



Synergy of Innovation between Hybrid Corn Seed Production and Seed Companies: A Review

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ABSTRACT

The availability of seeds is one of the most essential aspects of agricultural development in developing countries and Indonesia is no exception. This requires adequate technological innovation and institutional support. This study aims to describe the synergy of innovation at the level of national companies that provide hybrid corn seeds to farmers. Three levels of company performance were compared namely well-established companies, middling, and less-developed companies. The results showed the performance of hybrid corn seed companies from 2019 to mid-2022 was mainly influenced by the degree of synergy between seed companies and their supporting institutions in implementing improvements in seed production technology. Established companies have better synergy with supporting institutions, hence, they can adequately apply seed production technology producing 4,900 tons of quality seeds, and distributing them to various regions specifically 12 provinces. Meanwhile, companies that have low synergies with their supporting institutions are very weak, producing seeds only in small quantities at 400 tons. This implies that technological innovations and institution synergy for hybrid corn seed production can be applied by national companies with adequate support from local institutions.

INTRODUCTION

The seed quality is the most important and primary factor that impacts the success of corn growth and it also influences the performance of other production parameters. Therefore, strategies to increase national corn production are majorly focused on expanding the use of hybrid corn seeds which is easier to implement and has a greater contribution to increasing production (Bonny, 2017; Fagi, 2017; Ganga, 2010). The production difference between farms using hybrid seeds and those using composites ranges from 1.0 to 3.0 t/ha. Meanwhile, the clearing of new land must address technical issues such as fertility and the threat of pests, as well as non-technical issues comprising the availability of production facilities, infrastructure, and guarantees for the existence of cultivators

(Luthfi & Shohibuddin, 2016; Ramadhani, Setiowati, & Luthfi, 2019; Sastrawan, Barcia, & Uker, 2019).

Given that the planted area of corn in 2021 has exceeded 4.15 million hectares, efforts to deliver hybrid corn seeds are considered extremely urgent. There is still a 32 percent potential to boost national corn output (Pasandaran, 2006), despite ongoing efforts to promote the usage of hybrid corn seeds, which have only reached 68%. The development of production technology has increased the opportunity to provide more hybrid corn seeds and encouraged farmers to become growers of high-quality seeds. Farmers groups supported by the seed independent village area program were able to produce quality seeds, but the production activities did not continue due to a lack of marketing support. Meanwhile, based on farming

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analysis, hybrid corn seed production operations are extremely profitable (Bahtiar, Zanuiddin, & Azrai, 2020; Tahir, Tanveer, Ali, Abbas, & Wasaya, 2008). In response to this problem, an activity was carried out in 2019 tagged “Pilot Project for Farmer Corporation-Based Seed Production”. It was carried out in the Province of East Java by an integrated team, comprising the government, the private sector, and farmer groups (Bantolo, September 2019). The government provides production facilities based on recommendations from the Research Institute in the form of Standard Operating Procedures (SOP) for hybrid corn seed production. It also provides its market in the form of Direct Assistance for Superior Seeds (DASS). Meanwhile, the Private sector or National Seed Producer functions as a bridge by working with farmer groups to produce seeds. Research institutions conduct SOP training and also provide technical assistance in the field, while the private sector absorbs prospective seeds produced by farmer groups to be processed into seeds and then distributed to the market to meet DASS needs.

The provinces of Lampung, South Kalimantan, North Sulawesi, and South Sulawesi have been able to replicate this achievement. The development of each province ranges from developing to undeveloped. One of the reasons is the institutional support that allows the implementation of production activities in the field and the marketing of seeds to target areas. A more advanced hybrid corn seed production system has proven to be supported by better institutional innovation. Furthermore, the communication network between seed producers and the government has been built thereby making it easy to synchronize the activities of providing seeds for farmers. Cohesiveness with breeder farmer groups is continually strengthened to improve the quality of seed production. This effort has gradually increased the production volume and expanded the marketing area.

The condition of the hybrid corn seed production system in moderate areas has seemingly followed the footsteps and stages of development. Infrastructure, especially in processing warehouses and equipment has continued to develop as well as cooperation with farmer groups. However, communication with the central government is still lacking whereby making it more difficult to reach a wider market. For underdeveloped areas, the problem is more about cooperation with grower seed

which is still weak, and the processing infrastructure is inadequate, culminating in low-quality seed production and negative impacts on the expansion of the marketing area.

