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Please cite this publication as follows:

Etriya, E., Scholten, V.E., Wubben, E.F.M., and Omta, S.W.F. 2019. The impact of networks on the innovative and financial performance of more entrepreneurial versus less entrepreneurial farmers in West Java, Indonesia. *NJAS–Wageningen Journal of Life Sciences* 89. https://doi.org/10.1016/j.njas.2019.100308

You can download the published version at:

https://doi.org/10.1016/j.njas.2019.100308

The impact of networks on the innovative and financial performance of more entrepreneurial versus less entrepreneurial farmers in West Java, Indonesia

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Abstract

Farmers may vary in their response to or anticipation of agrifood market changes, which probably depends on their entrepreneurial degree and networks. This paper aims to investigate the effects of farmers' entrepreneurial degree and network content (i.e., business ties, technology ties, and network heterogeneity) on farm performance (i.e., innovative performance and financial performance). The data set was gathered through a survey of 262 vegetable farmers in West Java, Indonesia. Our findings reveal that more entrepreneurial farmers (106) have more business ties, technology ties, and heterogeneous networks compared to less entrepreneurial farmers (156). Further analyses using OLS regression confirm that farmers who are more entrepreneurial and have more business ties obtain both enhanced innovative and financial performance, while farmers who link to heterogeneous networks obtain only enhanced innovative performance. Overall, the findings of this study demonstrate that more entrepreneurial farmers with networks that are rich in business ties and diverse contacts have better farm performance.

Keywords: business ties, entrepreneurship, financial performance, network heterogeneity, innovative performance, technology ties.

1. Introduction

Farmers play an important role in sustaining economic development in rural areas (Carter and Rosa, 1998; Grande et al., 2011). Over two-thirds of rural people in developing countries are smallholder farmers who have or operate farms less than two-hectares in size (IFPRI, 2005). Despite this small size, together, they produce 80 percent of the food supply in these countries (FAO, 2017). Many smallholder farmers recognize the emergence of food supply chains for domestic or international markets that offer good prices, but require products of high quality in sufficient quantity, and delivered in a timely manner (FAO, 2017). For instance, Indonesian farmers are facing a rising demand for vegetables from modern food retail/supermarkets, food processors, and food exporters (Natawidjaja et al., 2007; Sahara et al., 2015; Sunanto, 2013). To survive and stay competitive, farmers are expected to be adaptive to changes and have entrepreneurial and innovative capabilities (McElwee and Bosworth, 2010). More entrepreneurial farmers may perceive these market changes as opportunities, while other farmers may perceive them as threats.

Farm entrepreneurship of smallholder farmers in the developing world has received little attention in the entrepreneurship literature and in rural studies. Previous studies on the entrepreneurial strategies of farmers primarily focused on the context of developed countries (Dias et al., 2019; Fitz-Koch et al., 2017), where farmers are generally operating large farms, have good access to resources, and are able to link to wider networks compared to smallholder farmers in developing countries.

The need for entrepreneurship and to identify opportunities in changing environments is recognized by conventional farmers (Salamon, 1992) and smallholder farmers (Yessoufou et al., 2018). While some farmers failed to adapt to market changes (Carletto et al., 2010), others were able to adapt by adopting or generating innovations (Gellynck et al., 2015; Leitgeb et al., 2011). However, the literature offers few conceptual models to explain the difference. In this paper, we expect that the ability to adapt to market changes or even create new markets may depend on the entrepreneurship degree of farmers and their access to networks.

More entrepreneurial farmers are more alert to opportunities and have a better understanding of the market (Grande et al., 2011; Verhees et al., 2012). More entrepreneurial farmers are expected to be able and willing to take risks and are more proactive (De Lauwere, 2005). Therefore, entrepreneurship provides farmers a basis to adapt to or anticipate market changes by seizing opportunities and satisfying new market demands (Grande et al., 2011; Vik and McElwee, 2011). As a result, more entrepreneurial farmers can create more added value (Grande et al., 2011) and sustain enhanced performance (Vik and McElwee, 2011).

Linking to the appropriate networks is suggested to be an important skill that helps farmers to identify and pursue opportunities (DeRosa et al., 2019; McElwee and Bosworth, 2010). Networks may provide farmers with relevant information about market needs, and then help farmers transform information into new or improved products to satisfy market demands (Phillipson et al., 2004). In the situation when information is widely available, farmers can rely on networks close to the farm, e.g., with other farmers, relatives, or neighbors (Darr and Pretzsch, 2008). However, to adapt to market changes, such networks may not be enough. A farmer with a heterogeneous network has contacts with more diverse types of information and knowledge sources (Renzulli et al., 2000). Therefore, linking to more heterogeneous networks could potentially provide the farmer with more diverse information about emerging opportunities (Darr and Pretzsch, 2008).

Prior studies have shown how farmers benefit from networks to acquire information (Isaac, 2012) and how networks positively influence learning (Darr and Pretzsch, 2008; Pratiwi and Suzuki, 2017), innovation (Spielman et al., 2011), and farm performance (Thuo et al., 2013). These studies, however, largely focus on the network structure and relations without incorporating the content of the information shared in the networks. We focus on network content as information and the knowledge obtained and exchanged between actors (i.e., farmers) and their contacts (Hoang and Antoncic, 2003). We study networks in terms of business ties, technology ties, and network heterogeneity. Business ties refer to the relationships between actors in the networks that share information about markets and business opportunities (Lechner et al., 2006), while technology ties refer to ties that share information related to new technologies, such as problem solving and potential new technologies/products (Ahuja, 2000a). Farmers who are more entrepreneurial, engage in technology and business ties, and link to heterogeneous networks are potentially more innovative and could have higher financial farm performance. Taking the concept of entrepreneurial orientation and network content, we aim to (1) identify the entrepreneurial degree of farmers, (2) compare the network content (i.e., business ties, technology ties, and network heterogeneity) of farmers, and (3) examine the impact of the entrepreneurial degree and network content on farm performance in West Java, Indonesia. We address the following research questions: what types of network content are linked to more entrepreneurial farmers and what types of network content improve farm performance?

This paper is organized as follows. The next section presents the theoretical framework elaborating on the farmers' entrepreneurial orientation, network content, and farm performance. Afterwards, we describe the operationalization of measures and data analyses in the methods section, followed by the section presenting the results and the testing of hypotheses. This paper ends with a discussion of the results and the implications, as well as potential avenues for further research.

2. Theoretical framework and hypotheses

2.1 Entrepreneurial farmers and networks

Entrepreneurship refers to value creation and opportunity identification from the business environment (Baron, 2006). The literature acknowledges opportunity as the key element of entrepreneurship, which refers to a future situation that is desirable and feasible to achieve (Shane, 2000; Shane and Venkataraman, 2000; Stevenson and Jarillo, 1990). An entrepreneur is an individual who seizes an opportunity, pursues it by creating a new venture or a new project (Bygrave and Hofer, 1991), and focuses to achieve business growth (Stevenson and Jarillo, 1990). Different from managers, who are concerned with managing and allocating available resources, entrepreneurs are willing to go beyond currently available resources by seizing and pursuing valuable opportunities (Kaish and Gilad, 1991; Shane, 2000). Likewise, entrepreneurial oriented firms are able to adapt to rapid changes in the environment (e.g., technologies, consumers, economic trends, social values, regulatory standards) by being alert to opportunities and being creative and innovative, whereas non-entrepreneurial oriented firms (i.e., administrative oriented firms) may perceive the environment changes as potential threats (Stevenson and Gumpert, 1985). Hence, the desire to pursue opportunities makes entrepreneurs differ from managers.

It might be argued that smallholder farmers are less entrepreneurial for three reasons. First, with the assumption of perfect market competition, smallholder farmers are usually perceived as price takers who produce non-differentiated products, which make them less competitive and have less bargaining power towards buyers (Kahan, 2013; McElwee and Bosworth, 2010). Second, smallholder farmers lack economies of scale compared to large-scale farmers (Wiggins et al., 2010). Third, smallholder farmers face high transaction costs when engaging in modern markets (e.g., supermarkets, food processors, and export markets) that are more concentrated and require demanding standards. With limited resources, smallholder farmers may find it difficult to meet the requirements of consistently high quality, certain quantity, traceability, and adaptability to rapid changes in market demands (Hazell et al., 2010). However, smallholder farmers may benefit from linking to modern markets. When sourcing from smallholder farmers is the best option for buyers of modern markets, some buyers arrange contractual agreements with smallholder farmers and commit to investing in providing farm inputs, technical assistance, and financial support to enhance the quality, quantity, and reliability of supplies (Reardon et al., 2005). Therefore, smallholder farmers may benefit from linking to modern markets by having secure outlets for their products and learning innovations.

