**A Typology of Agricultural Production System: Trajectories of Capability and Development**

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**Introduction**

There are many studies detailing the importance of intervention measures in agricultural sector and their positive impact on economic growth. Agrarian reform is often cited as the defining measure for some economies in charting a path towards an efficient economy and in turn, rapid industrialization (Henley, 2012; Lipton, 1977). South Korea and Taiwan, for instance, witnessed a rapid hike in agricultural productivity and economic progress after executing their respective versions of agrarian reform (see Vu, 2010). The land owners of these economies were directed to hand over their lands (most of which were derelict and underutilized) to the state and received compensation. The state proceeded to distribute the lands to poor, landless farmers, who bought small parcels of land via low interest rate loan schemes sponsored by the state. Making good use of these lands, the farmers started to become more productive and evolved to produce more sophisticated goods in the ensuing decades (Hsieh, 2011; Shin, 1998).

Another type of intervention is the setting up of public institutions to manage schemes resettling poor farmers from the rural areas to designated zones complete with planned villages, basic infrastructure, and farming facilities. The lands are held by the state while the estates are worked by the settlers who earn wages for their part in raising and harvesting crops (Jomo, 1986). The case of Malaysia's Federal Land Development Authority (FELDA) in managing rubber and oil palm resettlement schemes is a defining model for this type of intervention (Fold, 2000; Salleh, 1991; Wong, 2016).

These two interventions are accompanied by additional pro-poor measures such as the provision of subsidized agricultural inputs, guaranteed prices for export-oriented crops, public research institutions (PRIs) to help farmers raise their productivity, and modernization/diversification of the agriculture sector to produce more sophisticated products. These measures have indeed generated significant socio-economic progress. It is noteworthy that agricultural businesses in these economies have evolved and those farmers who used to work at the farms have also attained capabilities to produce (productively) and innovate. The command of technology enables many farmers to gain reasonable control over their environment. It is therefore vital to explore and elucidate the paths taken by key agrarian economies in pursuing development in their respective agricultural sectors.

There is consensus that the claim 'command over technology' in the agricultural sector is related to 'the ability to configure, adapt, transform, organise and design external knowledge emanating from other sector' (Thutupalli & Iizuka, 2016, p. 926). For them, there is a need to revise Pavitt's (1984) taxonomy on agricultural related capabilities as a revolution in biotechnology has brought about significant changes in learning routine among the stakeholders in the agricultural innovation system.

It is also argued that the new learning routine is locally embedded, location-specific, and subject to knowledge-based capital (Thutupalli & Iizuka, 2016).

This paper is interested in detailing the kind of capabilities which allow farmers to innovate and to be productive. The capabilities are viewed as an (deliberate) aftermath of a series of events that led to changes in government policies and social economic structure of a specific region. The narrative follows the tradition of history-friendly theorizing, providing an overview of the cause, the outcome of specific events, and their broader impacts on the economy. The paper will shed light on different types of agricultural system, outlining how they in turn lead to different farming capabilities and forms of competitive advantages.

**Results**

Taiwan: Rice and the People

Taiwan is an economy that has grown rapidly over several decades. There is ample literature elucidating the development process of its world class manufacturing sector, especially the semiconductor industry (e.g. Amsden & Chu, 2003; Mathews & Cho, 2000; Wong, Hu, & Shiu, 2015). The emergence of the semiconductor industry in the 1980s and subsequent success in creating niches in the 1990s are attributable to the early commitment of establishing a strong learning routine and fair distribution of income. Such a foundation is in turn rooted in Taiwan's farming sector during its formative years (Ho, 1982; Hsieh, 2011).

Kuomintang (KMT), the then ruling party, was forced to relocate to Taiwan in 1949 after losing the civil war to the Chinese Communist Party (CCP) in the Chinese mainland. One of the KMT's major concerns was the lack of economic activities in Taiwan. A land reform project was soon initiated to encourage rice farmers to acquire lands that were formerly owned by absentee landlords. The KMT also offered low interest rate loans to help them acquire such lands (Hsieh, 2011). This was the first governmental measure adopted to incentivise poor farmers to appropriate their acquired land for income generation. Farmers also received mass education to enable them to mobilize their skills if rice farming failed. In addition, there was a deliberate measure to connect farmers to industrialists (Wade, 2003). Industrial players subcontracted some tasks to farmers if the manufacturing tasks are found overwhelming in their factories. Farmers subsequently received some assistance to purchase machines and undergo training to perform the subcontracted tasks.

