

Consideration for Governmental Supports of Small Farmers for Rural Development

— A Case Study of the Rural Development Project in Northern Areas of Thailand. —

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Abstract

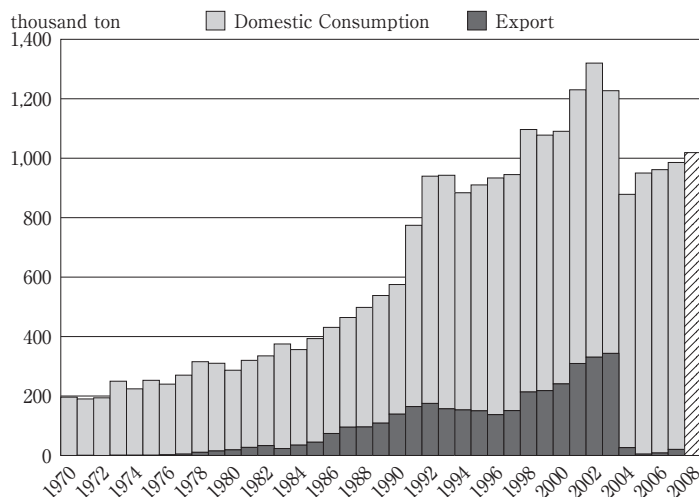
The purpose of this paper is to try to determine the effects of a governmental support for small farmers by a case study of the Rural Development Project in Thailand. This project aims to increase farmer's income by sideline chicken feeding. As the result, the project created a differentiated commodity of native chicken meat, also opened up the niche market for sustainable production of the sideline. The positive aspect of this project is that the project created five production societies, and keeping fairness of incomes and risks allocation in the societies. The negative aspect is that the fairness is kept by the government. The next step of developing this project is how to authorize fairness keeping to the societies.

Keywords : Governmental support, Small farmers, Differentiated commodity, Niche market.

1 . Introduction

The expansion of market economy, even in agricultural sector, involves several economic actors in the global competition as same as in industrial sector. Surviving this intensive competition, agribusinesses who are the main actors in food production develop original selling channels to many countries to increase their net income. They also develop their production organization to other countries to obtain more reasonable production inputs and labor force by their hyper mobility of capital.

On the other hand, small farmers who are the one of the main actors in rural agriculture tend to become the weak in market economy. For this reason, governments provide political supports to the farmers to maintain domestic agricultures. However, some of the supports only help to prolong the farmers' farming activities rather than to create independence and sustainability of their productions. For example, subsidies or tariff barriers well work to prevent rural agriculture from large capitals or reasonable import agricultural products. However, these supports never promote small farmers' economic independence or strength for competitions.

Figure 2.1. Total amount of chicken meat production in Thailand (1970-2009)

Source : FAOSTAT

* Detail data not available in 2009

From this point of view, the purpose of this paper is to try to determine the effects of governmental supports for small farmers by a case study. For this analysis, this paper chooses the Rural Development Project (RDP) as a model case. RDP is one of governmental projects related with chicken meat production, and operated by Chiang Mai Research Center (CRC), the Department of Livestock Development of Thailand.

The reason why this paper focuses on chicken meat production is that the major chicken meat production of broiler primarily created “integrated production system” in agricultural sector. Also Thai government had promoted to develop domestic agriculture by Newly Agro Industrializing Country (NAIC) strategy. For this effort, some of the agribusinesses became Transnational Companies (TNCs) in animal feeds or livestock productions.

The data using in this paper is retrieved from previous studies and statistics, also from original field surveys from 2006 to 2010.

2. Transition of chicken meat production in Thailand

Figure 2.1 shows domestic chicken meat consumption and the export in Thailand. The amount in 1970 is made from old layer hens, culled chickens: chicken meat was made from culled chickens before broiler became popular.

A local company introduced broiler production and started the meat export in 1973. After that, many companies entered to the production to obtain export share. Large broiler producers today also started chicken meat export until in the mid-1980s. Therefore the export increased gradually until early in the 1990s.

In the 1990s, China and Brazil developed chicken meat export in the international market. Thus the export from Thailand was depressed, and Thai chicken meat exporters exploited domestic market to compensate their overproduction. The result of this effort, domestic chicken meat consumption was increased in this period.

In 1997, Avian Influenza occurred in Hong Kong and in 2001, in China again. Thus the export from Thailand augmented in 1998 as an alternative. However, the Influenza was transmitted to Thailand in 2003, and the meat export was prohibited in January 2004. Therefore the export amount sharply decreased. For this occurrence, Thai chicken meat exporters had shifted their production from frozen chicken meat to processed meat such as ready-to-cook or ready-to-eat products. This processed meat is heat-treated and higher safeness than frozen one. Thus the exporters could obtain export permission and started the meat export again.

3. Broiler production system : the case of CPF

Most famous broiler producer in Thailand is Charoen Pokphand Food Public Company Limited (CPF). This company is an agribusiness sector of Charoen Pokphand Group Company Limited (CP Group). This company is a local company and became the first broiler producer in Thailand.