Although smallholder farmers own and manage a limited number of resources (e.g., farmland) compared to large-scale farmers, they potentially have advantages to adapt to market changes for the following reasons. First, smallholder farmers are efficient users of resources (Wiggins et al., 2010), which is depicted in studies reporting that small farms produce higher yields per hectare than larger farms in some developing countries (Eastwood et al., 2010; Hazell et al., 2010; Heltberg, 1998). Second, modern science is concerned with improving agricultural productivity, including that for small farms (Hazell et al., 2010). Particular farm innovations are suitable for small farms, such as the application of new seeds using specific technology in fertilization, water control, crop protection, and organic cultivation (Hazell et al., 2010; Wiggins et al., 2010). These situations may stimulate smallholder farmers to meet the market demands by adopting the innovations.

Linking to networks is suggested as a top-level skill that helps farmers overcome their disadvantages and enhance their potential in identifying and pursuing opportunities (DeRosa et al., 2019). Farmers who link to wider and diverse networks may access more resources, such as social capital and social embeddedness. These resources help famers identify opportunities by providing information and knowledge, which lead to developing innovations to meet anticipated upcoming market demands. For instance, networks allow smallholder farmers to learn new farm technologies (Bandiera and Rasul, 2006). When participating in modern markets, networks also help smallholder farmers decrease search and transaction costs by providing access to information and monitoring contractual agreements (Barrett, 2004). Furthermore, networks may also provide information related to markets (Phillipson et al., 2004). Thus, networks help farmers access more resources, help them better understand the markets and enable them to pursue opportunities by developing innovations.

Entrepreneurial small firms have the potential to be adaptive to changes in the business environment (Avlonitis and Salavou, 2007) or create changes in the markets. Small farms might have a similar potential to small firms, as they are more flexible to market changes (Carter and Rosa, 1998; Phillipson et al., 2004) or may anticipate changes in the markets. For instance, vegetable farmers in Thailand (together with other actors) initiated changes in the sweet pepper supply chain by introducing this vegetable into traditional markets, which was previously marketed in supermarkets or export markets (Schipmann and Qaim, 2010).

More entrepreneurial farmers may show not only the capability to manage farm resources but may also show the ability to take and manage more risks (Shadbolt and Olubode-Awosola, 2016), identify opportunities, formulate business strategies, develop innovations, and engage in networks (McElwee and Bosworth, 2010; Vik and McElwee, 2011). Consequently, more entrepreneurial farmers may explore more benefits from the existing technologies, create more value for the existing products, develop new products, and diversify farm businesses (De Lauwere, 2005). These characteristics fit with entrepreneurial orientation. Less entrepreneurial farmers, by contrast, may show characteristics of waiting for the actions of other firms (i.e., being followers) (De Lauwere, 2005), playing it safe to avoid high risks (Shadbolt and Olubode-Awosola, 2016), or being reluctant to exploit new opportunities with uncertainties (Avlonitis and Salavou, 2007). Less entrepreneurial farmers might have difficulty adapting to environment changes. For instance, farmers in Guatemala had access to global markets, but some of them were unable to sustainably adopt innovations by discontinuing producing high-value crops for export markets. These farmers may lack the capacity to deal with the complex technologies required by global markets or may be unable to manage risks (Carletto et al., 2010). This situation might stop less entrepreneurial farmers from seizing opportunities from market changes.

Entrepreneurial orientation provides a basis for firms to make an entrepreneurial decision with specific entrepreneurial aspects in terms of styles, methods, and practices that facilitate the ability to seize opportunities (Covin and Slevin, 1989; Lumpkin and Dess, 1996; Martins, 2016). Entrepreneurial orientation is part of the internal firm capabilities, which consists of the proactiveness and risk taking that facilitate firms to innovate to achieve better performance (Atuahene-Gima and Ko, 2001). Our study uses entrepreneurial orientation, which reflects the skills of entrepreneurial farmers (McElwee and Bosworth, 2010), as a basis to distinguish between more entrepreneurial farmers and less entrepreneurial ones (Avlonitis and Salavou, 2007).

Entrepreneurs may search for information on opportunities from non-traditional sources, such as from their sparse networks (Kaish and Gilad, 1991). Likewise, to better understand the market and satisfy the market demands, farmers are suggested to develop skills in linking to networks that through social capital and social embeddedness provide access to resources (McElwee and Bosworth, 2010). We expect that more entrepreneurial farmers benefit from their networks by identifying valuable opportunities.

Networks refer to a set of actors (individuals or organizations) around a certain actor and a specific set of relations between the actors (Hoang and Antoncic, 2003; Renzulli et al., 2000). Networks share important resources for firms in terms of information, advice (Hoang and Antoncic, 2003), and knowledge (Gunawan et al., 2016). Entrepreneurial firms use the information and knowledge shared in the networks to identify opportunities, protect their resources (Elfring and Hulsink, 2003), and solve problems (Ripollés et al., 2012). Entrepreneurial firms may identify opportunities from alertness to existing opportunities from market changes with expected returns or from judgment/belief regarding new opportunities with unknown returns (Kirzner, 1992; Klein, 2008). To pursue the (expected or unknown) returns of opportunities, entrepreneurial firms can engage in diverse networks to obtain valuable information and resources from knowledgeable contacts (Greve and Salaff, 2003). A focus on pursuing opportunities may make networks of more entrepreneurial firms differ from less entrepreneurial firms. Likewise, we expect that the network content of more entrepreneurial farmers may be different from less entrepreneurial farmers.

The literature acknowledges networks as important social resources either for individuals or for organizations (Burt, 1992) because networks have a facilitative role in various inter-organizational contexts (Gulati, 1999), serve as sources of resources and information (Ahuja, 2000a), and are media to transfer resources (Hoang and Antoncic, 2003). The valuable resources embedded in the networks have a social capital function, which is defined as the economic returns that are gained through social exchanges and relations (Fafchamps and Minten, 1999; Lin, 1999). Important aspects of social capital are serving the flow of information and channeling access to resources (Lin, 1999).

The valuable resources shared in the networks may be in the form of non-redundant information (Burt, 2001) or beneficial information (Claro et al., 2003; Renzulli et al., 2000). Non-redundant information refers to dissimilar information shared from non-redundant sources of information, which is characterized by less cohesive contacts (i.e., contacts who are weakly tied to each other) and non-structurally equivalent contacts (i.e., contacts who are linked to different source of information) (Burt, 2001). An actor may obtain non-redundant information or beneficial information from linking to networks that share specific types of information (e.g., business ties or technology ties) (Hoang and Antoncic, 2003) or from linking to heterogeneous relationships (i.e., network heterogeneity) (Renzulli et al., 2000). When facing market changes, networks may provide firms with relevant information related to new opportunities. Furthermore, networks help firms digest new information by improving information credibility and interpretability (Uzzi, 1996).

The network content focuses on the resources embedded and shared in the networks. The resources consist of tangible resources (e.g., capital) and intangible resources (e.g., information, advice, know how, and problem solving) (Hoang and Antoncic, 2003). We focus on network content as information and knowledge obtained and exchanged between actors and their contacts. For farmers, the network content may explain what types of information are important to undertake innovation and to enhance farm performance when facing market changes. We investigate network content based on discussion topics (i.e., business ties and technology ties) and network relations (i.e., network heterogeneity).

Business ties or technology ties can be in the form of collaboration networks (i.e., ties where the focal actor collaborates with his/her contacts in business activities or in R&D projects) (Ahuja, 2000a) or external networks (i.e., ties without any cooperation between the focal actor and his/her contacts) (Zhang and Cui, 2017). For farmers, collaboration networks in business and technology usually exist in farmer groups or cooperatives.

2.1.1 Business ties

Business ties refer to the relationships between the actors involved in the networks that share information about markets and business opportunities (Lechner et al., 2006).

Business ties consist of relations with competitors, governmental agents, and universities or relations with actors involved in a business transaction, such as buyers and suppliers (Lechner et al., 2006). Engaging with different actors provides different benefits. Ties to suppliers help firms gain knowledge, problem solving, and new combinations from various components or inputs. Ties to buyers are an important source of information about changes in market preference. Ties to buyers help firms detect new market needs and new market niches, so firms can then quickly adapt to market changes. Ties with universities help firms collaborate with other firms in sharing management practices and innovations (McElwee, 2006). Business ties also help actors in the networks face uncertainties in the business environment (Gulati, 1999), such as helping the firm make join plans with its suppliers or buyers (Claro et al., 2003). Thus, business ties consisting of suppliers, buyers, and competitors provide channels for firms to access beneficial information related to opportunities (Brown and Butler, 1995).

