, and retailers, which typically use codified and tacit knowledge, and generate tacit knowledge via investment in human capital. Third, the indirect demand domain includes a group of more distant actors influencing and impacted by innovation, including final consumers, policymakers, social interest groups (e.g. charities and NGOs), and markets complementary to the agri-food sector, such as energy or pharmaceutical markets. Fourth, the intermediary domain considers organisations that may not necessarily be involved in knowledge creation or usage, but play a catalytic role in connecting fragmented system constituencies and facilitating knowledge spillover. As an example of private innovation intermediaries, trade associations disseminate information on business opportunities, management practices, and technological standards so that participating firms can introduce best managerial practices to improve productivity, thereby acting as a broker and resource provider. As an example of public innovation intermediaries, *Kosetsushi* act as a catalyst or mediator for local SMEs to develop industrial and academic networks, as well as acting as a consultant which provides solutions to technological problems through consultation and education for SME engineers (Fukugawa and Goto, 2016; Fukugawa, 2016). This study aims to identify these key actors of knowledge creation and dissemination in the AIS of Indonesia, with a focus on innovation intermediaries, which will be indicated in Figure 1.

The infrastructures of the AIS fall into three categories. First, knowledge

infrastructure refers to R&D facilities, libraries, training systems, knowledge, expertise, know-how, and strategic information. Second, physical infrastructure refers to transportation systems, telecommunication systems, and utilities that require major investments that cannot be made independently by the actors of the system. This factor has strong impacts on the AIS according to geographical features (e.g. area, altitude, archipelago, or continent) of the nation. Third, funding infrastructure refers to public support schemes represented as tax credit, subsidies, grants-in-aid, and innovation vouchers and private initiatives like incentives from banks. This study aims to identify AIS infrastructures in Indonesia in reference to innovation intermediaries, such as farmers' associations, which aim to educate people, lobby for public works, and mitigate financial constraints that farmers encounter.

Based on the structural approach to the AIS, this study aims to generate a map, as shown in Figure 1, identifying key system constituencies and infrastructures they are embedded in, thereby articulating different types of interactions (i.e. diffusion and feedback systems) amongst actors mediated by different types of innovation intermediaries in the AIS of Indonesia.

The structural approach builds on a mechanistic (or engineering) view that assumes that systems have clear national, regional, and sectoral boundaries and can be engineered towards an unambiguous goal, which is to support innovation. Although this feature has methodological merits, it also limits the possibility of exploring dynamic, evolutionary, and self-organising aspects of the AIS, as the system may change according to entrepreneurial activities by system constituencies as well as changes in the external environment. The 'process approach' augments such downsides of the structural approach. This approach is suitable for the analysis of a 'system innovation', rather than an innovation system, whereby niches (or technological innovation systems) in which entrepreneurs experiment with a novelty emerge and develop, which is radical agricultural innovation (Knickel et al., 2009; Elzen et al., 2011; Lamine, 2011; Elzen et al., 2012).

The 'functionalist approach' to the AIS (Hekkert et al., 2007) has affinity with the process approach in that it addresses niche activities, providing insights into the interaction of functions that determine the slow and difficult change of a locked-in system towards a new equilibrium (Hekkert et al., 2007: 418). This approach builds on a biological view that assumes the whole body cannot function well if sub-systems (e.g. organs) are lacking or do not collaborate with others harmoniously, and examines whether specific functions are fulfilled. Combining insights from Hekkert et al. (2007)

and Bergek et al. (2008), eight functions (or processes) have been identified as important for innovation systems to perform well. They include F1: knowledge development (either through research or learning by doing); F2: entrepreneurial activities (i.e. exploiting new or overlooked opportunities) and commercial experimentation; F3: knowledge diffusion in networks; F4: mobilising monetary resources (i.e. funding); F5: mobilising non-monetary resources (e.g. in-kind contributions, supply human capital); F6: market formation (i.e. commercialisation of innovative products and services); F7: guidance of the search (i.e. identifying problems, recognising the potential for change, and showing the direction of search for new technologies, markets, and partners); and F8: creation of legitimacy (i.e. counteract resistance to change and legitimate technologies). Mapping the functions contributes to identifying propellants of innovation, i.e. sets of functions that reinforce each other and accelerate developments, as well as impedance of innovation (Hekkert et al., 2007). As explained in the next section, this study articulates the roles that each innovation intermediary plays in the AIS and the functional configuration of such roles in the AIS, which will be shown in Table 5.

When focusing on the diffusion element of innovation, it is important to understand the role that innovation intermediaries play in the system of innovation and the functional configuration of such roles in that system. Hellin (2012) compared the emergence of AISs in Mexico and Peru through agricultural extension services. In Peru, agricultural collectivisation occurs with NGOs and the Kamayoq (farmer-to-farmer extension agents) acting as a key mediator of local networks, while AISs fail to emerge in Mexico where a linear model of technology diffusion was adopted. Hellin (2012) argued that it is not until collectivisation is combined with networking that heterogeneous value chain actors create AISs, which casts doubt on the effectiveness of pluralistic and diversified extension systems hailed as a model for agricultural technology transfer in developing countries, without making the paradigm shift from a linear technology transfer approach to one that supports the emergence of an AIS.

In the context of innovation intermediaries in the AIS, recent studies highlight the significance of ‘pluralism’ in agricultural extension (World Bank, 2012). Pluralistic extension systems are different from traditional ones in that they aim to provide solutions to local farmers’ problems jointly, rather than individually. Further, innovation intermediaries (public, private, or NGO) increase the diversity of providers of knowledge that could match the diversified needs of local farmers. Such attributes are important when taking account of the increased complexity of recent problems

surrounding the AIS, such as disasters caused by climate change, since they require various types of knowledge, joint efforts, and tailor-made solutions. This suggests that the efficient division of labour amongst innovation intermediaries becomes more valuable in the AIS, and that the valuable composition of innovation intermediaries varies according to country and region. In the same context, taking the example of the privatisation of agricultural extension services in the Netherlands, Klerkx and Leeuwis (2008) identified three key activities of innovation intermediaries in the AIS: demand articulation, network brokerage, and innovation process management. Demand articulation is to understand local needs, solution providers, and the nature of problems. Network brokerage is to fill the information gap between seekers and providers of solutions, organise a platform for knowledge sharing, and help smallholders access the resources needed. Innovation process management is to create, maintain, and facilitate relationships, thereby filling a cultural gap. Based on the idea of Klerkx and Leeuwis (2008), this study articulates the roles that each innovation intermediary plays in the AIS and the functional configuration of such roles in the AIS, which will be shown in Table 5.

In the context of innovation intermediaries in the AIS of developing countries, an increasing number of empirical studies have focused on how and when agricultural extension systems affect innovation and technology diffusion. Appendix 1 summarises the literature review on this topic, from which two important implications can be derived. First, innovation intermediaries in the AIS are not confined to public extension stations, which shows the significance of pluralism in agricultural extension. Previous studies show that voluntary collectives amongst farmers, such as NGOs and self-help groups, help the AIS work better (Hellin and Dixon (2008) in Peru; Debnath, Saravanan, and Datta (2016) in Northeast India), and that the introduction of a pluralistic approach is conducive to technology transfer productivity (Kassem (2014) in Egypt; Baig and Aldosari, 2013). Second, findings from previous studies imply that the determining factor in the technology transfer productivity of agricultural extension services lies not only in physical factors, such as demonstration fields, but also in organisational factors. These include the improvement in the quality of extension staff through education and training (Al-Sharafat, Altarawneh, and Altahat (2012) in Jordan; Issa and Issa (2013) in Nigeria; Agunga and Putra (2015) in Indonesia; Carmen and Bautista (2016) in the Philippines; Ofuoku and Agbamu (2013) in Nigeria); capabilities for appropriate direction and consultation services (Chi and Yamada (2002) in Viet Nam; Cole and Fernando (2012) in India); and the enhancement of

social capital (Jamil et al. (2015) in Pakistan; Elias et al. (2015) in north-west Ethiopia). These implications are consistent with findings from previous studies in developing, emerging, and advanced economies on technology transfer organisations (e.g. university-based technology licensing offices) in that the technology transfer productivity (e.g. the number of patents licensed to firms and royalty revenue) is affected not only by physical factors such as location but also by organisational factors such as incentive mechanisms designed for staff of technology licensing offices (Lach and Schankerman [2008] in the United Kingdom; Fukugawa [2009] in Japan; Adekunle [2013] in Nigeria; Hsu et al. [2015] in Taiwan).