These three facts show the importance of institutional functions in encouraging the sustainability of development activities, including the use of a hybrid corn seed supply system for farmers (Subekti, Sudarko, & Sofia, 2015). According to previous research, institutions can streamline the implementation of group activities, increase team cohesiveness in a program to achieve common goals, facilitate the dissemination of information to resolve problems more quickly, strengthen marketing networks through various forms of communication, and accelerate understanding of critical issues related to program objectives (Arsyad et al., 2021). There is a need for synergizing in the application of corn seed production technology innovations at the seed producer level, with institutional innovations played by relevant agencies in order to encourage the growth of quality corn seed. In other words, institutions need to be strengthened for the production of quality seeds, in sufficient quantities and in accordance with the preferences of farmers in various remote rural areas. This synergy is the main topic in the discussion of this paper. Therefore, this research aims to describe the synergy of innovation at the level of national companies that provide hybrid corn seeds to farmers.

MATERIALS AND METHODS

The review covered scientific articles (Siddiqui et al., 2022) on corn seed production or perspectives toward institution innovation, especially corn seed production. We applied the criterion in selecting articles as follows: (1) articles have been peer-reviewed by the journal and conference series; (2) articles dominantly reporting on corn seed production and institutions; (3) books and scientific reports which are strongly related to corn seed production and institution innovation, (4) only articles published dominantly in the last ten years (2014 to 2022) were included and focusing on national corn seed production. Three government programs are continuously being developed, namely: the program for the establishment of 10,000 seed-independent villages, the program for providing DASS, and the pilot project for the national hybrid corn seed production based on farmer corporations. All of

them are intended to support the development of corn commodity areas that have been determined by the government.

It is important to note that, to achieve the target of 10,000 independent villages for rice, corn, and soybean seeds, the Agency for Agricultural Research and Development (AARD) was assigned to create a model. Specifically, this was carried out in 5 provinces, namely: Nanggroe Aceh Darussalam, Central Sulawesi, Southeast Sulawesi, and South Sulawesi, as well as West Nusa Tenggara. In 2015 each region carried out production of 1 ha through the farmer groups and accompanied by researchers from the Assessment for Agricultural Technology (AIAT) and Agricultural Extension Workers. All the locations are capable of producing quality national hybrid corn seeds with a productivity level of 1.0 to 2.5 t/ha of quality seeds. The products are marketed through the free market and disseminated to members of the assisted farmer groups concerned. This experience motivated the group to expand its production area in 2016, but the products are difficult to market, because group members were also registered as prospective location farmers recipients of DASS. In 2017 marketing was linked to seed companies PT. Sang Hyang Seri and PT. Pertani. Consequently, some areas were able to distribute their seeds, while others did not meet the requirements for DASS. This experience has made farmer groups lose interest in producing national hybrid corn seeds.

To overcome the problem, this research was conducted to examine hybrid corn seed production based on farmer corporations organized by the Directorate of Seeds, in collaboration with the AARD and National Seed Producers foster farmer groups to produce national hybrid corn seeds. Initially, the activity was carried out in Tuban district, East Java province in 2019, involving 10 farmer groups to cultivate 60 ha of land from the target of 100 ha. The results were satisfactory and all of them can be distributed to meet the needs of the DASS program, and the free market. This success was replicated at other maize production centers outside Java, namely: East Lampung district, Lampung Province; Bone Regency, South Sulawesi Province; Minahasa Regency, North Sulawesi Province; and Tanah Laut Regency, South Kalimantan Province.

The success of each region in producing corn seeds varies greatly, ranging from advanced

and developing to underdeveloped. The only advanced area is East Java, the moderate areas are North Sulawesi and South Kalimantan, while the undeveloped areas are South Sulawesi and Lampung. Consequently, the guideline was used in determining the sample of seed companies to describe the synergy between the parties involved in the process of providing hybrid corn seeds for farmers. To complete the review, we also study the model of corn seed production in the three different regions above and simultaneously discussed.