Because more entrepreneurial farmers focus on seizing new opportunities, we expect that they will have more business ties than their counterparts. Thus, the hypothesis proposed is as follows:

H1: More entrepreneurial farmers will have more business ties than less entrepreneurial farmers.

2.1.2 Technology ties

Technology ties refer to the relationships between actors involved in the networks that transfer and share information and knowledge related to technologies, such as information about new products and problem solving (Ahuja, 2000a) and new or combinatory knowledge (Singh et al., 2016). Technology ties enable the focal actor in the networks to solve problems together with the suppliers or buyers (Claro et al., 2003). The information shared in technology ties may also support innovation activities in the firm, such as the process of product development (Håkansson et al., 1999).

Because more entrepreneurial farmers are likely to be more innovative, we expect that they will have more technology ties than their counterparts. Thus, the hypothesis proposed is as follows:

H2: More entrepreneurial farmers will have more technology ties than less entrepreneurial farmers.

2.1.3 Network heterogeneity

The concept of network heterogeneity is derived from the concept of the network range, which describes the characteristic diversity of a firm's or an individual's contacts (Marsden, 1990). The greater the network range, the less redundant information that one can obtain (Renzulli and Aldrich, 2005). Network heterogeneity presents the degree of characteristic dissimilarity between alters of an ego (i.e., contacts of the focal actor), or describes the diversity of the actor's contacts (Renzulli et al., 2000; Zheng and Zhao, 2013). Heterogeneous contacts come from dissimilar environments, which causes the contacts to have diversity in their perception of information. Therefore, heterogeneous contacts may provide a greater range of information (Granovetter, 1973; Scholten, 2006) or non-redundant information.

The literature acknowledges that heterogeneous networks are the important resources to access broader knowledge by providing firms with the opportunity to indirectly link with contacts beyond the direct contacts (Renzulli et al., 2000). The more heterogeneous the networks, the more diverse the information that can be obtained (Blau, 1977). Heterogeneous networks contribute to enriching the information and encourage information assimilation (Podolny and Page, 1998), which lead to new knowledge (Powell and Brantley, 1992).

In the agricultural context, diverse actors within the networks provide various resources for farmers in terms of information and capital (Isaac, 2012). Interactions with diverse actors, such as research institutes, buyers, and suppliers, bring diverse information and resources (Spielman et al., 2011). By assimilating information and resources, heterogeneous networks facilitate the learning process that promotes innovation (Spielman et al., 2011; Thuo et al., 2013) and provide resources for firms to identify opportunities (Renzulli et al., 2000).

As opportunities and innovations are important for more entrepreneurial farmers, we expect that they will have more heterogeneous networks than their counterparts. Thus, the following hypothesis is proposed:

H3: More entrepreneurial farmers will have more heterogeneous networks than less entrepreneurial farmers.

2.1.4 Farm performance

Farm performance may represent the ability of farmers to turn the resources into positive outcomes. The outcomes can be reflected in the form of innovations developed by farmers (i.e., innovative performance) or revenues (i.e., financial performance).

Entrepreneurship is the important driver to achieve innovative performance (Bessant and Tidd, 2009) by seizing opportunities for creating value (Drucker, 1985). Innovative performance represents a firm's ability to create or respond to the market changes (Schoonhoven et al., 1990). Entrepreneurial firms may initiate the market changes as the 'creative destruction' (Schumpeter, 1934) by foreseeing future market demands and then take more risks to formulate new products that are 'new to the world' (i.e., radical innovation) (Lumpkin and Dess, 1996). Entrepreneurial firms may also respond to the market changes by improving the existing products that are 'new to the industry' (i.e., incremental innovation) (Tidd et al., 2005). In a similar way, prior studies suggest that more entrepreneurial farmers are concerned with developing innovations to introduce new products (Pannekoek et al., 2005) or improved products to meet the market demands (Leitgeb et al., 2011). Consequently, more entrepreneurial farmers may allocate more resources to innovate and achieve higher innovative performance than less entrepreneurial farmers. Thus, the following hypothesis is proposed:

H4a: More entrepreneurial farmers will show a higher level of innovative performance than less entrepreneurial farmers.

More entrepreneurial farmers are expected to be more innovative and proactive; therefore, they will use their networks more actively to gain enhanced performance (Grande et al., 2011). More entrepreneurial farmers are more focused on searching for novel information, which can be accessed through their networks (DeRosa et al., 2019; Moreno and Casillas, 2007). This focus will help farmers satisfy market needs and use their networks to access farm inputs more efficiently to create added value for their customers (Knudson et al., 2004), which can result in enhanced revenue (Micheels and Gow, 2015). Therefore, we expect that more entrepreneurial farmers will achieve higher financial performance than less entrepreneurial farmers. Thus, the following hypothesis is proposed:

H4b: More entrepreneurial farmers will show a higher level of financial performance than less entrepreneurial farmers.

2.2 Networks and farm performance

2.2.1 Business ties and farm performance

The topics discussed within the business ties focus on market trends, business opportunities, and market intelligence (Lechner et al., 2006). The literature suggests that business ties provide firms with several resources. First, business ties share market information about existing situations as well as future trends that may include information about opportunities (Boso et al., 2013). Business ties share market information that may not exist in open markets, such as product information and credible partners (Jantunen et al., 2005). Second, business ties help firms quickly respond to market demands by providing access to advice and resources and skills in problem solving (Boso et al., 2013; Hoang and Antoncic, 2003). When facing new markets, business ties provide firms with learning, resources, and inside information about the markets (Li and Zhou, 2010). When dealing with fast changes in the industry, business ties support firms to adapt to changes (Jantunen et al., 2005). Third, business ties provide wide access to the resources and capabilities of contacts within the ties, which enrich firms with new knowledge (McElwee, 2006). Therefore, business ties help firms to learn by assimilating new knowledge with existing knowledge (Jantunen et al., 2005).

Long-term relationships with suppliers or customers may enhance the firm's innovative performance (Uzzi, 1997). Information from customers is important for firms to create new products or improvements (Von Hippel, 1978). For farmers, engaging in business ties provides them with opportunities to predict market trends, and together with suppliers or buyers, farmers can anticipate the upcoming market demands. Therefore, business ties are a means for farmers to meet market demands by introducing new vegetables or improvements to the existing vegetables. Thus, the following hypothesis is proposed:

H5a: Business ties will positively influence innovative performance.

The main interest of firms connecting in business ties is to increase the economic benefits, which can be achieved in two ways. First, business ties coordinate the exchanges through collaboration (Ghosh and John, 1999). Collaboration then improves logistic coordination, which reduces the transaction costs in terms of customer acquisitions and distribution costs. Business ties reduce transaction costs by accelerating searches, strengthening trust, and helping transfer information (Jantunen et al., 2005). The interaction results in mutual trust between parties, which may reduce opportunistic behavior of business partners (Luo, 2008; Park and Luo, 2001). Furthermore, business ties reduce transaction costs by developing trust and improving communication (Dess et al., 1997). Therefore, trust and communication within business ties may facilitate trades without formal contractual agreements (Woolcock and Narayan, 2000). Business ties also help firms achieve economies of scale. By pooling the resources belong to the actors in the ties, business ties may reduce the costs per unit of output (Luo, 2008; Park and Luo, 2001). Therefore, business ties may enhance the financial performance of a firm by decreasing transaction costs and achieving economies of scale.

Business ties provide firms with information about market demands, which creates opportunities (Lin, 1999). Business ties also help farmers negotiate with input suppliers, creditors, and processing firms (Meurs, 2001). A prior study reported that ties to customers or suppliers have the potential to directly influence financial performance (Hoang and Antoncic, 2003). Thus, business ties help firms access resources that may enhance the firm performance (Hoang and Antoncic, 2003).

In the context of agriculture, business ties are one of the important resources for farmers to develop farm businesses and discover business opportunities (Spielman et al., 2011) by providing organizational resources and facilitating knowledge transfer (Shirokova et al., 2016). Business ties allow farmers to transform ideas into new venture creation (Grande, 2011; Lawson and Samson, 2001). Hence, business ties that provide economic benefits and market information may help farmers enhance financial performance. Thus, the hypothesis is proposed as follows:

H5b: Business ties will positively influence financial performance.