The literature review shows that AIS studies have addressed innovation intermediaries. Some studies refer to the different functions of innovation intermediaries in the AIS, and others point to the need for quality improvement in extension staff, which would be conducive to better demand articulation, network brokerage, and innovation process management (Klerkx and Leeuwis, 2008). However, previous studies conducted in developing countries defined and analysed innovation intermediaries in the AIS individually, rather than as a system constituency. This study sees the process of agricultural innovation (knowledge creation and dissemination) as a systemic rather than linear one, and identifies a diversified set of system constituencies as innovation intermediaries, echoing the surge of interest in pluralistic extension systems. These include the public sector (e.g. extension stations and their workers, self-help groups, voluntary groups, NGOs, industry associations, and cooperative associations) and the private sector (e.g. consulting companies and multinational enterprises). Based on a systemic view of the agricultural innovation process, this study aims to identify the bilateral knowledge flow between public research and smallholders, intermediated by economic agents, thereby articulating the feedback system working in the AIS. As described in the next section, information obtained through interviews, literature, and statistics will be used to create a map showing such knowledge flow in Indonesia's AIS.

3. Method

The study began with data and information collection by perusing official documents and existing academic papers, which were obtained through relevant government websites, international journal directories, and other pertinent sources.

Official documents, such as the government's strategic plan and publications, provided secondary information and data to build preliminary understanding before conducting one-on-one interviews.

Online data collection relied on public access to several official websites of Indonesian governmental agencies where data, information, and documents can be downloaded and compiled.

Several interviews with representatives from relevant ministries and departments, higher education institutions, the private sector, and industry associations were conducted from September to November 2017. Interviews were recorded and notes were taken during the talks. All respondents agreed to the recording of the interviews, and details of all respondents will always remain confidential. Any discrepancies or lack of clarity in the information gathered from secondary sources were raised during most of the interviews to cross-check and validate. Appendix 6 contains the list of interviewees.

4. Results

The main finding of this study is a map depicting Indonesia's current AIS (Figure 1). The map was developed based on the analyses built on the information gathered and synthesised from desk research and interviews. In Figure 1, actors or agencies are depicted in grey/shaded boxes, while the white boxes provide explanations of the duties, responsibilities, or activities that link one actor to the other. The two-way arrows represent the presence of a formal feedback and/or communication mechanism that this study could identify. The absence of two-way arrows does not necessarily imply that the feedback mechanisms allowing the sharing of information and knowledge between actors do not exist. This study believes in the general premise that some forms of informal feedback mechanism may take place amongst actors across different levels of governance. However, establishing the presence of formal mechanisms would require further investigations, which transcend the time frame of this study.

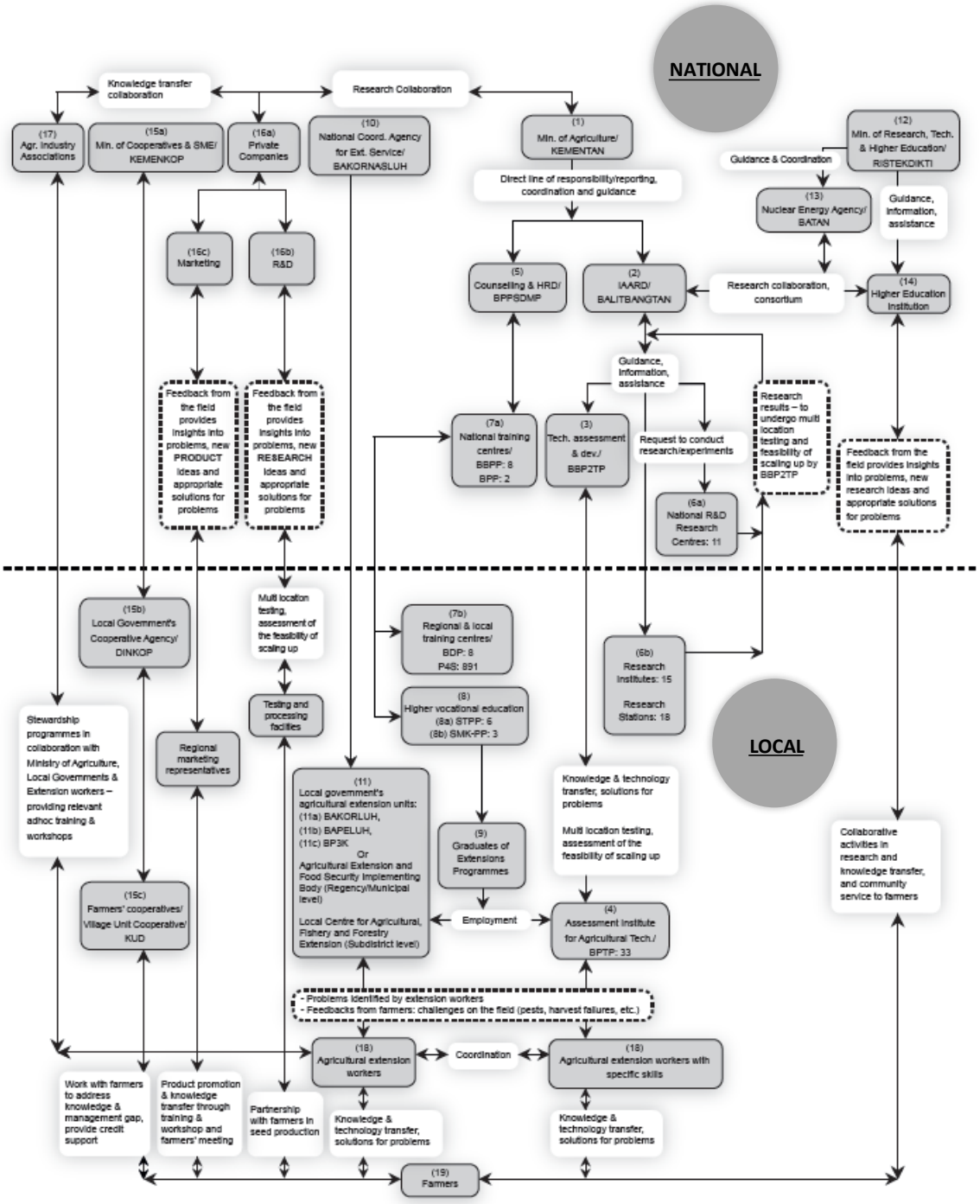
The AIS can be seen as a complex ecosystem-like arrangement in which different actors or agencies of the public and private sectors operate within and across different levels of governance hierarchy. In generating the map of the system, actors or agencies were identified and classified based on their (i) institutional functions (research

management or knowledge dissemination), and (ii) institutional hierarchies (the level of governance where the agencies/actors operate). This section first provides an overall assessment of the AIS in Indonesia, then comments on the role played by individual AIS constituencies.

1 – Ministry of Agriculture (KEMENTAN)

At the national level, several ministries and ministerial-level agencies play a key role in the country's agricultural research and extension. These include the Ministry of Agriculture (KEMENTAN); the Ministry of Research, Technology and Higher Education (RISTEKDIKTI); the National Nuclear Energy Agency (BATAN); and the Indonesian Institute of Sciences (LIPI). KEMENTAN is the leading national public sector body responsible for the provision of guidance and policies relating to the development of the agriculture and food sector, as well as keeping the trajectory of the R&D activities within its purview in agreement with national interests. The ministry directs and coordinates several departments or agencies, including the Indonesian Agency for Agricultural R&D (BALITBANGTAN) and the Counselling Agency and Human Resources Development of Agriculture (BPPSDMP). These two agencies are under KEMENTAN, whose work is most pertinent to agricultural research and extension.

Figure 1: Indonesia's Current Agricultural Innovation System



BALITBANGTAN = Indonesian Agency for Agricultural Research and Development; BAKORLUH = Coordinating Agency for Extension; BAPELUH = Implementing Agency for Extension; BP3K = Office for Agricultural, Fishery and Forestry Extension.

Note:

1. Two-way arrows represent possible formal feedback mechanisms that exist between relevant actors in the map.
2. Dashed boxes highlight certain information that flows in the upward direction.

Source: Authors' elaboration.