Farmers in a community learned from each other the productive methods in farming while performing subcontracted tasks for extra income. The government on the other hand provided support for agricultural essentials and set specific prices for certain export-oriented goods to encourage farmers to diversity their businesses (fruits, tea, fisheries, etc.). An old agricultural research institute established during the Japanese occupation, Taiwan Agricultural Research Institute (TARI), was endowed with resources to equip farmers with cultivation techniques and other productive knowledge[1]. The early establishment of learning routine and mobilization of human resource enabled the farmers to acquire different set of skills and tacit knowledge (Wong, 2016). They also established farmers unions as they saw the need to inform the government or industrial players their collective views and needs. The unions are instrumental to form joint-effort associations with government agencies to derive rice-related products (such as soap, wine and candy) and establish a wide distribution network of consumers (Wong et al., 2015).

[1] There are other PRIs such as Taiwan Livestock Research Institute and Tea Research and Extension Station that were empowered in the 1950s and 1960s respectively to perform research at districts that are better-endowed to cultivate other farming activities.

Taiwanese farmers in the 1970s and 1980s indeed have been well endowed with different set of skills and capital. Scientists in TARI are required to transfer basic scientific knowledge to farmers so they can be informed about crop-breeding knowledge[2] and participate in certain scientific experiments that may improve the quality of agricultural products or harvesting processes through adopting state-of-the-art technologies. Both farmers and scientists were involved in translating explicit knowledge into tacit ones (and vice versa). This two-way interaction has made many Taiwanese farmers into high quality rice and processed rice producers.

Scientists in TARI are endowed with resources to perform research that would advance emerging technologies (such as biotech) for agricultural sector. It is to be observed how the potential emergence of biotechnology would shape the agricultural production and the features of its system.

Malaysia: Palm Oil and the State

Malaysia is an upper middle income economy that has achieved noticeable socioeconomic progress since its independence in 1957. While it has transformed itself from a natural resources-dependent economy into a more manufacturing and services oriented one, Malaysia still relies to a large extent on the agricultural sector, especially palm oil. Since its 1957 independence, Malaysia has been ruled by a coalition representing the three major ethnic groups (i.e. Malay, Chinese, and Indians), but with the Malay-centric United Malays National Organization (UMNO) as the hegemon. Malaysian rural areas have traditionally been ethnic Malay strongholds, so there was (and still is) an imperative to focus development in these areas (Fold, 2000).

One of the main vehicles to develop the rural areas is the Federal Land Development Authority (FELDA). Established in 1956, FELDA was founded to handle the resettlement of rural poor into newly developed areas and to organise smallholder farms. Its ultimate goal is to eradicate poverty through the cultivation of cash crops, particularly palm oil. Lots are allocated to individual settlers, mostly ethnic Malays who met the selection criteria of being landless or near-landless (Cramb & McCarthy, 2016). Each family is allocated 1,000 square metres of land on which to build a home and four hectares of land for agriculture. The development cost of the area, including other infrastructure such as roads and drainage, are paid for by settlers over a period of 15 years (Fold, 2000; Salleh, 1991). They are then grouped with other families to form a settler scheme, which in turn is part of a larger integrated rural project. Currently, the largest of these rural projects is the Johor Bahru project in the southern state of Johor (incorporating 17,551 settlers) (see Mohamad Nor, 2011).

There has been ample public research institutions (PRIs) established to support the growth of the palm oil industry. On top of FELDA's in-house research and development arm, the industry is also generously supported by agriculture-focused government agencies such as the Malaysian Agricultural Research and Development Institute (MARDI) and Palm Oil Research Institute of Malaysia (PORIM) (Rajarao, 2013). Both these PRIs were established in the 1970s in response to the government's decision to intervene more strongly in the economy, with PORIM specifically designed to provide fully-committed single crop research and development (R&D) support to the then fledgling palm oil industry (Ong, 1987). According to Rock and Sheridan (2007), R&D efforts by

[2] We were informed during the interview with scientists in TARI that farmers interact closely with the scientists in TARI. They always seek advice from scientists if they find something unusual in their crops or plants. For instance, farmers often utilize mobile applications to send pictures of their plants to scientists. The scientists in TARI are required to investigate and reply promptly (partly to avoid spreading of diseases to other plants). In addition, scientists often distribute their research findings (written in Chinese) to inform farmers about the possible applications of their research.