2.2.2 Technology ties and farm performance

Especially through collaboration networks, Ahuja (2000a) suggests that technology ties enhance innovative performance through the following four mechanisms: (1) resource and knowledge sharing, (2) knowledge spillover, (3) complementary, and (4) economies of scale. First, technology ties transfer and share resources and knowledge, so a firm can access physical assets, knowledge, and skills, which are developed together with other firms. Second, technology ties provide a firm with access to gain knowledge spillover and the ability to recombine and reconstruct the knowledge to form combinatory knowledge, which is useful for the innovation process. The combinatory knowledge includes know-how, technical break-through, different angles to see problems, or the specific approaches of one firm compared to another (Ahuja, 2000a; Singh et al., 2016). Knowledge and information are exchanged by frequent communication, intense interactions, and focus on specific topics (Rowley et al., 2000). Third, technology ties help a firm gain complementary skills from different firms. By elaborating the competence of other firms, the firm can focus and improve its own knowledge and finally enhance its innovative performance. Fourth, by becoming involved in a collaborative project, technology ties help a firm gain economies of scale by increasing the return proportion of the innovation output, especially for a project that requires a large investment (Rogers, 1995). Hence, technology ties channel different resources and provide various methods, which may help a firm enhance its innovative performance.

The function of knowledge spillovers in technology ties can be made through inter-firm collaboration as collaborative linkages. These linkages are sustained, focused, and intense interactions that involve the exchange of information. Sustained interactions are frequent communication, focused interactions mean that the relations will be used to communicate a specific type of topic of collaboration, and intense interactions imply that collaborative firms have a great incentive and opportunity to share information (Rowley et al., 2000). In the agricultural context, technology ties may contribute to improving innovative performance by collaborating with other farms, buyers, suppliers, or supportive actors. Thus, technology ties may provide farmers with important resources to develop innovations that yield new or improved products (Spielman et al., 2011). Thus, the following hypothesis is proposed:

H6a: Technology ties will positively influence innovative performance.

Firms with rich social capital that engage the technology ties have large access to diverse resources for seizing entrepreneurial opportunities. First, technology ties through inter-firm collaboration provide firms with information, knowledge, and complementary resources, so firms can share the risks between the firms in the ties (Lee et al., 2001; Pennings and Harianto, 1992). Furthermore, inter-firm collaboration through technology ties helps firms access external know how (Pennings and Harianto, 1992). Second, technology ties with universities or research institutes help firms build knowledge that may be difficult for firms to develop by themselves. Furthermore, universities or research institutes provide technical resources and consultancy services for firms to help solve problems (Lee et al., 2001). Managing efficient networks in technology ties can enhance the firm performance by providing firms with various information and capabilities and by reducing the costs of redundancy, complexity, and conflict (Baum et al., 2000). Therefore, technology ties help firms adopt technology and, ultimately, enhance financial performance (Ahuja, 2000b; Lechner et al., 2006). Hence, technology ties provide firms with rich resources to pursue opportunities and eventually enhance firm performance.

In the agricultural context, technology ties provide opportunities for farmers to gain competitive advantages over rival firms by gaining information and resources to enhance added value by producing new or improved products and, thus, enhance financial performance. The following hypothesis is thus proposed:

H6b: Technology ties will positively influence financial performance.

2.2.3 Network heterogeneity and farm performance

Networks play an important role for innovation development by channeling the exchange of complex information. Heterogeneous networks provide diverse information and knowledge (Mailfert, 2007), which help firms identify ideas and opportunities (Kontinen and Ojala, 2011) and, in turn, stimulate firms to innovate (Mailfert, 2007). For farmers, linking to heterogeneous networks allow them to access advanced information and knowledge. For instance, participating in workshops conducted by a cooperative gives farmers an opportunity to discuss and share the latest knowledge in farming practices and business with experts (Faysse et al., 2012).

Low redundancy between contacts in heterogeneous networks enhances the value of the information that the firms obtain from the networks (Granovetter, 1973). For instance, linking to market-related networks supports farmers in improving their production system, while connecting to government agencies supports farmers in exchanging information, sharing costs, and adopting a new farming system. The government provides support if the farmers experience financial problems in applying the new farming system (Nelson et al., 2014). A study reported that the more heterogeneous the partners in an alliance are, the higher the firm's innovative performance (Capaldo, 2007). In a similar vein, another study indicated that the more heterogeneous the contacts in the networks are, the greater the possibility the farmers have to enhance their innovative performance (Isaac, 2012). Thus, the following hypothesis is proposed:

H7a: Network heterogeneity will positively influence innovative performance.

The more heterogeneous the networks, the more diverse information and resources a firm could gain from its contacts, which will help the firm to perform better. Previous studies found that firm performance is enhanced when the firms are linked to wider external networks or more diverse networks (Lee et al., 2001; Zheng and Zhao, 2013).

Different types of contacts bring different types of information or advice on innovation; these diverse types of contacts or information and support from various contacts potentially contribute to positive returns to the social capital of a firm (Renzulli et al., 2000). Heterogeneous networks facilitate dissemination of complex information and, ultimately, help farmers enhance their farm performance (Isaac, 2012; Thuo et al., 2013). Furthermore, heterogeneous networks facilitate farmers to access cheaper and more diverse resources compared to the ones available in the market (Mailfert, 2007). A study showed that linking to heterogeneous contacts within an alliance improves the firm revenue (Baum et al., 2000). Thus, heterogeneous networks may facilitate farmers to gain higher financial performance by providing information, advice, and resources. The hypothesis is proposed as follows:

H7b: Network heterogeneity will positively influence financial performance.

3. Methods

3.1 Context

West Java is the main vegetable production area in Indonesia and contributes to 35 percent of the national vegetable production (KEMENTAN, 2017; Natawidjaja et al., 2007). The average farm size of vegetable farmers in West Java was 0.55 hectare and the average farmer age was 43.50 years old (KEMENTAN, 2012). Based on market values, three types of vegetables are produced in West Java, consisting of low-value vegetables (e.g., cabbage and carrots), medium-value vegetables (e.g., tomatoes and potatoes), and high-value vegetables (e.g., sweet peppers and lettuce). Most farmers sold their products individually to traditional market channels via village traders, which dominated the traditional market systems in West Java (Hernández et al., 2015).

In the 1990s, the vegetable demands of modern markets (e.g., supermarkets, food processors, and export markets) in the cities around West Java (e.g., Jakarta and Bandung) rose, and vegetable farmers started to participate in the supply chains of these modern markets. Most farmers were organized by farmer groups or cooperatives that collected and delivered vegetables to supermarkets/exporters/food processors via dedicated or specialized wholesalers. These farmers could earn market shares between 11-15 percent and received net revenues 10-30 percent higher than those who participated only in the traditional market channels (Natawidjaja et al., 2007).

3.2 Data

To understand in detail whether the entrepreneurial degree and network content have an effect on farm performance, a study on vegetable farmers was conducted. The study population was defined as farmers (i.e., owners and managers) who produced vegetables in the form of leaves, fruit, tubers, or flowers in the area of West Java between 2009-2012. Vegetable farmers in West Java were selected as our study population because they have access to actors in the vegetable supply chains. The actors consist of participants who are involved in transaction activities, such as suppliers, buyers in modern and traditional markets, and participants who provide business and innovation support, such as research institutes and universities (Natawidjaja et al., 2007).

To pretest the questionnaire, preliminary in-depth interviews were conducted with six experts from a farmer cooperative, a farmer group, a non-governmental organization, and an agricultural university between May and December 2011. Based on the interviews, five regions in West Java (i.e., Pangalengan Bandung, Cisarua Bandung, Warung Kondang Cianjur, Pacet Cianjur, and Bogor) were purposively selected for the survey based on the following criteria: variation of vegetable types, diversity of technologies, and access to diverse actors in the vegetable sector.