2 – Indonesian Agency for Agricultural R&D (BALITBANGTAN)

The agency serves as the primary public body carrying out both research management as well as knowledge dissemination activities through its various working units. These comprise 29 research management units (11 national research centres, 15 regional research institutes, and three local research stations) and 35 knowledge dissemination units (one Centre for Agricultural Technology Assessment and Development (BBP2TP), one national research repository and information centre, and 33 local Assessment Institutes for Agricultural Technology (BPTPs)). Each of these working units' scope is largely contingent on the hierarchy of institutions to which they are designated. For example, some working units perform research activities that are designed to respond to location-specific problems. The agency plays a central role since it runs and organises virtually all research and studies on agriculture, from early conceptualisation and experimentation to the end of the research phase at which new knowledge is ready for dissemination to farmers and society at large. In general, the agency's R&D activities are geared towards (i) meeting the current national interest, which is to achieve self-sufficiency in the food and agricultural sector; (ii) meeting researchers' specific interests or expertise; (iii) catering to local demands or problems; and (iv) meeting certain targets or ad hoc requests. The agency also works closely with researchers of LIPI, BATAN, and universities through several different schemes such as research collaborations and consortiums.

3 – Centre for Agricultural Technology Assessment and Development (BBP2TP)

The Indonesian Centre for Agricultural Technology Assessment and Development (ICATAD or BBP2TP) is a technical unit under BALITBANGTAN responsible for assessing research findings. Research that has come to fruition at BALITBANGTAN has to undergo a series of assessments which involves multi-location trials and/or on-farm testing in several locations to determine the possibility of mass production, including the identification of problems that might otherwise remain unseen.

4 – Assessment Institute for Agricultural Technology (BPTP)

BBP2TP works with its local assessment institutes located in 33 provinces. These assessment institutes, officially called Assessment Institutes for Agricultural Technology (AIATs or BPTPs), serve as focal points through which multi-location or on-farm testing are administered. BPTPs also provide extension services, including trainings and workshops, tailored to promote new technology packages formulated by

BBP2TP based on the research developed by BBP2TP researchers. This extension service engages extension workers who are trained and equipped with specific skills that will facilitate them in introducing new technologies to farmers.

5 – Counselling Agency and Human Resources Development of Agriculture (BPPSDMP)

Apart from the extension service provided by BBP2TP through BPTPs, two other streams of extension service involve different government agencies and entities. One is under the BPPSDMP and the other is organised by the Implementing Body for Agricultural, Fishery and Forestry Extension, which operates under regency or municipality governments. The BPPSDMP is a public agency under KEMENTAN, which shares the same institutional hierarchy with BALITBANGTAN. The work of BPPSDMP is centred on human resource development across all agencies and working units within KEMENTAN. This includes the management and provision of vocational education as well as training services and facilities for extension workers. Currently, BPPSDMP manages several training centres and vocational schools, while assisting local governments in managing their agricultural extension/food security units.

6a – National research centres

At the national level, 11 research centres work under BALITBANGTAN to conduct research in various topics from food crops and horticulture, to agriculture engineering and biotechnology.

6b – Research institutes and stations

Within the aforementioned national research centres (6a), BALITBANGTAN oversees a number of local research bodies, comprising 15 research institutes and three research stations (Appendix 4).

7a – National agricultural training centre (BBPP) and agriculture training centre (BPP)

The BBPP and BPP are the two technical implementation units under the BPPSDMP responsible for the provision of training programmes and the required systems and services.

7b – Local agricultural education and training centre (BDP) and training centre for agricultural and rural subsistence (P4S)

The provision of training programmes is also done through some provincial and regency training centres. Little information is available regarding the line and scope of responsibility of these local training centres. However, it is understood that these local agencies lie within the purview of and receive direction from the BPPSDMP as specified in its Strategic Plan, 2015–2019 (BPPSDMP, 2016).

8 – Formal agricultural extension education

The provision of education, including the transfer of knowledge that takes place within the realm of training and education in the agricultural extension system, involves two different institutions. One is a higher-level vocational school or academy (STPP (8a)), which is equivalent to a bachelor's degree. The other is a higher secondary school in agricultural development (SMK-PP (8b)), offering vocational education at secondary or high school level. Quite different from their regular/non-vocational counterparts, these higher education institutions belong to the Ministry of Agriculture instead of the Ministry of Education and Culture and fall under the auspices of the BPPSDMP along with the aforementioned education and training centres.

9 – Graduates of extension programmes

As briefly mentioned earlier, several possible routes exist for students wishing to work as an agricultural extension worker, including (i) full-time worker, (ii) part-time staff, (iii) daily basis/casual worker, and (iv) voluntary worker. Extension workers delivering public extension services, whose employment is on part-time and daily bases, are eligible for incentive arrangements that are different from their full-time counterparts. They may work under the Ministry of Agriculture or under local governments at regency (*kabupaten*) or municipal (*kota*) levels and receive remuneration from either of the two. Generally, students who graduate from STPPs may pursue a career as an extension worker by becoming a civil servant or working at a private agricultural company. Meanwhile, students enrolled in SMK-PPs may continue their education to STPPs or embark on a similar path to STPP graduates, but with a lower starting position, such as casual or daily-basis employment. The number of extension workers by province in 2017 is shown in Table 1.

Table 1: Number of Extension Workers by Province, 2017 (number of workers)

Island	Province	Extension Workers
Sumatera	Nanggroe Aceh Darussalam	2,863
	North Sumatera	3,017
	West Sumatera	1,518
	Riau	1,120
	Riau Islands	75
	Jambi	1,234
	Bengkulu	982
	South Sumatera	1,845
	Bangka Belitung Islands	347
	Lampung	1,497
Java	Banten	623
	DKI Jakarta	118
	West Java	4,104
	Central Java	4,616
	DI Yogyakarta	518
	East Java	4,585
Bali	Bali	776
Nusa Tenggara	West Nusa Tenggara	1,301
	East Nusa Tenggara	2,128
Kalimantan	West Kalimantan	1,211
	Central Kalimantan	1,046
	South Kalimantan	1,324
	North Kalimantan	180
	East Kalimantan	1,028
Sulawesi	South Sulawesi	2,697
	West Sulawesi	436
	Central Sulawesi	1,220
	Southeast Sulawesi	1,064
	Gorontalo	472
	North Sulawesi	861
Maluku	North Maluku	550
	Maluku	618
Papua	West Papua	500
	Papua	793
Total		**47,267**

Source: Counseling Agency and Human Resources Development of Agriculture (BPPSDMP), Integrated database. http://db.bppsdmp.pertanian.go.id/# (accessed 14 October 2017).

10 – National Coordinating Agency for Extension Service (BAKORNASLUH)

The establishment of BAKORNASLUH is specified in Law No. 16/2006 and Presidential Regulation No. 154/2014. The agency is accountable to the President and is composed of several ministries including the Coordinating Ministry for Economic

Affairs, the Ministry of Agriculture, the Ministry of Maritime Affairs and Fisheries, and the Ministry of Environment and Forestry (CYBEXT). The agency is responsible for ensuring that coordinated, integrated, synchronised, and optimal extension work is being implemented nationally.

11 – Local government agricultural extension units

Local governments organise and manage extension workers employed under their administrations, while working together with various actors/agencies in the system, including the BPPSDMP, BALITBANGTAN, BBP2TP, universities, the private sector, farmers' cooperatives, and industry associations. The formats of institutional arrangements that manage and organise extension services and their workers at local levels do not seem to be consistent. According to Law No. 16/2006 on Agricultural, Fishery and Forestry Extension, reinforced by Presidential Regulation No. 154/2014, the following institutions have the responsibility to carry out various tasks pertaining to agricultural extension:

11a – Provincial coordinating agency for extension service (BAKORLUH), accountable to the President through the minister.

11b – Regency/municipal implementing agency for extension service (BAPELUH), accountable to the head of regency or mayor of a municipality.

11c – Office for sub-district agricultural extension (BP3K), accountable to the head of BAPELUH.

However, not all local governments have established the aforesaid agencies (11a, 11b, and 11c) after the enactment of the law. Some set up BAPELUH and BP3K, while others continue to organise their extension programmes by combining or attaching them to the local agricultural department, which is under the purview of the regency or municipal government. Table 2 shows national and regional agricultural extension division and training centres.