DISCUSSION

This review covered some important findings. First, we explained the National Corn Seed Production Profile to show the production system. Second, the review explored the development of National Hybrid Corn Seed Production Technology. The next important explanation (third) is the dissemination of Hybrid Corn Production Technology. Another crucial issue (fourth) is the institutional innovation of the National Hybrid Corn Seed System. It covers how the Institutional structure and actors were discussed, and how the norms and rules in Hybrid Corn Seed Production System were running. Finally (fifth), we persuasively depicted the institutional innovation contribution of the Hybrid Corn Seed System in the country and its implication.

Development of National Hybrid Corn Seed Production Technology

The development of hybrid corn seeds in Indonesia can be separated into three distinct periods namely: 1981 to 1985, 1986 to 2013, and 2014 to the present. The first period started by building partnerships with the company PT. Cargil in 1983 culminated in the production of the C1 variety with an average yield of 5.8 t/ha. During the same time frame, the Bogor Agricultural University also released the IPB-4 variety with an average yield of 5.4 t/ha. The hybrid corn seeds provided to farmers during this time period were 100% multinational, especially C1 and P1 varieties, while the IPB-4 variety did not develop due to the absence of multiplying corporations. In the second period, global companies such as PT. Syngenta, PT. Bayer/BASF, and PT. DuPont, Monsanto were developed (Safitri, Riana, & Widyawati, 2021). These multinationals hold 60% of the global market share. Indonesia seized this opportunity by creating cooperation,

allowing it to release 32 varieties, including 12 types of Cross Three Lines and 20 varieties of Single Cross (Saleh et al., 2018; Syaharuddin, Azrai, Nur, Abid, & Wu, 2020). During this time frame, foreign corporations continued to dominate the domestic hybrid corn seed industry. National enterprises were operating autonomously without substantial government backing. Therefore, they were unable to compete with multinational corporations and can only contribute less than 10%.

In the third period, the Agricultural Research and Development Agency assembled hybrid corn varieties with more specific characteristics using the Multiparent advanced generation intercross population method based on molecular general technology, double haploid, and technology 4.0 and produced 7 varieties (Aqil et al., 2021). Additionally, varieties with water-resistant characters and potential yields of more than 13 t/ha were released (Muliadi, Effendi, & Azrai, 2021). Other varieties with drought-resistant characters and potential yields of 12.51 t/ha and 7.22 t/ha under normal or stressed conditions were also developed (Efendi, Takdir, & Azrai, 2017). To widely introduce the potential of these varieties, dissemination was carried out in production centers in collaboration with national companies. This attracted a good response from the Regional Government, the National Seed Company, and the IHR.

Dissemination of Hybrid Corn Production Technology

An East Java pilot project, titled "Development of hybrid corn seeds based on farmer corporations", was implemented in 2019 to address the issue of seed marketing. This success was replicated in Central Java, Lampung, South Kalimantan, and North Sulawesi to fulfill the needs of the DASS program (Bantolo, Agustus 2019). The program's performance in each province varied from slow, to moderate, and fast. In East Java, the development was more advanced due to the support from the government policy, farmers group, and high skill of company staff, culminating in the production of 4,900 tons of seeds distributed to 12 provinces in Indonesia, namely: East Java, Central Java, West Java, Yogyakarta, Banten, South Kalimantan, Central Kalimantan, North Sumatra, Lampung, West Nusa Tenggara, South Sulawesi, and Gorontalo. The moderate seed companies still have simple processing plants, but received strong

support from the government and farmer groups. They produce 1,247 tons of seeds, which are distributed to Gorontalo, North, Central, and West Sulawesi, as well as Maluku. However, slow-moving seed companies do not receive any help from farmer groups, and their workers are less effective because they only have a simple plant to process their products. This company can only make 400 tons of seeds, which are sent to South Sulawesi and West Nusa Tenggara.