To determine the study population, we compiled a list of vegetable farmers from several sources, including local authorities, extension agents/agricultural officials, and cooperative managers, which yielded 3,732 vegetable farmers. Afterwards, we verified the list through farmer-group chairpersons in villages, and they confirmed that the list did not fit with the existing situation in 2011-2012. Some farmers on the list did not produce vegetables anymore or had moved to other areas. To update the list, these farmer-group chairpersons then recommended other farmers who were producing vegetables in their villages but theirs names were not available on the list. A previous study conducted in West Java experienced similar difficulties in finding an accurate, comprehensive, and updated study population from local authorities (Gunawan et al., 2016). We obtained 1,263 vegetable farmers on the updated list as the basis for the sampling frame. We found that not all farmers on the list could be contacted due to incomplete addresses, so probability sampling was not possible. Therefore, we chose the quota sampling method, which was proportional to the number of farmers in each selected region (i.e., 27 percent in Pangalengan Bandung, 10 percent in Cisarua Bandung, 35 percent in Warung Kondang Cianjur, 13 percent in Pacet Cianjur, and 15 percent in Bogor). This sampling method could give sufficient statistical power to identify group differences (Bornstein et al., 2013). We obtained a total sample of 282 farmers who were available and responded positively to our requests for survey participations.

We first developed the questionnaire in English. We then carefully translated the questionnaire into the Bahasa Indonesia language. In an attempt to reduce bias due to language translation, we discussed the questionnaire intensively with experts from an agricultural university in terms of the questionnaire's language and the content. Afterwards, we pretested the questionnaire with a few farmers to obtain more insights and make corrections before the final version was used for the interviews. Next, the survey was conducted through face-to-face interviews in Bahasa Indonesia, administered from January to August 2012. To better understand the details of farming processes, the local language (i.e., Sundanese) was also used during the interviews, especially for explaining farming practices. In the process of data compilation, we carefully translated some data that were still in Sundanese into Bahasa Indonesia. For the data analyses, twenty observations were excluded due to missing data on networks and gross revenues, or due to small farm size (less than 0.05 ha). The final sample size was 262 respondents.

Most of the farms in developing countries represent the 'simple firms' (Miller, 1983) type of farms, which is generally run by the owner-managers. Simple firms are typified as small firms with a simple structure and the power to make decisions is centralized with the leaders. The firms are organized with few staff members, less differentiated business units, and coordinated by direct supervision. The power and knowledge of the leaders may reflect the entrepreneurial degree of the firms. These characteristics make the role of the leaders vitally important for the firms (Miller, 1983). Likewise, farms in West Java demonstrated similar characteristics with simple firms. We used the farmer as the unit of analysis with the assumption that the farmer – as the farm leader – represents his/her farm, consistent with the concept of entrepreneurial orientation, which assumes the firm as the unit of analysis (Covin and Wales, 2019; Lumpkin and Dess, 1996; Wiklund and Shepherd, 2005).

Measurements

Innovative performance. Developing innovations for farms involves experiments. The experiments refer to the research activities conducted by farmers to generate information, namely 'farmers' experiments', which are acknowledged to have contributions to agricultural innovations (Leitgeb et al., 2011). Farmers' experiments aim at testing hypotheses or attempting new innovations, such as evaluating the suitability of new technologies before the farmers fully apply them. Farmers' experiments are usually conducted on small plots of land. The experiment plot indicates the R&D input to produce innovative outputs (Hagedoorn and Cloodt, 2003), such as new products (Gunawan et al., 2016). On these plots, farmers conduct activities, such as trials for new varieties, new farm inputs (e.g., pesticides or fertilizers), or new technology (e.g., using screen shade or plastic tunnel). This paper used the plot size for the experiments (m^2) to proxy innovative performance. Due to a skewed distribution, the data of the plot size were transformed by the formula log (X_i + 1).

Financial performance. The success of product commercialization can be seen from enhanced sales or revenues (Szymanski et al., 2007), which represent the financial performance of a firm. In the context of agriculture, revenues demonstrate the value of the output produced on the farm (Argilés and Slof, 2001) and indicate a farmer's ability to convert farm inputs into financial output (Bojnec and Latruffe, 2009). This paper operationalized financial performance as gross farm revenues, which refer to the total sales of farm productions accounted when the transaction has occurred (Argilés and Slof, 2001). Based on the concept of total revenue (Mankiw, 2003), financial performance was measured as the sum of the gross revenues from all vegetables produced in a year (2011), which is formulated as follows:

$$Gross\ farm\ revenues = \sum_{i=1}^{n} P_i \times Q_i$$

where P_i is the vegetable price, Q_i is the vegetable quantity sold, and i is the vegetable type.

This measure was transformed by the formula log (*Xi*) due to a skewed distribution.

Entrepreneurial degree. Entrepreneurial orientation was used to distinguish the entrepreneurial degree of farmers. This paper took into account three items from the dimension of proactiveness and three items from the dimension of risk-taking (Table 1), measured in a seven-point Likert scale (Covin and Slevin, 1989). The entrepreneurial orientation literature usually includes the dimension of innovativeness as part of entrepreneurial orientation (Wiklund and Shepherd, 2005). In our research models, we employed the innovation-related variable (i.e., innovative performance) as the consequence of being more entrepreneurial (Drucker, 1985). To avoid redundancy with innovative performance, we excluded the dimension of innovativeness from entrepreneurial orientation construct. We follow the general rule to test the relationships of entrepreneurial orientation with other variables/constructs that are mutually exclusive (Covin and Wales, 2019).

Networks. In this paper, a network refers to a group of people with whom the farmer discusses his or her farm business. Our study focuses on the egocentric network analysis that examines the relations surrounding each individual as an actor, which is different from the total networks involving all engaged actors (Marsden, 1990). To perform the egocentric analysis, the name-generator technique was employed to gather the data. The name-generator technique asked the respondent to identify several names of contacts with whom they discussed their farm and what topics were discussed (Wasserman and Faust, 1994). The respondents were asked to identify a maximum of seven names as the most important contacts. This approach is suggested to avoid the problem of recall accuracy (Burt and Ronchi, 1994; Greve and Salaff, 2003). The questions were as follows: (1) “Could you indicate people with whom you discussed your farm business? (2) “Could you indicate the relationship type of each contact, e.g., relative, fellow farmer, extension agent, supplier, or buyer?” Based on these questions, we categorized the network variables into business ties, technology ties, and network heterogeneity.

Network content: **business ties, technology ties**, **and network heterogeneity**. Network content refers to the type of information or topics that were discussed between the actor and his/her contacts related to farm businesses. We divided the network content based on the discussion topics (i.e., business ties and technology ties) and based on the diversity of the network relations (i.e., network heterogeneity). Business ties and technology ties were adapted from the concept of relational mix (Lechner et al., 2006). These types of ties may be relevant for the context of agriculture in developing countries (Spielman et al., 2011).

The question measuring network content was an open question; consequently, a respondent may mention more than one topic that was discussed with his/her contacts. For instance, the discussion topics of a farmer with a buyer may be related to both technology development and business opportunities. Only the first answer was taken into account as network content because the first answer described the farmer's primary concern. We assumed that the primary topic was the most important topic. Each topic was then categorized and coded into business ties (1 = business ties; 0 = otherwise) or technology ties (1 = technology ties; 0 = otherwise). Other topics related to routine farm activities were excluded from our study (Table 2). Because one relationship represented one topic, we made sure that the number of contacts (i.e., network size) was equal to the number of topics (network content) (Lechner et al., 2006). Finally, the ***business ties*** were measured by counting the proportion of business ties to network size; whereas, the ***technology ties*** were measured by counting the proportion of technology ties to network size.

To measure network heterogeneity, we first identified the following five types of network relations when a contact linked to a focal actor (i.e., the farmer): *horizontal* networks came from fellow farmers, relatives or friends; *upstream networks* came from input suppliers; *downstream networks* came from buyers; and *sponsorship networks* came from research institutes or universities (Table 3). Although the contacts may have more than one relation type when dealing with the focal actor, as both a buyer and a relative, we took into account only one relation, by taking the first answer of the respondent as his/her primary relation. To calculate the network heterogeneity, we followed the formula suggested by Renzulli et al. (2000), which is adapted from the Herfindal-Hirschiman coefficient method (Cohen and Sullivan, 1983).

$$Heterogeneity = 1 - [(horizontal/total)^2 + (upstream/total)^2 + (downstream/total)^2 + (sponsorship/total)^2]$$

A zero score of heterogeneity represents a completely homogeneous network, while a score close to one indicates a more heterogeneous network (Renzulli et al., 2000).

Control variables. Farmer age, farm size, and education were used as the control variables. The farmer age describes the human capital, whereas the farm size describes the physical assets of farms. Years of formal education was used as a proxy of human capital (Renzulli et al., 2000) or farmers' knowledge. Education equips farmers with knowledge and skills, which may help them learn new technologies or enhance financial performance. We expect that younger farmers, larger farm size, and longer durations of (formal) education correspond to both higher innovative and financial performance.