12 – Ministry of Research, Technology and Higher Education (RISTEKDIKTI)

RISTEKDIKTI is the leading government body responsible for conducting affairs in the realm of research, science, and technology; and is the result of a merger between the Ministry of Research and Technology and the Directorate General of Higher Education. The ministry coordinates universities and several non-ministerial government agencies including BATAN, BPTP, and LIPI (RISTEKDIKTI, 2017). It

also engages in a number of consortiums that involve the previously mentioned agencies as well as private companies

Table 2: National and Regional Agricultural Extension Division and Training Centres (number of departments/agency body)

No.	Technical Implementation Unit/Unit Pelaksana Teknis (UPT)	Number
1	National Agricultural Training Centre – providing training for civil servants and non-civil servants; (Balai Besar Pelatihan Pertanian (BBPP))	8
2	Agricultural Training Centre – providing training for non-civil servants; (Balai Pelatihan Pertanian (BPP))	2
3	Local Agricultural Education and Training Centre (Balai Diklat Pertanian Daerah (BDP))	8
4	Training Centre for Agriculture and Rural Subsistence (Pusat Pelatihan Pertanian dan Perdesaan Swadaya)	891
5	Coordinating Body for Agricultural Extension, Fishery and Forestry/ Provincial Agricultural Extension and Food Security Agency (Badan Koordinasi Penyuluh Pertanian, Perikanan dan Kehutanan/ Badan Penyuluhan dan Ketahanan Pangan dan Penyuluhan Pertanian Tingkat Provinsi)	34
6	Implementing Body for Agricultural Extension, Fishery and Forestry/ Regency Agricultural Extension and Food Security Implementing Body (Badan Pelaksana Penyuluhan Perrtanian, Perikanan, dan Kehutanan/Badan Ketahanan Pangan dan Pelaksana Penyuluhan)	413
7	Local Centre for Agricultural, Fishery and Forestry Extension (Balai Penyuluhan Pertanian, Perikanan dan Kehutanan)	5,232
	Total	**6,588**

Source: Counseling Agency and Human Resources Development of Agriculture (BPPSDMP), *Strategic Plan, 2015–2019*. Available at: http://sakip.pertanian.go.id/admin/file/Renstra%20BPPSDMP%202015%20-%202019%20Edisi%20Revisi.pdf (accessed 14 October 2017).

13 – National Nuclear Energy Agency of Indonesia (BATAN)

As Indonesia's nuclear energy agency, BATAN's work revolves around the use of nuclear technology in the field of R&D. This includes the use of nuclear technology in developing superior varieties of paddy, soybean, mung bean, sorghum, and tropical wheat (BATAN-a). The agency is under and accountable to the President, and receives direction from and is coordinated by RISTEKDIKTI (BATAN-b).

14 – Higher Education Institution, including universities conducting research and offering programmes and/or courses related to agricultural R&D

According to Kadir et al. (2003), about 20 universities offer programmes in agricultural R&D and related subjects. No mandatory format guides how universities, researchers/faculties, and students engage in technology transfer and knowledge dissemination. This means that various different programmes and mechanisms could be implemented. However, this may occur through at least two possible channels. One is a community engagement programme known as the student community service (KKN) established in the early 1970s (Hardjasoemantri, 2007). The programme requires students to perform community service hours (normally 3 months) during a semester break. Knowledge dissemination and transfer of information may often take place during KKN between beneficiaries of the programme (e.g. villagers, farmers), students, and their supervisors (usually a full-time lecturer and researcher).

The next possible channel is an independent body or institute tasked with research and community services, commonly known as LPPM. The LPPM of Bogor Institute of Agriculture (Institut Pertanian Bogor/IPB), for example, designs and directs its operations and programme activities towards ensuring that the results of its research are available to the public at large, as well as improving the university's research capacity and strengthening its innovative performance and presence on the global scene (LPPM IPB-a). This is done through several types of community service (LPPM IPB-b), where direct interaction between people in rural areas (such as farmers) and the university faculties and students, is facilitated.

15a – Ministry of Cooperatives and Small and Medium-sized Enterprises (KEMENKOP)

KEMENKOP's main responsibility is the provision of assistance to the President for policy formulation and coordination in the field of cooperatives and SMEs. Following decentralisation, subnational agencies such as the Local Government Cooperatives Agency (DINKOP, 15b) and the Village Unit Cooperatives (KUD, 15c) are no longer under the ministry's management, but might continue receiving
guidance, training, direction, and supervision, as implied in the ministry's official profile.

15b – Local Government Cooperatives Agency (DINKOP)

Local government cooperatives agencies (DINKOPs) are established by subnational governments at provincial and/or regency levels and are responsible for the tasks pertinent to cooperatives and SMEs. Their administrative and fiscal responsibilities are under the domain of the respective local governments' administration of either provinces or regencies.

15c – Farmers' Cooperatives, Village Unit Cooperative (KUD)

Cooperatives began to play a role in Indonesia's agriculture sector with the establishment of village business units at the height of the government self-sufficiency programme in the mid-1970s (Susilo, 2013). The unit was later renamed the Village Unit Cooperatives (KUD) to manage the farm credit scheme, distribution of agriculture input and incentives, farm commodities marketing, and other economic activities (Suradisastra, 2006).

According to the manual for forming an agricultural cooperative, extension workers and cooperative officers assigned by relevant local government agencies provide regular support for KUDs (BPPSDMP, 2012). Support for the operation and improvement of KUDs can also come from the Ministry of Cooperatives and Small and Medium Enterprises (KEMENKOP) through various financial aid schemes and programmes, as well as from relevant subnational agencies such as DINKOPs. Most of these schemes and programmes, however, involve loose coordination amongst multiple ministries, are ad hoc in nature, or are contingent on the overall objectives of the national and local authorities. Combined with some other factors, including a long history of top–down policy during Suharto's New Order era (1966–1998) and numerous policy changes following the 1998 reform (Suradisastra, 2006; Susilo, 2013), it is not uncommon to hear about the struggle of many KUDs to thrive and continue their activities (Handriansyah, 2015; Tadung, 2017).

Glancing through the number of active cooperatives (Table 3), it is tempting to conclude that they do not face many problems since they seem to be increasing in number over the years. However, Indonesia's vice president has voiced concern over 'a worrying economic phenomenon', as more than 30% of all cooperatives are no longer active (Sugarda, 2016). Many KUDs are reported to be struggling to keep afloat and have filed for bankruptcy (Antara, 2017; DetikNews, 2017; Nugroho, 2017). The problems facing KUDs stem from various internal and external factors. The internal

causes are rooted in the quality of human resources. They lead to an inability to run the institution (KUD) in an effective and profitable manner, and ineptitude in providing professional financial services as well as generating a concrete master plan for the development of the institution. The external factors come from inadequate infrastructure and regulatory supports, and the absence of trust in cooperatives' ability to improve people's welfare. This is largely due to a long history of corruption involving KUDs during Suharto's New Order era (Suradisastra, 2006; Sugarda, 2016).

16a – Private Agricultural Companies

Private companies generally take on the role of producer of private goods, providing products and services that vary depending on their specialisation. Hence, their activities revolve around the production and sale of inputs including seeds, chemicals, fertilisers, and machinery. Figure 1 only illustrates the role of private agricultural companies actively engaging farmers in their line of production, where knowledge is presumably being passed on through partnerships, trainings, and workshops.

Private extension activities are more straightforward and efficient than their counterparts in the public sector. Typically, two divisions or departments are involved in the transfer of technology and/or knowledge dissemination. One is the R&D department (16b) and the other is the marketing department (16c). The case study of DuPont is an example of the activities of private agricultural R&D companies in Indonesia (Appendix 7).

17 – Agricultural Industry Associations

An agricultural industry association is an organisation founded and funded by businesses that operate in a specific industry of the agricultural sector (seed production, plant protection industry, or agriculture and farming equipment). One example of such associations is CropLife, an organisation representing eight multinational companies conducting activities in agricultural R&D. Based in Belgium, it works to promote agricultural technologies such as pesticides and plant biotechnology across the globe. The association's office in Indonesia was opened in 2001 and it has since worked with various stakeholders from the Ministry of Agriculture, local government agricultural departments, extension workers, and farmers. CropLife asserts that its activities are independent from its funders' business interests, despite being founded and funded by private companies.