Institutional Innovation of the National Hybrid Corn Seed System

Hybrid corn seed production activities in designated centers are considered very appropriate to realize seed independence. According to previous research bringing products closer to consumers is a powerful strategy for strengthening the thrust and attractiveness of products (Fatikhillah, Susilo, & Yulianingsih, 2015; Roidah, 2013). Farmers will obtain several benefits when the seed self-reliance program is realized, this includes: (1) seeds are produced in accordance with the demand (Mkhari, Matlebjane, Dlomu, Mudau, & Mashingaidze, 2006); (2) adaptability is more guaranteed because the seeds are produced in relatively the same environment (Hampton, Conner, Boelt, Chastain, & Rolston, 2016; Setimela, Monyo, & Bänziger, 2004); (3) the quality is more guaranteed, especially the growth power (Saenong, Azrai, Arief, & Rahmawati, 2016), (4) more affordable prices due to reduced transportation costs, and (5) easily accessible to farmers (Haque, Moniruzzaman, Rahman, & Alam, 2012; McGuire & Sperling, 2016). Although, these benefits are expected to have a significant impact on increasing the productivity of corn farming.

Despite these advantages, there are also a few obstacles, particularly in how to connect interdependent institutions. Therefore, intensive coordination and communication are needed from all participants in preparing work programs that provide benefits for each of the institutions involved. Good coordination and communication can solve problems quickly and positively influence customer trust. The production process must maintain quality, quantity and continuity, affordable prices, easy-to-reach locations, attractive packaging, and fast service to possible problems, all of which require coordination and communication skills (Christine & Budiawan, 2017; Scott & Sesmero, 2022).

Institutions are complexes of norms and behaviors that persist over time by serving the purpose of collective values (Uphoff, 1984). Based on this understanding, the institutional function in the hybrid corn seed system can be in the form of organizations that have structures and norms to pursue common interests. The integration of the government and the private sector is very important in developing hybrid corn seed agribusiness (Rahayu, Irmadamayanti, Febrianti, Syafruddin, & Ishak, 2020). The government functions as a policymaker compile work programs, and sets targets, while the private sector acts by building cooperation with the community to participate in achieving government programs.

Furthermore, institutions can also focus on the aspects of managing shared resources including the relationship between the rules for use, actors' management, and the specific resource potential that needs to be maintained. The dynamics of these three elements are regulated in an arena of action situations to produce patterns of interaction and obtain results (Mansuri & Rao, 2012) which encompasses coordination and cooperation, culture, inequality and elite domination, and group heterogeneity. A vibrant civil society can help mitigate market and government failures, and at the same time the interaction of markets, government, and civil society failures affects local development. Despite the recent upsurge in interest, participatory development policy is beset with a lack of conceptual clarity, with such interventions seen as a response to a development failure, much as other development interventions are viewed as responses to market or government failures. Decisions about whether, when, and how to promote local participation need to be made with an understanding of (1. In relation to the hybrid corn seed production system, it is necessary to regulate land, as well as facilities and infrastructure that will be used based on SOPs to produce quality and sustainable seeds (Oelviani, Praptana, & Jauhari, 2020; Oelviani, Sahara, & Praptana, 2021).

Moreover, institutions have sub-elements that always interact with each other, either directly or indirectly, sometimes as a driving *force* in one development program or program as an element driven by *dependence* (Saxena, Sushil, & Vrat, 1992). In the hybrid corn seed system, there are many institutions and related sub-elements from

the center to the regions and farmer groups, but not all fulfill their main functions (Syahyuti, 2003). The actors who play a role at every level have a high commitment to the rules and norms in managing resources to produce quality hybrid corn seeds in a sustainable manner. This model is in line with the idea that a good institution can manage resources efficiently and effectively to produce products or services that are beneficial to all supporting parties (Pokhrel, Dhakal, & Pandey, 2018; Pook, Chong, & Yuen, 2017), including corn seed development systems.

To realize good Standard Operating Procedure (SOP) implementation, institutional innovation support is needed and the contributions of these institutions encourage seed companies to produce and distribute hybrid corn seeds to farmers. This must also be supported by strengthening the network of cooperation between technology sources and seed producers to produce quality seeds. Additionally, cooperation between seed producers and policymakers needs to be strengthened to meet the needs of farmers.