4. Results

We conducted the tests for construct validity and reliability of entrepreneurial orientation. The principle component analysis (PCA) was performed to extract the underlying factors of entrepreneurial orientation, which consists of six items. One factor was extracted explaining 60.75 percent of variance with factor loadings of the items ranging from 0.72 to 0.81 (Table 1). The reliability test shows that the Cronbach's alpha of entrepreneurial orientation is 0.86, which meets the suggested threshold of 0.70 (Nunnally, 1978). Thus, both results confirm the validity and reliability of entrepreneurial orientation as a construct.

Table 1.
Entrepreneurial orientation: construct validity and reliability

Items	Factor loadings[1]	Cronbach's alpha
Entrepreneurial orientation		0.86
Proactive on initiating changes	0.75	
Proactive on being a pioneer	0.81	
Proactive over competitors	0.81	
Risk-taking on new projects	0.79	
Risk-taking on achieving goals	0.80	
Risk-taking on becoming a first mover	0.72	

[1]Based on Principle Component Analysis

To identify the entrepreneurial degree of farmers, a cluster analysis was performed. Cluster analysis aims to classify units, so the similarity between units within groups is greater than between units in different groups (Klastorin, 1983). Farmers were categorized based on a composite variable of entrepreneurial orientation. This composite variable was standardized to avoid the potential effect of a scale difference between items (Ketchen and Shook, 1996). The K-mean cluster analysis was used, which efficiently uses computer resources in identifying dissimilar clusters (Avlonitis and Gounaris, 1999). We tested for two, three, and four clusters. The results show that the scores for the distance between cluster centers were 4.14 for two clusters, 2.01 for three clusters, and 1.30 for four clusters. The choice of two clusters provides the acceptable solution based on the maximum external heterogeneity (between cluster) and internal homogeneity (within cluster) (Klastorin, 1983), and based on *a priori* theory (Ketchen and Shook, 1996). The two-cluster solution categorized farmers into groups, namely: more entrepreneurial farmers (n = 106; 40.46 percent) and less entrepreneurial farmers (n = 156; 59.54 percent). The difference between these two groups towards the items of entrepreneurial orientation is presented in Appendix 1.

Table 2 presents the distribution of the network content of farmers based on the discussion topics. Although both groups of farmers were interested in discussing topics related to routine farm activities, more entrepreneurial farmers seem to be more interested in topics related to markets and new technologies compared to less entrepreneurial farmers.

Table 2.
Network content of farmers based on discussion topics

Discussion topics	More entrepreneurial farmers (percent)	Less entrepreneurial farmers (percent)
Business ties		
Organization activities (in farmer groups or cooperatives).	3.43	0.52
Access to finance (e.g., credits from banks or soft loans from governments).	4.74	0.73

Discussion topics	More entrepreneurial farmers (percent)	Less entrepreneurial farmers (percent)
Markets (e.g., access to new markets or new market requirements).	33.99	10.11
Farm inputs (e.g., access to farm input suppliers).	14.38	3.34
Technology ties		
New technologies in farm inputs (e.g., new seeds), farming practices (e.g., hydroponic farming or organic farming), crop protection (e.g., integrated pest management), and equipment (e.g., greenhouse construction, drip irrigation, or sprinkle irrigation).	13.23	3.65
Non-business/non-technology ties		
Routine farm activities (e.g., planting, weeding, fertilizing, spraying pesticides, or harvesting).	30.23	81.65
Total	100.00	100.00

Table 3 compares the network relations of more entrepreneurial and less entrepreneurial farmers as the basis to measure network heterogeneity. More entrepreneurial farmers have a greater number of contacts with upstream, downstream, and sponsorship networks, whereas less entrepreneurial farmers have more contacts with horizontal networks (i.e., fellow farmers). The results indicate that more entrepreneurial farmers link to more heterogeneous networks compared to their counterparts, which confirmed the descriptive statistics (Table 4). These results indicate that more entrepreneurial farmers may access more non-redundant information from diverse network relations than less entrepreneurial farmers.

Table 3.

Network content of farmers based on network relations

	More entrepreneurial farmers			Less entrepreneurial farmers			
Network relations	Mean	s.d.	Mean ranks	Mean	s.d.	Mean ranks	Mann-Whitney U[1]
Horizontal	0.38	0.30	83.26	0.76	0.30	164.28	3,155**
Upstream	0.11	0.17	155.98	0.02	0.06	114.87	5,673**
Downstream	0.38	0.27	161.70	0.20	0.27	110.98	5,066**
Sponsorship	0.13	0.22	154.03	0.01	0.05	116.19	5,879**

[1]Based on the Mann-Whitney test using mean rank differences due to a non-normal data distribution.
More entrepreneurial farmers (n = 106), Less entrepreneurial farmers (n = 156)
** $p < 0.01$; * $p < 0.05$

Table 4 provides descriptive statistics of the network content, farm performance, and control variables of both more entrepreneurial and less entrepreneurial farmers. The network contents of both groups are significantly different, where more entrepreneurial farmers have more business ties, technology ties, and heterogeneous networks than less entrepreneurial farmers. Therefore, the hypotheses H1, H2, and H3 were confirmed. Regarding farm performance, more entrepreneurial farmers have higher innovative performance and financial performance than their counterparts. Therefore, the hypotheses H4a and H4b were confirmed. Furthermore, more entrepreneurial farmers have larger farm sizes, better education, and higher farm performance compared to less entrepreneurial farmers; however, they do not significantly differ on farmer age.

Table 4.
Network content and farm performance of more entrepreneurial and less entrepreneurial farmers

	Variables	More entrepreneurial farmers			Less entrepreneurial farmers			Mann-Whitney U[1] (000)
		Mean	s.d.	Mean ranks	Mean	s.d.	Mean ranks	
1	Innovative performance[2] (hectare)	0.12	0.19	179.52	0.03	0.12	98.87	3,178**
2	Financial performance[3] (000 USD)	30.04	56.70	184.92	4.70	14.32	95.21	2,606**
3	Farmer age (year)	44.17	9.57	133.30	43.72	12.15	130.28	8,077
4	Farm size (hectare)	2.90	4.31	179.03	0.57	1.00	99.21	3,230**
5	Education (year)	10.89	4.00	178.98	6.47	2.65	99.24	3,235**
6	Business ties	0.57	0.30	181.59	0.17	0.29	97.46	2,958**
7	Technology ties	0.12	0.21	150.19	0.03	0.11	118.80	6,287**
8	Network heterogeneity	0.44	0.20	171.81	0.20	0.23	104.11	3,995**

[1]Based on the Mann-Whitney test using mean rank differences due to a non-normal data distribution.
[2]Innovative performance was measured as the plot size for experiments (transformed in logarithm for the linear regression analyses).
[3]Financial performance was measured as gross revenues (transformed in logarithm for the linear regression analyses).
More entrepreneurial farmers (n = 106), Less entrepreneurial farmers (n = 156)
** p <0 .01; * p <0 .05

Most vegetable farmers in West Java are nearly fully commercial (Hernandez et al., 2015), as are the farmers participating in our study. The general characteristics of vegetables are perishable, which means that it is not possible to keep them longer for family consumption. The market value of vegetables varies among the different types. High-value vegetables (i.e., vegetables that give high economic return per unit of farm size or per unit of weight (GFAR, 2005) – representing product innovation – usually have premium prices and are marketed in modern markets. Low-value vegetables usually have highly volatile prices and are marketed in traditional markets. The tendency of more entrepreneurial farmers to produce high-value vegetables may explain the significant difference in the financial performance between more entrepreneurial farmers and less entrepreneurial farmers (Mann-Whitney U = 2,606; p < 0 .01). The average of the financial performance (i.e., gross farm revenues) of more entrepreneurial farmers was 6.40 times higher than that of less entrepreneurial farmers (Table 4).

One may question to what extent more entrepreneurial farmers received economic benefits from their farms. To illustrate this, we consider the minimum wages of labors in West Java, which was 1,286,421 IDR or 95.58 USD per month in 2011 (West-Java-Governor, 2010), as the opportunity cost for farmers working on their farms. On average, entrepreneurial farmers earned 30,040 USD for gross farm revenues per year (Table 4), or 19,011.37 USD per hectare per year, which was equal to 1,584.28 USD per hectare per month. The repeated survey conducted in 2016 for the same farmers showed that entrepreneurial farmers earned profits approximately 13 percent from their gross revenues. We assume the same proxy in 2011, so more entrepreneurial farmers earned profits approximately 205.96 USD per hectare per month, which was 2.15 times higher than minimum wages of labors of companies. On average, more entrepreneurial farmers managed a 2.90 hectare farm size (Table 4), so farmers could earn profits of approximately 597.28 per month, which was 6.25 times higher than minimum wages of labors of companies. This result indicates that working on farms gives entrepreneurial farmers a greater income than working on non-farms.