Table 3: Number of Active Cooperatives by Province

Province	2010	2011	2012	2013	2014	2015
Aceh	3,381	3,659	3,583	3,913	3,764	4,490
Sumatera Utara	6,222	6,391	6,395	6,678	6,708	6,285
Sumatera Barat	2,319	2,366	2,494	2,641	2,621	2,723
Riau	3,282	3,417	3,541	3,532	3,094	3,051
Jambi	2,346	2,357	2,435	2,272	2,291	2,263
Sumatera Selatan	3,160	3,461	4,609	4,227	4,336	4,450
Bengkulu	1,313	1,379	1,415	1,608	1,686	1,709
Lampung	1,996	2,249	2,249	2,875	3,041	2,760
Kepulauan Bangka Belitung	633	707	745	805	836	812
Kepulauan Riau	1,372	1,444	1,444	1,173	1,391	1,125
DKI Jakarta	4,790	5,021	5,177	5,579	5,645	6,016
Jawa Barat	14,771	14,856	15,051	15,130	15,633	16,855
Jawa Tengah	19,617	19,679	21,146	21,832	22,563	23,059
DI Yogyakata	1,926	1,926	2,061	2,172	2,269	2,369
Jawa Timur	19,437	25,052	25,154	25,552	27,140	27,472
Banten	4,083	4,298	4,298	4,578	3,895	4,168
Bali	3,632	3,766	3,970	4,202	4,401	4,327
Nusa Tenggara Barat	2,848	2,693	3,186	2,627	2,283	2,385
Nusa Tenggara Timur	1,487	1,800	2,122	2,408	2,818	3,394
Kalimantan Barat	2,302	2,363	2,529	2,697	2,871	2,944
Kalimantan Tengah	1,718	1,894	1,999	2,186	2,268	2,405
Kalimantan Selatan	1,493	1,578	1,616	1,633	1,669	1,769
Kalimantan Timur	3,458	3,458	3,458	3,950	3,524	3,501
Kalimantan Utara	n/a	n/a	n/a	n/a	426	512
Sulawesi Utara	3,185	2,970	3,359	3,396	3,426	2,927
Sulawesi Tengah	1,198	1,197	1,295	1,323	1,470	1,495
Sulawesi Selatan	5,105	5,523	5,442	5,051	5,318	5,404
Sulawesi Tenggara	2,323	2,510	2,510	2,443	2,616	2,697
Gorontalo	666	682	707	706	741	644
Sulawesi Barat	447	513	534	705	735	735
Maluku	1,870	1,912	2,090	2,160	2,370	2,418
Maluku Utara	778	848	820	777	831	1,711
Papua Barat	515	515	515	610	785	640
Papua	1,182	1,182	1,372	1,676	1,784	708
Total (Indonesia)	**124,855**	**133,666**	**139,321**	**143,117**	**147,249**	**150,223**

Source: Statistics Indonesia, Jumlah Koperasi Aktif Menurut Provinsi. Available at: https://www.bps.go.id/statictable/2014/01/15/1314/jumlah-koperasi-aktif-menurut-provinsi-2006-2016.html (accessed 14 November 2017).-

18 – Agricultural Extension Workers

The role of extension workers in the system is very important, if not paramount. They stand on the front line of technology transfer and knowledge dissemination, providing assistance and information needed by farmers. Traditionally, extension workers working in the public sphere teach farmers less specialised knowledge such as improved methods of farming and/or innovations in technology (Schwartz, 1994).

Meanwhile, the activities of the private sector, including its extension activities, are geared towards meeting business targets. Private extension workers generally focus on cash crops and/or the sale of inputs, and usually serve different capacities such as processor/exporter field staff providing production advice to out-growers and enforcing delivery of outputs, and input supply firm representatives combining education and marketing (Schwartz, 1994). This remains true today, as representatives of a multinational agricultural company operating in Indonesia provided similar explanations.

19 – Farmers

Many farmers in Indonesia, especially smallholder farmers, form a farmers' group (POKTAN). Several POKTANs can establish a federated farmers' group (GAPOKTAN). Traditionally, smallholder farmers sold their crops to intermediaries or brokers while having very little control, if any, over market prices. Taking collective action and forming a group allows farmers to address inefficiencies, coordination problems, and barriers to market access (Markelova et al., 2009), while providing them with opportunities to gain better and broader access to farm inputs as well as assistance provided by the government and the private sector (Organisation for Economic Co-operation and Development, 2012). Farmers can also join an agricultural cooperative, or establish one with other fellow farmers, to pool their resources and conduct formal economic activities (BPPSDMP, 2012). Table 4 shows the number of agricultural households by sub-sector while Table 5 summarises the key results.

Table 4: Number of Agricultural Households by Sub-Sector

Sub-Sector	2003	2013
Food crops	18,708,052	17,728,185
Horticulture	16,937,617	10,602,147
Plantation	14,128,539	12,770,090
Livestock	18,595,824	12,969,210
Forestry	6,827,937	6,782,885
Fishery	2,489,681	1,975,233
Agricultural services	1,846,140	1,075,935
Total	**79,533,790**	**63,903,685**

Source: Statistics Indonesia, *Sensus Pertanian 2013*, Available at: https://st2013.bps.go.id/dev2/index.php (accessed 14 October 2017).

Table 5: Functional Configurations of Actors in Indonesia's Agricultural Innovation System

Agricultural Innovation System Constituencies	Acronym	Ownership	Core Activities	Branches(No.)
1 Ministry of Agriculture	KEMENTAN	National	D	-
2 Indonesian Agency for Agricultural Research and Development	BALITBANGTAN	National	F	-
3 Centre for Agricultural Technology Assessment and Development	BBP2TP	National	A,B,C	-
4 Assessment Institute for Agricultural Technology	BPTP	Local	E,F	33
5 Counseling Agency and Human Resources Development of Agriculture	BPPSDMP	National	B,E	-
6a National research centres		National	F	11
6b Research institutes and stations		Local	F	18
7a National agricultural training centre/agriculture training centre	BBPP/BPP	National	E	8/2
7b Local agricultural education and training centre	BDP	Provincial	E	8
7b Training centre for agricultural and rural subsistence	P4S	Subdistrict	E	891
8a Higher level vocational academy	STPP	Local	E	6
8b Higher secondary school in agricultural development	SMK-PP	Local	E	3
10 National coordinating agency for extension service	BAKORNASLUH	National	A,B,D	-
11a Provincial coordinating agency for extension service	BAKORLUH	Provincial	A,B,D	n/a
11b Regency/Municipal implementing agency for extension service	BAPELUH	Regency/municipality	A,B,D	n/a
11c Office for sub-district agricultural extension	BP3K	Subdistrict	B	413
12 Ministry of Research, Technology and Higher Education	RISTEKDIKTI	National	D,F	-
13 National Nuclear Energy Agency	BATAN	National	D,F	-
14 Higher Education Institution (i.e. Bogor Institute of Agriculture)	IPB	National	A,B,D,E,F	-
15a Ministry of Cooperatives and Small and Medium-sized Enterprises	KEMENKOP	National	D	-
15b Local Government Cooperatives Agency	DINKOP	Provincial/regency/municipality	B, D, E	n/a
15c Farmers' cooperatives/Village Unit Cooperatives	KUD	Village	B	n/a
16a Private agricultural companies	-	Private	A,B,D,E,F	n/a
16b R&D department of private companies	-	Private	A,B,D	n/a
16c Marketing department of private companies	-	Private	A,B,E	n/a
17 Agricultural Industry Associations	-	Private	A,B,D,E	n/a*
18 Agricultural Extension Workers	-	National or subnational depending on the employment type	B,E	
19 Farmers, including Farmers' Groups	POKTAN, GAPOKTAN	Village	A,B	n/a

A = demand articulation, B = network brokerage, C = innovation process management, D = foresight, E = organisation educational activities, F = general knowledge producers, n/a = not applicable.

* = For public extension workers see Table.

Source: This classification was adopted from Klerkx and Leeuwis (2008), with some adjustments made to accommodate the context of this study.

5. Discussion and Conclusion

After careful deliberation over the AIS map (Figure 1) and the insights of previous empirical and theoretical studies, combined with the analysis of information obtained through interviews (Appendix 6), this study arrives at several key inferences to help elucidate the division of labour within the system. They are outlined as follows.

1. Knowledge transfer occurs through multiple channels across different administrative hierarchies and involves various actors, the majority of which are from the public sector.
2. The government continues to play a dominant role in the AIS, from policy design and knowledge creation to the provision of extension services.
3. Other actors, including those in the private sector, educational institutions, cooperatives, non-profit organisations, and extension services, also play an important role in evolving the system.
4. The changing governance system and the ensuing shift in political, administrative, and fiscal decision-making have introduced uncertainties to the arrangement and management of actors and resources in the system, which may take some time to resolve.