PORIM is one of the key factors leading to substantial increases in worker productivity, the introduction of weevils to improve pollination, and the development of new varieties of palm oil with less 'fatty acid' and of new processed products that are competitive alternatives to the liquid oil produced in temperate countries (Gopal, 1999). Indeed, industry data shows that Malaysia is the most productive palm oil producer in the world. Yielding 4.31 tons of crude palm oil (CPO) per hectare, it is significantly more productive than most palm oil producing countries. Only two countries come close to matching it – Indonesia (4.14 tons of CPO per hectare) and Costa Rica (4.13 tons of CPO per hectare) (see Potter, 2016).

Notwithstanding the success illustrated above, the relationship between the settlers and FELDA is occasionally fraught with tension. The settlers are expected to till the land on a piece-rate system, but more in the form of wage labourers rather than co-owners. They are not encouraged to be innovative or autonomous as the majority of the commercial decision is undertaken by FELDA. FELDA's market power is underwritten by its monopoly of inputs (in land use and all phases of production), and monopsony of outputs (fruit harvest). In addition, the operation of these lots is tightly controlled by a hierarchical management system. Amongst other things, settlers could only receive land titles when the development cost of their land has been met (Cramb & McCarthy, 2016). They are also required to pay back the development cost to FELDA through periodic deductions from the sale of fresh fruit bunches harvested from the palm oil trees. Hence, their weekly or monthly income is essentially the net proceed after such expenses are deducted. For these settlers, they are merely technology users as experimentation and R&D are conducted by scientists from FELDA and the PRIs. In this environment, the farmers can still be fairly productive when they are properly trained to use the technologies supplied. Nevertheless, their productivity has been undermined by land insecurity. According to Pletcher (1991), the settlers' claim to true smallholder status has been tenuous after several rounds of adjustment to the original system of individual titles to land. FELDA and the government only agreed to restore land ownership back to the system of individual titles to land in 1988 in response to increasing discontent among the settlers.

In 1991, FELDA announced that all schemes not yet populated by settlers but still in the early phases of land development would be managed as a traditional plantation company with real wage labourers instead of settlers. These workers will receive wages and benefits on conditions similar to those prevailing in the commercial sector (Fold, 2000). FELDA's announcement reflects the unsustainability of the original scheme in view of land shortages (especially in Peninsular Malaysia) and the high resettlement cost. In addition, Malaysia's relatively high labour cost and shifting demography threaten to undermine the sustainability of this scheme. For the latter, Malaysia's urbanization trend and aging population has certainly caused labour shortage on the plantations. While foreign labour from neighbouring countries (especially Indonesia) has been increasingly sourced, these labourers do not have a long term stake or interest in the viability of the domestic palm oil industry as well as FELDA. There are also occasional question marks raised over their legal status, in addition to the potential social problems brought about by uncontrolled immigration. More generally, a newer generation of developing countries are attempting to supplant Malaysia in cultivating their own palm oil industries. Some of them have aggressively attracted the investment dollars of agrofood transnational corporations (MNCs) from Malaysia itself. This is especially apparent in the case of Indonesia (see Varkkey, 2013).

**Discussion**

Taiwan: Innovation-Oriented System

Figure 1 corresponds to the context of Taiwan's agricultural system. It has a strong network, with intense and frequent interaction between the farmers, between the PRIS, and between farmers and PRIs. The network established within the farming society enables farmers to share knowledge and learn from each other. Newly discovered methods or processes that can lead to (higher) productivity can be easily diffused through this network. The farmers also interact closely with PRIs scientists to acquire scientific knowledge and state-of-the-art technologies, improving productivity as well as quality of their farming products. The scientists are required to disseminate important information about market, machines, and emerging technologies to the farmers. The close two-way relationship is conducive to help farmers acquire productive skills and innovative capability. Table 1 illustrates the hypothesized features of this system.