The business growth of farmers could be indicated by the farm-size growth. The average farm-size growth (2009-2011) of more entrepreneurial farmers was 27.51 percent, which was almost two times higher than that of less entrepreneurial farmers (i.e., 14.41 percent). In addition to producing vegetables, 51.89 percent of the more entrepreneurial farmers and 32.69 of the less entrepreneurial farmers run other (farm/non-farm) businesses, while 21.70 percent of the more entrepreneurial farmers and 26.92 percent of the less entrepreneurial farmers earned extra incomes from doing other jobs. It seems that more entrepreneurial farmers tend to pursue opportunities by enlarging or diversifying their farm businesses, whereas less entrepreneurial farmers tend to be involved in other jobs to secure their livelihood.

Entrepreneurial degree, network content, and farm performance

We performed regression analyses to test the hypotheses related to farm performance, which was reflected by innovative performance and financial performance. Significant positive correlations were found between the variables of network content and the variables of farm performance. The correlation coefficients of all variables range from 0.00 to 0.59 and among independent variables range from 0.00 to 0.53 (Appendix 2), indicating the absence of multicollinearity.

Table 5 reports the results of the linear regression analyses for innovative and financial performance. We first entered the control variables for both linear regression models resulting in a significant share of variance in farm performance (Model 1: $R^2 = 0.26$, $F = 30.90$, $p < 0.01$; Model 3: $R^2 = 0.37$, $F = 51.04$, $p < 0.01$). Farm size and education positively influence innovative performance (Model 1: β of farm size = 0.29, $p < 0.01$; β of education = 0.34, $p < 0.01$), as well as financial performance (Model 3: β of farm size = 0.34, $p < 0.01$; β of education = 0.40, $p < 0.01$). Farmer age neither has a significant influence on innovative performance nor financial performance.

Next, we entered the main variables (i.e., entrepreneurial degree, business ties, technology ties, and network heterogeneity) into the models, which significantly increase the variance explained of innovative performance (Model 2: $adj\text{-}R^2 = 0.43$, F-change = 20.40, $p < 0.01$) and financial performance (Model 4: $adj\text{-}R^2 = 0.46$, F-

change = 11.89, $p < 0.01$). These findings indicate that enhanced farm performance can be reached not only by enlarging farm size or having higher formal educations but also by being more entrepreneurial and linking to networks.

Table 5.
Linear regression: Farm performance

	Innovative performance[1]		Financial performance[2]	
	Model 1	Model 2	Model 3	Model 4
	β	β	β	β
Control variables				
Farmer age	0.03	0.01	-0.06	-0.09
Farm size	0.29**	0.20**	0.34**	0.26**
Education	0.34**	0.08	0.40**	0.21**
Main variables				
Entrepreneurial farmer[3]		0.25**		0.25**
Business ties		0.22**		0.13*
Technology ties		0.02		-0.08
Network heterogeneity		0.14*		0.09
R-square	0.26	0.44	0.37	0.47
Adj R-square	0.26	0.43	0.36	0.46
F	30.90**	28.89**	51.04**	32.38**
F-change		20.40**		11.89**

[1]Innovative performance was measured as the plot size for experiments (transformed in logarithm).
[2]Financial performance was measured as gross revenues (transformed in logarithm).
[3]Cluster membership in a binary construct: 1 refers to more entrepreneurial farmers, 0 refers to less entrepreneurial farmers.
$N = 262$
** $p < 0.01$; * $p < 0.05$

Hypothesis 4a and 4b expect more entrepreneurial farmers to have a higher level of farm performance. The results in Table 5 show that more entrepreneurial farmers have higher innovative performance (Model 2: $\beta = 0.25, p < 0.01$) and higher financial performance (Model 4: $\beta = 0.25, p < 0.01$) than less entrepreneurial farmers. These results support hypotheses H4a and 4b.

We tested the effect of network content (business ties, technology ties, and network heterogeneity) on farm performance. We predicted a positive relationship between business ties and innovative performance (hypothesis H5a) and between business ties and financial performance (hypothesis 5b). The results show that business ties indeed positively influence innovative performance (Model 2: $\beta = 0.22, p < 0.01$) as well as financial performance (Model 4: $\beta = 0.13, p < 0.05$). Hence, hypotheses H5a and 5b were supported.

We also expected that technology ties positively influence innovative performance (hypothesis H6a) and financial performance (hypothesis H6b). However, the results demonstrate that technology ties neither influence innovative performance nor financial performance (Table 5). Thus, hypotheses H6a and H6b were not supported.

Finally, we predicted that network heterogeneity positively influences innovative performance (hypothesis H7a) and financial performance (hypothesis H7b). The results reveal that network heterogeneity positively influences innovative performance (Model 2: $\beta = 0.14$, $p < 0.05$), but it does not influence financial performance. Thus, only hypothesis H7a was confirmed.

Robustness checks

We conducted analyses to check the classic assumptions of the linear regression models of innovative performance and financial performance. To detect the presence of collinearity between variables, the data were checked by using the following indicators: variance inflation factor (VIF), tolerance statistics (1/VIF), and correlation coefficients (Field, 2009). The individual scores of VIF were lower than 10 and the average VIF was not substantially greater than 1 (average VIF = 1.58). All scores of the tolerance statistics were greater than 0.20. The individual correlations between independent variables were not too high, ranging from 0.00 to 0.53 (Appendix 2). The highest correlation coefficient was 0.53 ($p < 0.01$) between business ties and network heterogeneity. The three indicators confirm that collinearity was not a problem for the models. Next, the Breusch-Pagan test shows that the assumption of homoscedasticity was met for the linear regression model of innovative performance (Chi-Square = 0.84, $p = 0.36$) and financial performance (Chi-Square = 1.99, $p = 0.16$).

5. Discussion

The main objective of this paper is to examine the impact of entrepreneurial degree and network content on farm performance in adapting to market changes. The results show that more entrepreneurial farmers differ from less entrepreneurial farmers based on demographic characteristics and network content. More entrepreneurial farmers engage in a greater number of business ties and relate to more heterogeneous networks compared to less entrepreneurial farmers. Regarding the demographic characteristics, more entrepreneurial farmers show a higher education level and larger farm size, but they do not show significant differences in age compared to less entrepreneurial farmers. The tested models show that more entrepreneurial farmers and business ties in the networks increase both innovative and financial performance; network heterogeneity only increases innovative performance. A remarkable note is that technology ties do not influence either innovative or financial performance. These findings underline the importance of more entrepreneurial farmers, business ties, and network heterogeneity in promoting farm performance.

The results posit that more entrepreneurial farmers have better innovative performance compared to less entrepreneurial farmers (hypothesis H4a), which is in line with findings of prior studies on SMEs in Indonesia (Gunawan et al., 2016) and in Greece (Avlonitis and Salavou, 2007). These results imply that more entrepreneurial farmers who are proactive and willing to bear more risks make greater use of experimental plots and have stronger innovative and financial performance compared to less entrepreneurial farmers. Table 4 indicates that the portion of the plot size to farm size of more entrepreneurial farmers was 4.14 percent (0.12 hectare over 2.90 hectare), which was slightly lower than their counterparts of 5.26 percent (0.03 hectare over 0.57 hectare). These portions may indicate that more entrepreneurial farmers may take more risks by enlarging their experiment plots because they have quite large farm sizes as resources to innovate, which are five times higher than the farm sizes of their counterparts. It was too risky for less entrepreneurial farmers to enlarge their experiment plots, which might reduce their farm size to produce vegetables for generating income.

We found that business ties support farmers to improve innovative performance (hypothesis H5a) as well as financial performance (hypothesis H5b). This finding is supported by a previous study conducted in Ethiopia that showed that less access to business ties inhibits farmers from innovating (Spielman et al., 2011). Network content, especially business ties, potentially provide different types of information and resources, such as knowledge and learning (Spielman et al., 2011), business advice (Arregle et al., 2015), access to capital (Hoang and Antoncic, 2003), or business resources (Arregle et al., 2015). These information and resources may enable farmers to pursue innovative performance by helping them identify opportunities and better understand the market demands, then translate them into innovations (Fafchamps and Minten, 1999). Afterwards, this set of information and resources signal farmers to allocate resources to innovate and then introduce the outcomes to the markets. Therefore, the impact is finally reflected in their innovative performance and is ultimately depicted in their financial performance.