In total, 19 actors were identified during the study (September–November 2017). Each undertakes responsibilities that can be grouped into six categories represented by the letters A to F. These letters denote the actors' core activities. A represents demand articulation, B is network brokerage, C is innovation process management, D is foresight, E is organisation educational activities, and F is knowledge producer. This classification derived insights from a study by Klerkx and Leeuwis (2008), with a few adjustments to accommodate the context and focus of this study.

A, or demand articulation, refers to the process of understanding and clarifying both demand and supply. This involves the use of methods such as dialogues between producers and users of knowledge, as well as problem diagnosis and analysis.

B, or network brokerage, refers to the role that fills information gaps by initiating and maintaining networks or connections amongst various actors in the AIS, including organising a platform or meeting place for knowledge sharing, as well as helping smallholders to access the resources they need.

C, or innovation process management, refers to the role that carries out assessment processes for research outcomes to gauge the feasibility of scaling up, as well as the provision of intellectual protection service and/or commercialisation of innovation outcomes.

D, or foresight, refers to the process of forecasting and planning future needs.

E, or organisation educational activities, refers to the role that facilitates and manages knowledge transfer in both a formal curriculum-based setting (e.g. in schools, academies, and universities) as well as in an ad hoc or thematic-based setting (e.g. 1-day training, workshop, or field visit).

F, or knowledge producers, refers to the role that generates or produces knowledge, which is defined very broadly in this paper and hence includes all kinds of knowledge and technologies.

As shown in Table 5, the role of demand articulation (A) is assumed by several actors of the public and private sectors as well as educational institutions, and industry associations. This might indicate that the channels through which demands can be passed and articulated by users and suppliers of knowledge all the way to regulators and producers of knowledge already exist at almost all administrative hierarchies (village level to national level, and vice versa). Moreover, most actors undertaking the demand articulation role also assume the role of network brokerage (B) and, in the case of some actors, the role of foresight (D) and educational activities (E). There are at least two ways to look at this. Actors having to assume several important roles might reduce the line of bureaucracy that may exist between actors. On the other hand, as the classic theory of division of labour suggests, specialisation can lead to higher output. Hence, in the context of this study, concentrating on a few core activities might result in a more effective transfer of research or innovation outcomes. More evidence is required to firmly establish an argument, but this should suffice to provide an interesting basis for future research.

It is important to highlight that both Figure 1 and Table 5 portray the actual arrangement of division of labour amongst the identified actors in the AIS, which can be different from the formal designations of these actors. This brings the discussion back to the four key findings and the underpinning factors behind these four findings.

The answer lies partly in the historical transformation of the governance system, including that of the agricultural sector. The agricultural extension and innovation system in Indonesia has taken many shapes from the beginning of the post-independence era to the present day. Aiming to meet the basic need of the post-war population, Sukarno's Old Order (1945–1966) introduced several agricultural extensions and rural developments programmes that were unsuccessful and had to cease following the overthrow of the government. The successive administration, Suharto's New Order, placed a strong emphasis on agricultural intensification through the introduction of various 'modern' agricultural practices as well as encouraging the formation of farmers' groups, which became top–down and coercive over time (Lubis, 2012; Suradisastra, 2006). The fall of the Suharto's New Order in mid-1998 brought some fundamental changes, including the implementation of a decentralised governance system that transforms the way agricultural extension and innovation system is being carried out. The transformation process is ongoing and reflected through the intricacies of Indonesia's agricultural extension and innovation system.

The current decentralised governance system devolves political, administrative, and fiscal autonomies to provincial and district (municipal/regency) levels. Before this, subnational governments assumed the function of implementing agencies of national policies and programmes (Nasution, 2016). After decentralisation, both provincial and municipal/regency level governments were delegated the responsibility and authority to draft their regional planning, in which they can decide their region's development trajectories and priorities, including determining the size and structure of expenditure budgets–a function previously held by the central government (Nasution, 2016; Regulation of the Ministry of Home Affairs No. 54/2010). This can explain the difference in development plans between local governments, since the agricultural sector is not always a priority for regional budget allocation. Manufacturing and non-agricultural industries are often prioritised, as their contribution generally outweighs the agriculture sector, as in the case of one district where only 3% of the regional development budget is allocated to agricultural development although more than 30% of the district's population earns a living through agriculture (Lubis, 2012).

Decentralisation, particularly decentralised planning, has given rise to uncertainty in public extension. Even though local governments now manage extension activities, they may accord low priority to the agricultural sector, including the management of extension activities. This can be understood, as the diversity of natural resources creates different economic and development potential. However, districts with economic

potential in agriculture might pursue the development of other sectors producing higher value-added products, such as manufacturing. In addition, despite the national government's attempt to reinvigorate the agricultural sector by introducing several laws and regulations and establishing relevant agencies (see previous section, actors 10 and 11), not all subnational governments can follow through for various different reasons, including (i) decentralisation, combined with the differing capacities of government officials; and (ii) the intricate informal institutional arrangement, where personal and institutional interests are intertwined with the legacy of past institutional arrangements (Usui and Alisjahbana, 2003; Lubis, 2012).

Designing and implementing new allocation mechanisms is complex and rarely a smooth process, requiring strong local government leadership and a pool of administrative and technical skills (Rahman, 2003), which are not always readily available at local levels. This produces a disjointed innovation system where the link between public R&D and the transfer of its innovation, supposedly done through extension services, is very blurred. This increases the uncertainty of the incentive mechanism for public actors/agencies.

As depicted in Figure 1, more than half of the actors/agencies involved in the agriculture extension and innovation system are from the public sector. This by no means implies that the role of private actors is minuscule. Rather, it showcases that the agricultural sector in Indonesia remains a sensitive sector and that the transformation process is continuing, with the government taking centre stage. For decades, the role of government in agricultural extension and R&D has been central. Agencies such as BALITBANGTAN are tasked with designing and conducting different studies relating to various subjects in the agricultural sector. Other government agencies, including BATAN and LIPI, are also involved in the R&D activities and collaborate with BALITBANGTAN through different consortium and collaboration schemes–most of which appear to be carried out on an ad hoc and intermittent basis.

Incentives for individual researchers working at these agencies are provided through a promotion mechanism that allows researchers to apply for a distinct 'expertise' position through several assessment processes. Different individuals may go through a different set of assessments depending on factors such as the individual's current structural position in his/her department, educational background, experience, publications, and so forth (Ministerial Regulation No. 128/Permentan/OT.160/12/20013). Researchers may also file patent applications for their inventions to obtain financial incentives from patent licensing. However, there is

little clarity on the extent of such inventions being disseminated and transferred to farmers. According to BALITBANGTAN, it has invented and managed hundreds of agricultural innovative technologies (BALITBANGTAN-b). Yet, the information regarding the number of these innovations being disseminated and adopted by downstream users, including farmers, remains unclear.

Meanwhile, private R&D and extension is organised and managed in a more direct manner, involving fewer internal actors in a less bureaucratic environment. Profit generation is the main driver underpinning private actors' decision making, which is dynamic and pliable, as laid out by Schwartz (1994) when explaining the concept of private and public goods in the realm of agricultural extension. A clear-cut incentive mechanism enables private companies to further their innovation and extension activities. However, the private sector is in a rather vague position because of the government's unclear stance on the role of the private sector, including a vague regulatory environment and the prevailing narrative, which casts private companies, especially foreign ones, in a negative light. This is illustrated in the case study of DuPont Indonesia (Appendix 7).

Like the private sector, the activities of KUDs are mostly driven by opportunities to generate more profits. This is done by taking collective action and acting as a group to gain greater access to the market. During their heyday, from the 1980s to the 1990s, many KUDs thrived on the role of village-level economic agent, such as fertiliser distributor, which according to Suradisastra (2006) was made possible by various top–down policy supports and financial assistance. However, as mentioned in the previous section, many KUDs are teetering on the brink of bankruptcy and closing down. Like agricultural extension after decentralisation, where the institutional arrangement of extension deteriorated as many had been accustomed to centralised decision making, many KUDs are struggling to manage their organisations independently in key areas such as financial management, human resources development, board development plans, and long-range strategic plans, even though a few were able to make their way amid such uncertainty (Tempo, 2017).