Institutional Innovation Contribution of Hybrid Corn Seed System

The three dimensions of agricultural development are related to each other, namely: the physical-technical, economic-financial, and institutional. In the implementation of the hybrid corn seed production system, the physical-technical dimension discusses the application of production technology based on SOPs, the economic dimension associated with the provision of inputs to produce output, while the institutional dimension discusses the behavior of actors in various activities, such as seed production and marketing. This form of support is very important in improving organizational management, strengthening social relations, as well as increasing the participation of actors, including the government, private, and community. The activities of related agencies will create a communication model that accelerates the dissemination of information to all members (Salman, Kasim, Ahmad, & Sirimorok, 2021). Based on several institutional functions, two elements in an institution that can describe its contribution are institutional structures and norms or rules enforced in institutions.

Hybrid Corn Seed Institutional Structure and Actors

The institutional structure in the hybrid maize seed system is identified at three levels, namely: national, regional, and local. At the national level, there are two major institutions, namely Commission IV of the Indonesian House of Representatives (IHR) and the ranks of the Ministry of Agriculture. The Commission IV of IHR in charge of agriculture, since 2017 has expressed hope that 40% of the seeds assembled by the Ministry of Agriculture will be used in government programs. This policy forms a very strong basis to strengthen program integration within its agencies. Consequently, all agencies need to unite in supporting the provision of corn seeds in accordance with their main duties and functions. This integration is used as a guideline in building a communication network with national seed entrepreneurs, and this is very important to connect the interests of relevant agencies in a business process (Franco & Haase, 2021a qualitative research approach was adopted, specifically the case study method. The context of analysis studied here was formed of five SMEs (cases; Lui, Ngo, & Hon, 2006; Mohamed, Abdullah, Othman, & Uli, 2009; Wong, Tjosvold, & Zhang, 2005a qualitative research approach was adopted, specifically the case study method. The context of analysis studied here was formed of five SMEs (cases).

Building communication with all relevant parties, especially from networks to legislators and policymakers is usually not easy as it requires dialogical skills, courage, and significant transaction costs (Pralhad & Hamel, 1999). According to previous reports, the condition of interest interdependence in a working system based on economic principles, anticipatory planning, and following the direction of political will is an inseparable series (Karim, Moniruzzaman, & Alam, 2010; Pesämaa, Pieper, da Silva, Black, & Hair Jr, 2013; Poradova, 2020; Sinaini & Iwe, 2020).

At the regional level, the institutional structure identifies five institutions, namely: the Governor, the Department of Agriculture, Research Institutes, Universities, and Seed Companies. The governor's political desire to realize seed independence has become a guideline for the Department of Agriculture in forming a Working Team to provide seeds for farmers. The main tasks of each member of the work team are the Provincial Agriculture

Office, synchronizing the central program with regional programs, and planning the distribution of results. Meanwhile, Research Institutes and Universities prepare technology recommendations, while the Seed Company plans and implements seed production in collaboration with farmers (Aidoo & Freeman, 2016), in order to get more efficient of corn seed systems.

In established areas, the Governor's suggestions and hopes have long been conveyed to the staff, hence, East Java was selected as the center of seed production in Indonesia. In areas with medium seedlings, the role of the Governor is also reflected in the form of encouragement as well as motivation to staff and the community. The Provincial Agriculture Office follow-up by developing a corn seed system in the area, encouraging local companies to establish processing industries. Furthermore, the role of the Governor in undeveloped regions is to build a processing industry and test production technology. These efforts are not well established with seed companies, there are even concerns that the local government will take over the production business, hence, the companies are not aggressively developing their processing industry.

The research institutions play three roles as technology providers namely providing seed source and technology components, training implementers, and monitoring. Despite the role played by universities in the development of information technology, there is still a lack of communication in the aspect of discussing involvement in field activities. This suggests that the success of seed production systems will be determined by interactions between related institutions, including universities (Brekalo & Albers, 2016; Hilman & Mohamed, 2011; Jaffee & Srivastava, 1994; Ramirez, 2013). This implies that interconnectivity among stakeholders of corn seed production is really necessary.

For seed companies, the government's seed procurement program is a highly anticipated opportunity. The company responds accordingly, communicates and conveys its capabilities, and competes by demonstrating financial capabilities, human resource expertise and availability of facilities, as well as its performance in providing seeds. This clear integration and division of tasks are expected as an indicator of success to realize institutional connectivity from the national, regional to

regional levels in supporting business sustainability (Lechner & Dowling, 2003; Sambasivan, Siew-Phaik, Mohamed, & Leong, 2013).