Although technology ties support farmers with technology-related information, including problem solving (Ahuja, 2000a), we do not find evidence that technology ties stimulate farmers to innovate (hypothesis H6a) or increase financial performance (hypothesis H6b). The technology-related information introduced by these ties may not yet be ready to be applied, or may require expensive investment to be realized (Eisenhardt and Schoonhoven, 1996; Lechner et al., 2006). Therefore, the positive impact of technology ties is not expressed by the existence of both innovative and financial performance. We presume that the positive impact on farm performance might be seen in the long-run. The innovation can be demand-driven (Stefano et al., 2012), so business ties have more of an effect on farm performance.

Heterogeneous networks provide access to different types of information that make farmers more open-minded in recognizing business opportunities or in accepting new approaches and innovations in agricultural practices (Polman and Slangen, 2008; Spielman et al., 2011). Each network relation provides specific types of information. Downstream and upstream networks can provide access to information beyond transaction activities, such as making plan to reduce market risks, channeling the latest technologies (Claro et al., 2006), reducing information costs and negotiation costs, and also facilitating access to modern markets (Lu et al., 2008). Horizontal networks provide farmers access to knowledge and information related to new technologies, such as through farmer-to-farmer extension programs (Kiptot and Franzel, 2014). Farmers learn and observe innovations or experiments conducted by their fellow farmers, relatives, or neighbors as a reference before adopting an innovation (Bandiera and Rasul, 2006). Connecting to sponsorship networks helps farmers to learn and adapt formal research methods in addition to their informal research methods, such as collaboration in generating improved or local-adapted innovations (Hoffmann et al., 2007). This diverse type of information and support from various contacts may explain why network heterogeneity enables farmers to pursue innovative performance (hypothesis H7a). Managing heterogeneous networks might be difficult and costly for farmers; therefore, we presume the impact on financial farm performance might be seen in the long-run.

Farm size and education of farmers lead to both higher innovative and financial performance (Table 5). A larger farm size may provide farmers with more space to conduct trials and experiments (Feder, 1985). A larger farm size could also help farmers bear more risks because they may have sufficient space to grow vegetables as the source of their income (Marra et al., 2003). Therefore, farm size is important to gain both enhanced innovative and financial performance. We used the duration of formal education as a proxy of farmers' knowledge, which positively influences financial performance, but not innovative performance. This situation may indicate that formal education helps farmers better understand market needs and the allocation of farm resources, which ultimately realize enhanced revenues. Although the knowledge gathered during formal education might serve as a basis for farmers to design trials and experiments properly (Leitgeb et al., 2012), formal education has a time lag and is not the only source of farmers' knowledge. Farmers may also learn from non-formal education, such as trainings (Pratiwi and Suzuki, 2017) or observations of other farmers' experiments (Bandiera and Rasul, 2006). These two sources of knowledge, which are not included in this paper, might directly influence farmers to innovate. We recommend future studies to include non-formal education as one of predictors for innovative performance.

6. Conclusions

The empirical results of this study demonstrate that more entrepreneurial farmers are able to face market changes by linking to business ties and heterogeneous networks that potentially contain non-redundant information, which help these farmers achieve a higher farm performance. The results show that more entrepreneurial farmers have more business ties, technology ties, and heterogeneous networks than less entrepreneurial farmers. We further incorporate the entrepreneurial degree and network content into the analysis of farm performance. We find that more entrepreneurial farmers, business ties, and network heterogeneity enhance innovative performance and financial performance. We highlight the importance of entrepreneurial degree and business ties in enhancing both innovative and financial performance, whereas network heterogeneity is especially important for farmers in enhancing innovative performance.

We acknowledge that our study has some limitations. First, we conducted our study using a single type of farmers – vegetable farmers – in West Java, who tend to be closer to public research institutes or universities and also have more market choices than other types of farmers in other areas. This choice may have limited the generalization of our findings to other types of farmers. Second, our study uses a cross-section design that cannot capture the dynamics of farmers' networks, entrepreneurial degree, innovation, and farm performance. We suggest that future studies use a longitudinal or panel data design, which would provide more comprehensive insight into the dynamics of these variables. Third, we used plot size for experiments as the indicator for innovative performance, which indicates R&D inputs (Hagedoorn and Cloodt, 2003). Because innovative performance may cover other indicators, such as new products (Hagedoorn and Cloodt, 2003) or new improvements, our findings may limit the interpretation of innovative performance. We suggest that different types of indicators be combined to reflect innovative performance as a construct that indicates farm performance. Fourth, this study focuses on network content as an information type without taking into account other resources shared in the networks, such as intangible and tangible assets. Finally, the study population of this paper might suffer from interest bias coming from the agricultural officials or cooperative managers who provided the farmer list or availability bias coming from sample selection due to incomplete farmer addresses that made it difficult for us to reach all the farmers on the list. We suggest that future studies improve the methods for collecting data, which may reduce the potential bias and better represent the population.

We hope this paper will contribute to a better understanding the differences in network content between more entrepreneurial farmers and less entrepreneurial farmers. Previous studies suggest that entrepreneurship is important for farmers to adapt to changes in the business environment (Grande et al., 2011; Phillipson et al., 2004). To address these changes, farmers need to not only be entrepreneurial but also to engage in networks (Phillipson et al., 2004). We argue that entrepreneurial farmers with extensive networks build up social capital (Boso et al., 2013), which may help them to develop innovations and achieve better performance. To our knowledge, few studies pay attention to incorporating farmers' entrepreneurial degree and networks to face changes in the business environment. Our findings indicate that innovations for farmers are more demand-driven rather than supply-driven, reflecting from business ties, which have a more significant impact on innovative and financial performance than technology ties. We recommend that policy makers help farmers engage with people or organizations that provide business information, which may stimulate farmers to translate the market demands by developing innovations.

Acknowledgements

This work was supported by Nuffic for the Netherlands Fellowship Programs under Grant CF6830/2010, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia (via Research Institute and Community Services-IPB University under Grant 1563/IT3.11/PN/2018), and the Department of Agribusiness, Faculty of Economics and Management, IPB University. The authors would like to thank two anonymous reviewers for their constructive comments. We would also like to thank Johan van Rooyen, Meine Pieter van Dijk, Ron Kemp, Gerben van der Velde, Nunung Kusnadi, Harianto, Amzul Rifin, and Suprehatin for their helpful comments on an earlier draft of this paper. Additionally, for their research assistance, we thank Rendi Seftian, Dwi Puspa Buanasari, and Aprilyan Setiadi.

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Appendix

Appendix 1.

Farmer profiles based on entrepreneurial orientation

Items	Factor loadings[1]	More entrepreneurial farmers Mean	s.d.	Mean rank	Less entrepreneurial farmer Mean	s.d.	Mean rank	Mann-Whitney U[2]
Proactive on initiating changes	0.75	4.50	2.31	186.56	1.63	1.17	94.09	2,431**
Proactive on being a pioneer	0.81	3.45	1.92	191.22	1.19	0.50	90.92	1,937**
Proactive over competitors	0.81	3.83	1.29	189.75	2.01	0.76	91.92	2,093**
Risk-taking on new projects	0.79	3.89	1.75	192.71	1.42	0.79	89.91	1,780**
Risk-taking on achieving goals	0.80	5.27	1.62	198.72	2.02	1.11	85.82	1,142**
Risk-taking on becoming a first mover	0.72	4.23	1.81	182.33	2.13	1.09	96.96	2,880**

[1]Based on Principle Component Analysis.
[2]Based on the Mann-Whitney test using mean rank differences due to a non-normal data distribution.
More entrepreneurial farmers (n = 106), Less entrepreneurial farmers (n = 156)
** $p < 0.01$; * $p < 0.05$

Appendix 2.

Correlation matrix of variables

	1.	2.	3.	4.	5.	6.	7.
1. Innovative performance							
2.Financial performance	0.59**						
3.Farm size	0.40**	0.47**					
4.Farmer age	-0.00	-0.10	0.04				
5.Education	0.43**	0.52**	0.34**	-0.14*			
6.Business ties	0.52**	0.48**	0.26**	-0.02	0.44**		
7.Technology ties	0.15*	0.07	0.07	-0.08	0.20**	-0.08	
8.Network heterogeneity	0.45**	0.37**	0.18**	-0.07	0.33**	0.53**	0.31**

N = 262
** $p < 0.01$; * $p < 0.05$