The present study illustrated the whole picture of the AIS in Indonesia by identifying relevant innovation system constituencies and interactions amongst them, with a focus on innovation intermediaries. Future study should scrutinise knowledge creation and dissemination more closely by making clear the characteristics of research that public research institutes and universities conduct (e.g. new variety of plants, pest and disease control, and agricultural machineries) and technology transfer channels that

innovation intermediaries employ (e.g. seminars for education and training, technical consultation, establishing and diffusing standards, and patent licensing). Furthermore, future study should investigate to what extent public research institutes and universities are responsive to local research needs, and what type of feedback mechanisms exist between actors in the agricultural innovation system. Last, it should examine whether and how the way division of labour is organised varies across agricultural products (rice, cassava, sugar cane, etc.), reflecting the product-level variations in market size, appropriation conditions, and technological opportunities.

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Appendix 1: Summary of Literature Review

Author(s)	Region	Product	Key Performance Indicators	Determinants	Moderators
Chi and Yamada (2002)	Viet Nam		Adoption of new technologies by farmers	Technical training	Belief on ensure high yield of new technology The direction from agricultural extension
Al-Sharafat, Altarawneh, and Altahat (2012)	Jordan	Olive	Net profits Production	Establishment of field demonstration sites Training of extension workers	
Cole and Fernando (2012)	India	Cotton	Adoption of new and efficient technologies Degree of risk aversion	Use of a mobile-phone based agricultural consulting service by farmers	Farmers' education Alternative dissemination channels, such as radio, for the illiterate (Baig and Aldosari [2013])
Hellin (2012)	Mexico and Peru		Agricultural collectivization through extension	Kamayoq, in Peru, mediating local networks (Hellin and Dixon [2008]) as propellant Linear technology transfer approach, in Mexico, as deterrent	Local networks where heterogeneous value-chain actors create agricultural innovation systems
Adekunle (2013)	Nigeria		Access of rural female farmers to appropriate extension services	Demonstration materials and equipment, Training of field extension agents, good relationship between extension and research arms	
Issa and Issa (2013)	Nigeria		Users' perception of extension service quality	Number and quality of extension workers	

Author(s)	Region	Product	Key Performance Indicators	Determinants	Moderators
Kassem (2014)	Egypt	Poultry	Farmers' knowledge acquisition	Combination of different dissemination channels, such as lecture, demonstration, field exhibition, mass media, discussion, and conversation	
Agunga and Putra (2015)	Indonesia		Adoption of information and communication technology Collaboration with non-governmental organisations	Quality improvement in extension workers through training in communication for development	
Asif, Khan, Khan, and Zakria (2015)	Pakistan		Production	Bridging social capital like friends so that farmers would have personal acquaintance with extension workers	
Elias, Nohmi, Yasunobu, and Ishida (2015)	Ethiopia		Users' satisfaction with agricultural extension services	Frequent contact with extension workers	
Carmen and Bautista (2016)	Philippines	Perishable food	Efficiency of extension services	Establishing the district office engaged in research and extension Quality improvement in extension workers	
Debnath, Saravanan, and Datta (2016)	India		Access to credit Price determination Direct sales	Increase in extension workers Collaboration with non-governmental organisations and self-help groups (Ofuoku and Agbamu (2013) in Nigeria)	Quality improvement in leaders through regular training

Source: Authors' elaboration.

Appendix 2: Regional/Local Agencies Under the Purview of the Counseling Agency and Human Resources Development of Agriculture (BPPSDMP)

No.	Technical Implementation Unit/Unit Pelaksana Teknis (UPT)	Number
1	Sekolah Tinggi Penyuluh Pertanian (STPP) Higher level vocational school or agricultural extension academy	6
2	Sekolah Pertanian Pembangunan (SPP), both public and private Secondary level vocational school in agricultural development	81
3	Sekolah Menengah Kejuruan Pertanian Pembangunan (SMK-PP) Higher secondary vocational school in agricultural development	3
4	Balai Diklat Pertanian Daerah (BDP) Local agricultural education and training centre	8
5	Balai Besar Pelatihan Pertanian (BBPP) National agricultural training centre – providing training for civil servants and non-civil servants	8
6	Balai Pelatihan Pertanian (BPP) Agricultural training centre – providing training for non-civil servants	2
7	Pusat Pelatihan Pertanian dan Pedesaan Swadaya (P4S) Training centre for agriculture and rural subsistence	1,096
8	Badan Koordinasi Penyuluh Pertanian, Perikanan dan Kehutanan/ Badan Penyuluhan dan Ketahanan Pangan dan Penyuluhan Pertanian Dinas Pertanian Coordinating body for agricultural extension, fishery and forestry/ Agricultural extension and food security agency	34
9	Badan Pelaksana Penyuluhan Perrtanian, Perikanan dan Kehutanan/ Badan Ketahanan Pangan dan Pelaksana Penyuluhan, Dinas Lingkup Pertanian Tingkat Kabupaten/Kota Implementing body for agricultural extension, fishery and forestry/ Regency agricultural extension and food security implementing body	413
10	Balai Penyuluhan Pertanian di Tingkat Kecamatan Local centre for agricultural extension	5,430

Source: BPPSDMP or Counseling Agency and Human Resources Development of Agriculture (2016).

Appendix 3: List of National Research Centres Working under BALITBANG

No.	National Research Centre	Location
1	Indonesian Centre for Food Crops Research and Development (ICFORD) PUSLITBANG Tanaman Pangan (PUSLITBANGTAN)	Bogor, West Java
2	Indonesian Centre for Rice Research (ICRR) Balai Besar Penelitian Tanaman Padi (BB PADI)	Subang, West Java
3	Indonesian Centre for Horticulture Research and Development (ICHORD) PUSLITBANG Hortikultura (HORTI)	Jakarta
4	Indonesian Centre for Estate Crops Research and Development (ICECRD) PUSLITBANG Tanaman Perkebunan (BUN)	Bogor, West Java
5	Indonesian Centre for Animal Science Research and Development (ICARD) PUSLITBANG Peternakan (NAK)	Bogor, West Java
6	Indonesian Centre for Agricultural Land Resources Research and Development (ICALRRD) Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian (BBSDLP)	Bogor, West Java
7	Indonesian Centre for Agricultural Socio Economic and Policy Studies (ICASEP) Pusat Sosial Ekonomi dan Kebijakan Pertanian (PSEKP)	Bogor, West Java
8	Indonesian Centre for Agricultural Engineering Research and Development (ICAERD) Balai Besar Pengembangan Mekanisasi Pertanian (BB MEKTAN)	Serpong
9	Indonesian Centre for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRD) Balai Besar Penelitian Bioteknologi dan Sumberdaya Genetik Pertanian (BB BIOGEN)	Bogor, West Java
10	Indonesian Research Centre for Veterinary Sciences (IVETRI) Balai Besar Penelitian Veteriner (BB BALITVET)	Bogor, West Java
11	Indonesian Centre for Agricultural Post Harvest Research and Development (ICAPOSTRD) Balai Besar Penelitian dan Pengembangan Pasca Panen Pertanian (BB PASCAPANEN)	Bogor, West Java

Source: Authors' elaboration.

Appendix 4: List of Local Research Institutes and Local Research Stations

No.	Item	Location
	Research Institutes	
1	Indonesian Legumes and Tuber Crops Research Institute (ILETRI)	Malang, East Java
	Balai Penelitian Tanaman Kacang dan Umbi (BALITKABI)	
2	Indonesian Cereals Research Institute (ICERI)	Makassar, South Sulawesi
	Balai Penelitian Tanaman Serealia (BALIT SEREAL)	
3	Indonesian Medicinal and Aromatic Crops Research Institute (IMACRI)/	Bogor, West Java
	Indonesian Spice and Medicinal Crops Research Institute (ISMCRI)	
	Balai Penelitian Tanaman Rempah dan Obat (BALITTRO)	
4	Indonesian Tobacco and Fibre Crops Research Institute (ITFRI)/	Malang, East Java
	Indonesian Sweetener and Fibre Crops Research Institute (ISFRI)	
	Balai Penelitian Tanaman Pemanis dan Serat (BALITTAS)	
5	Indonesian Coconut and Palmae Research Institute (ICOPRI)	Manado, North Sulawesi
	Indonesian Palmae Research Institute (IPRI)	
	Balai Penelitian Tanaman Palma (BALIT PALMA)	
6	Indonesian Spices and Industrial Plants Research Institute/	Sukabumi, West Java
	Indonesian Industry and Freshner Crops Research Institute (IFCRI)	
	Balai Penelitian Tanaman Industri dan Penyegar (BALITTRI)	
7	Indonesian Ornamental Crops Research Institute (IOCRI)	Cianjur, West Java
	Balai Penelitian Tanaman Hias (BALITHI)	
8	Indonesian Tropical Fruits Research Institute (ITFRI)	Solok, West Sumatera
	Balai Penelitian Tanaman Buah Tropika (BALITBU)	
9	Indonesian Vegetables Research Institute (IVEGRI)	Bandung, West Java
	Balai Penelitian Tanaman Sayur (BALITSA)	
10	Indonesian Research Institute for Citrus and Subtropical Fruits (ICISFRI)	Batu/Malang, East Java
	Balai Penelitian Tanaman Jeruk dan Buah Subtropik (BALITJESTRO)	