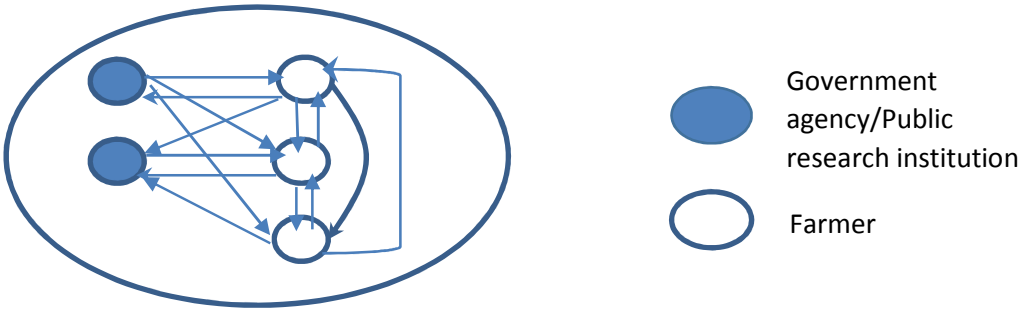


Figure 1: Illustrated Model for Innovation-Oriented System

Table 1: Hypothesized Features of Innovation-Oriented System

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| • Unique bonds in the community (rooted in a Marshallian network) enable diffusion of knowledge<br>• Strong interaction with scientists enabling farmers to adopt state-of-the-art or emerging technologies<br>• Farmers acquire basic scientific knowledge and can perform certain experiments with scientists<br>• Farmers are well informed and acquire other skills (beside farming)<br>• Strong unions to mobilize resources, diversify businesses, and negotiate with different stakeholders in the value chain<br>• Farmers are endowed with both productive (in terms of yield) and innovative (in adopting state-of-the-art/emerging technologies and performing experimentation to improve quality of products) capabilities |

Malaysia: State-Anchored System

Figure 2 shows Malaysia's palm oil agricultural system. The network is not as dense as that observed in Taiwan's rice agricultural system as the land settlers do not interact with each other very intensively. In addition, the interaction between the settlers and the PRIs is almost entirely one-way. The PRIs provide crop knowledge and training to the settlers, who are expected to apply them in the field. While feedback and monitoring mechanism are installed by FELDA and the PRIs, the transmission of knowledge takes place in a top-down rather than bottom-up manner. Although they have attained reasonable crop yields, the settlers contribute little to genuine innovation as they are

treated more as malleable wage labourers in a hierarchical system rather than entrepreneurs. Unlike their Taiwanese counterparts, they are not incentivized to diversify their enterprises into other related activities. This state-anchored system can still yield good outcomes, evidenced by Malaysia's dominance in almost the entire value chain of palm oil, from seedling research to final consumer goods marketing. However, much of such gains is appropriated by large land- and capital-owning organizations such as FELDA (and other commercial plantation companies) rather than the land settlers themselves. Moreover, the viability of this system is predicated on a disciplined and relatively young labour force, which in the contemporary era necessitates the hiring of immigrant labourers rather than local settlers (who in any case are an increasingly small group). Table 2 illustrates the hypothesized features of this system.


Figure 2: Illustrated Model for State-Anchored System

Table 2: Hypothesized Features of State-Anchored System

- Weak bonds between the settler community inhibiting knowledge diffusion
- Knowledge transferred from scientists to settlers in a top-down format
- Settlers acquire basic scientific knowledge, but primarily as end users
- Settlers do not generally acquire other skills (apart from farming)
- Unionism is discouraged to enforce labour discipline
- Settlers are productive (in terms of yield), but not innovative (in adopting state-of-the-art/emerging technologies and performing experimentation to improve quality of products)

<u>In Pursuit of Innovation: A Tale of Two Countries</u>

Taiwan's and Malaysia's rice- and palm oil-oriented agricultural systems provide a contrasting picture on how different capabilities are gradually acquired by the farming community of both economies.

Firstly, the case of Taiwan is used as the defining example of a highly innovative system. The rice farming society of Taiwan displays some features of a Marshallian system. Farmers interact closely to enable themselves to be informed about important methods and information about their products market. They utilize the acquired land efficiently, established union to mobilize resources and expanding their marketing and distribution networks. Such (collective) effects led farmers to produce productively in the 1960s. An old research institute (TARI) were endowed with more resources in the 1970s to empower farmers with skills to innovate. Farmers and scientists of TARI interact closely to perform certain scientific experimentations that may improve quality of agricultural products. TARI is required to inform farmers about the state-of-the-art technologies that may improve farmers' productivity or quality of their products. Farmers in Taiwan, as we observed, attained high level of sophisticated skills for both production and innovation.

The case of Felda's resettlement scheme manifest the state-anchored system. Poor and unorganised farmers or peasants are resettled at designated areas that are developed for organised farming activities. Resettled farmers have the privilege to utilise both basic infrastructures and agricultural essentials provided in the developed areas. Farmers are trained to be organised and becomes wage labour by harvesting and maintaining the estates. Farmers may not inherent a unique bond like the case of Marshallian one as they were relocated from different places. Farmers earn wages according to productivity and world market prices of the products. There are research institutions performing agricultural related research activities. The scientists from the research institutes are required to interact with farmers. However, the interaction that enable farmers to perform innovative activities may be limited as farmers did not (unable to) acquired scientific knowledge. Farmers can be productive as they are trained to work hard and to use given technologies but rarely participate in joint research with scientists.

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