At the local level, several institutions related to the provision of seeds were identified, namely: the Department of Agriculture, the Seed Company, the Center for Seed Supervision and Certification (SSC), the Center for Food Crops and Horticulture Protection (FCHP), Agricultural Extension Center (AEC), and farmer groups. The Regent's political desire to show individual performance is exhibited by providing support to all the staff in performing their duties properly, including the provision of seeds for farmers by the Department of Agriculture. An indicator of success at the regional level is that grower farmers can produce seeds correctly; and on time to benefit all related parties (Arief, Koes, & Komalasari, 2020; Rahmawati, Suwanti, & Aqil, 2019).

Well-established companies continue to improve their communication network with supporting institutions to synergize their seed production plans with market needs. Furthermore, companies that are classified as moderate are focused on increasing factory capacity, while underdeveloped companies need to strengthen cooperation with farmer groups (Gunter, Moore, Eubank, & Tino, 2017). The difference in emphasis illustrates the importance of institutional reform (Chen & Chang, 2016; Išoraitė, 2009; López-Duarte, González-Loureiro, Vidal-Suárez, & González-Díaz, 2016; Shanmugam & Nair, 2004). The higher the level of seed companies, the more they are required to develop and intensify the ability to coordinate as well as communicate, both internally and externally (Gümüs & Apak, 2011; Ömür, Tunç, & Düren, 2012; Raikwar, 2020; Rexhepi, Ramadani, Rahdari, & Anggadwita, 2017). This conveys an important message that communication networks, synergy and market are crucial components in improving corn seed systems.

Norms and Rules in Hybrid Corn Seed Production System

The role of norms or rules, both written and unwritten, is to maintain togetherness and cohesiveness in achieving common goals (Yao, Shanoyan, Peterson, Boyer, & Baker, 2019). This is often overlooked in the implementation of development programs. The hybrid corn seed production system has strict rules set out in SOPs,

which are very necessary to maintain production quality, as one of the factors that must be met in developing marketing (Kartawinata & Wardhana, 2015). The higher the adherence to these rules, the greater the possibility to get maximum results (MacRobert, Setimela, Gethi, & Regasa, 2014; Sugiman, Abidin, & Asaad, 2020). The rules and norms in the hybrid corn seed production system are attached to all the actors involved, from the central to the regional level. At the central level, it is written in a Technical Guide that lists the number and types of seeds to be produced, the requirements for partners, and the requirements of the farmer groups. However, these detailed regulations often make it difficult for actors at the regional level leading to delays in the implementation of production (Kunwar & Shrestha, 2014).

From the technical aspect, previous research has recommended very strict SOPs for seed production. These SOP recommendations have not been fully implemented by seed producers due to difficulties in obtaining fertile soil and available water sources for irrigation, isolation from maize cultivation, scarcity of fertilizers, as well as conducting roguing and detachment which affect the quality and quantity of results (Ali, Kuswanto, & Kustanto, 2019). Furthermore, rules in terms of harvesting, processing, and marketing are not strictly followed according to the agreement because there are no risks or fines for violators. This shows that the enforcement of the rules and norms of the agreement is still weak (Nuryanti & Swastika, 2011) especially in terms of collective purchasing of farm inputs and selling their agricultural products efficiently. Indonesia has a long experience in formation of farmers' groups since Mass Intensification (BIMAS. These challenges can be overcome with a social approach (Baker, Boyer, Peterson, & King, 2018). Therefore, the rules and norms of the hybrid corn seed production system should be made as simple and flexible as possible to ease the adaptation of actors at the central and regional levels to environmental conditions (Shi, Chavas, & Stiegert, 2010). This is reasonable to say that, without the enforcement of rules and norms, the results will not satisfy all parties.

CONCLUSION AND SUGGESTION

The system for providing hybrid corn seeds that can meet the needs of farmers is largely determined by the synergy between government

policies, and the role of private sector in implementing technological innovations. This synergy is in the form of innovation from agricultural institutions that need to be developed in various national corn production centers. It is expected to sustain hybrid corn seed production systems by strengthening communication networks, market, enforcement of rules and norms to support national output.

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