No.	Item	Location
11	Indonesian Research Institute for Animal Production (IRIAP) Balai Penelitian Ternak (BALITNAK)	Bogor, West Java
12	Indonesian Agroclimate and Hydrology Research Institute (IAHRI) Balai Penelitian Agroklimat dan Hidrologi / BALITKLIMAT	Bogor, West Java
13	Indonesian Wetland Research Institute (IWETRI) Balai Penelitian Pertanian Lahan Rawa (BALITTRA)	Banjarbaru, South Kalimantan
14	Indonesian Soil Research Institute / ISRI Balai Penelitian Tanah (BALITTANAH)	Bogor, West Java
15	Indonesian Agricultural Environment Research Institute (IAERI) Balai Penelitian Lingkungan Pertanian (BALINGTAN)	Pati, Central Java
	Local Research Stations	
1	Tungro Diseases Research Station (TUNDRES) Loka Penelitian Penyakit Tungro (LOLIT TUNGRO)	Sidenreng Rappang, South Sulawesi
2	Beef Cattle Research Station (BCATRES) Loka Penelitian Sapi Potong (LOLITSAPI)	Pasuruan, East Java
3	Goats Research Station (GOATRES) Loka Penelitian Kambing Potong (LOLIT KAMBING)	Sei Putih, North Sumatera

Source: BALITBANGTAN, http://en.litbang.pertanian.go.id/about/ (accessed 10 September 2017).

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Appendix 5: Glossary

BAKORNASLUH	Badan Koordinasi Nasional Penyuluhan or National Coordinating Agency for Extension
BAKORLUH	Badan Koordinasi Penyuluhan or Coordinating Agency for Extension
BALITBANGTAN	Badan Penelitian dan Pengembangan Pertanian or Indonesian Agency for Agricultural Research and Development
BAPELUH	Badan Pelaksana Penyuluhan or Implementing Agency for Extension
BATAN	Tenaga Nuklir Nasional or National Nuclear Energy Agency of Indonesia
BBP2TP	Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian or Indonesian Centre for Agricultural Technology Assessment and Development
BBPP	Balai Besar Pelatihan Pertanian or National Agricultural Training Centre
BDP	Balai Diklat Pertanian or Local Agricultural Education and Training Centre
BP3K	Balai Penyuluhan Pertanian, Perikanan, dan Kehutanan or Office for Agricultural, Fishery and Forestry Extension
BPPSDMP	Badan Penyuluhan dan Pengembangan Sumber Daya Manusia Pertanian or Counseling Agency and Human Resources Development of Agriculture
BPP	Balai Pelatihan Pertanian or Agricultural Training Centre
BPTP	Balai Pengkajian Teknologi Pertanian or Assessment Institute for Agricultural Technology
DINKOP	Dinas Koperasi dan Usaha Mikro, Kecil, Menengah or Local Government Cooperatives Agency
GAPOKTAN	Gabungan Kelompok Tani or Federated Farmers' Group
KEMENKOP	Kementerian Koperasi dan Usaha Kecil Menengah Republik Indonesia or Ministry of Cooperatives and Small and Medium Enterprises of the Republic of Indonesia
KEMENTAN	Kementerian Pertanian Republik Indonesia or Ministry of Agriculture of the Republic of Indonesia
KKN	Kuliah Kerja Nyata or Student Community Services

KUD	Koperasi Unit Desa or Village Unit Cooperatives
LIPI	Lembaga Ilmu Pengetahuan Indonesia or Indonesian Institute of Sciences
LPPM	Lembaga Penelitian dan Pengabdian Masyarakat or Institute for Research and Community Service
POKTAN	Kelompok Tani or Farmers' Group
P4S	Pusat Pelatihan Pertanian dan Pedesaan Swadaya or Training Centre for Agricultural and Rural Subsistence
RISTEKDIKTI	Kementerian Riset Teknologi dan Pendidikan Tinggi Republik Indonesia or Ministry of Research, Technology and Higher Education of the Republic of Indonesia
SMK-PP	Sekolah Menengah Kejuruan-Pertanian Pembangunan or higher secondary level vocational school in agricultural development
STPP	Sekolah Tinggi Penyuluhan Pertanian or higher-level vocational school/agricultural extension academy

Appendix 6: List of Interviewees

Name of Institution/Organisation	Type of Institution/Organisation	Date of Interview	Location
PT. DuPont Agricultural Products Indonesia	Private	04 September 2017	Jakarta
BALITBANG	Public	14 September 2017	Jakarta
BBP2TP	Public	05 October 2017	Bogor
BPATP	Public	05 October 2017	Bogor
IPB	Public	06 October 2017	Bogor
Croplife	Non-profit organisation	24 November 2017	Jakarta

BPATP = Balai Pengelola Alih Teknologi or Institute for Agricultural Technology Transfer; IPB = Institute Pertanian Bogor or Bogor Institute of Agriculture.

Appendix 7: Case Record of Dupont Indonesia

DuPont Indonesia began operations in the early 1970s and was established as a subsidiary of DuPont USA. It has three legal entities, including PT DuPont Agricultural Products Indonesia (henceforth, DuPont or the company), whose business comprises two major activities–crop protection and seed production. To support these activities, the company operates three manufacturing sites in East Java. The Malang site focuses on the production of hybrid corn seed, while the Sidoarjo and Pasuruan sites produce protection chemicals.

The seed production line mainly focuses on the research and development (R&D) of two important commodities: rice and corn. Farmers, including smallholder farmers, are involved in seed production, especially the production of hybrid corn seed. The company's hybrid corn seed has been in Indonesia's market since 1986 and is a market leader. The characteristics of hybrid seed are such that the creation of incentives through repeat orders is possible. Developed by crossing two genetically unrelated inbred parents with dissimilar characteristics, hybrid seeds can generate high yields, increase value, and reduce production costs. However, these superior traits of interest are only reliable for one generation, requiring farmers to re-purchase new seeds for subsequent planting. From a business perspective, this allows private R&D companies like DuPont to produce and monetize hybrid seeds to meet farmers' needs in producing and maintaining high-quality and high-volume yields.

In conducting its R&D activities, DuPont employs two of its divisions: the marketing and R&D units. The field-marketing teams often discover or receive inputs from farmers regarding specific needs and/or problems arising in the field while undertaking product promotion. These inputs are passed onto regional teams, which decide the most appropriate solutions and allocate resources to meet farmers' needs or address the problems. This is known as a bottom–up process where solutions–mostly in the form of farm inputs–are provided to farmers as a response to problems and/or needs raised by farmers. In the reverse direction is a top–down process, primarily involving the company's field teams introducing new farm inputs deemed suitable for Indonesia agro-climatic conditions.

According to DuPont's representatives, Indonesia has seen a 40% increase in corn productivity since the mid-2000s. In contrast, other staple commodities such as rice and soybean demonstrate a modest increase of about 10%. The company considers the role of private companies in boosting national corn yields significant, as private companies produce most of the seed used by farmers. However, the policy approach on the position of private agricultural R&D remains obscure, especially regarding the three staples–rice, corn, and soybean. This has created uncertainty and confusion among actors in the private sector, disincentivising companies to conduct further R&D in the country.

One major source of concern expressed during the interview with the company's representatives is pertinent to the draft law on the plant cultivation system, which would override Law No. 12/1992. The concern is primarily directed toward the lack of a public hearing through which private sector representatives could follow the review of the draft law and ascertain how the draft law will impact foreign investors like DuPont. If preferences are given to national agricultural companies and the draft law is passed without a grandfather policy–a provision enabling old laws to continue to take effect while the new one applies only to future cases–private companies that established their presence in Indonesia before the enactment of the law will be affected and might consider divestment as an option.

Source: Authors' elaboration.

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