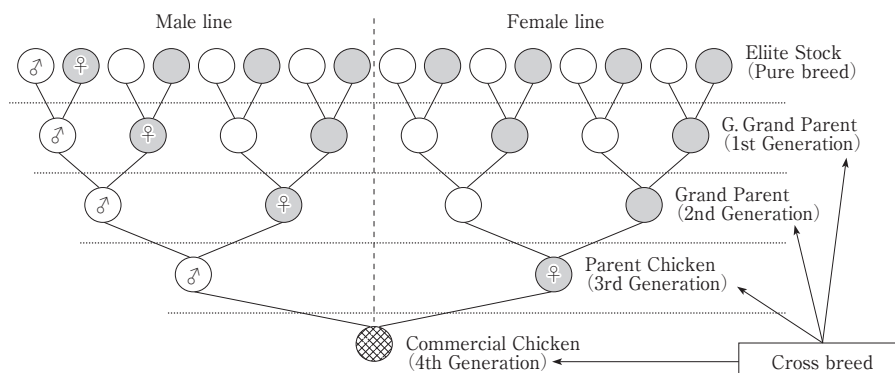
CP Group began operation as a trading company in 1921, and had exchanged egg products and fertilizer between Thailand and Hong Kong. This company started to import and sell animal feed in 1954. After that, this business gradually developed and the company needed more effective selling channels. For this reason, the company began broiler production jointed with Arbor Acres who is a broiler breeding company in 1971.¹⁾ CP Group also started chicken meat export to Japan cooperated with some Japanese companies such as Nippon Meat Packers, Seiyu, and Meiji Dairies Corporation.²⁾

In the 1980s, many companies started broiler production and the competition among the companies was intensifying. The six of them became major chicken producers in Thailand. During this period, CP Grope aggregated several stages of chicken meat production and the relative production sectors to obtain scale economy for its production. The company finally created complete integrated production system and applied this system to other food production such as shrimp, pig, fruit, vegetable, seed and plant, and dairy. Thus the company became a large conglomerate.³⁾

In the 1990s, all chicken meat exporters tried to obtain domestic market because some countries were developing the share of international market. During this period, CP Group built domestic distribution network and selling channels by obtaining super market chains and a convenience store chain. However, Asian currency crisis occurred in 1997 and the company was forced to restructure itself.⁴⁾ CPF was consequently established by this restructuring.

In 2002, nitro furan antimicrobial was detected several times from Thai chicken meat ex-

Figure 3.1. Broiler's bloodline



Source : CPF

ported to EU. Therefore Thai government ordered to chicken meat exporters to improve this problem. On the other hand, Avian Influenza was transmitted to Thailand in 2003. For these occurrences, CP Group resolved to change its operating policy from price-oriented to food-safety-oriented.

CPF's production system is a typical broiler production system. The company integrates production stages from chick hatching to meat retailing. This system is characterized by Broiler's bloodline, feed, feeding system, and its organization.

3.1. Broiler's bloodline

"Broiler" is not the name of chicken species. It is a kind of crossbreed chicken, but is special hybrid one called "first filial generation." For example, general crossbreed chicken has intricately mixed bloodline because of no crossing control. Therefore the chicks have variety of appearances and characteristics because of the rule of inheritance even they were born from same parents. On the other hand, broiler is created through three generations crossing (see figure 3.1). Each generation of parents have good characteristics to increase productivity. A broiler is born with all of these characteristics as fourth generation. However, when cross the broilers, they never bring same characteristics of their chicks as fifth generation because of the law of genetics.

Broiler is called "commercial chicken" because they are only produced to yield the meat. For this purpose, broiler's digestion is well developed and can eat feed whole day. It also can gain its weight almost half of the feed weight that they ate. This is why broiler has high productivity. For example, ordinal chicken generally takes 3 months to be 1.6 kilo-gram, but broiler takes only 31days. Even if an ordinal crossbreed chicken is raised by exactly same feed and conditions with broiler, the weight is never gain as same as broiler. For this reason, broiler production developed and the meat represented chicken meat in a short time.

3.2. Feed

CPF's animal feed is high calorie grain meal to maximize broiler's productivity. The feed contains maize and soy bean as main materials also fish meal, vitamins, and minerals as additional materials. CPF analyzes necessary nutrition at each broiler growth stages and defines the materials' proportion. The company is the biggest feed producer in Thailand and makes several types of feeds by itself. The proportion of each specific feed is regulated exactly same as the definitions by computer system. For several growth stages, the company has 6 brands of animal feeds also 9 brands of aquatic feeds.⁶⁾

3.3. Feeding system

CPF's feeding system is characterized by the chicken house and the feeding management. The house is completely covered by walls to protect chickens from infections. The house also cut sunshine and keeps inside the dark, and darkish lighting system keeps chickens calm. CPF's ordinal chicken house is 1,440m² (120m × 12m) and be able to keep 22,000 heads of chicken.⁷⁾ For this mass feeding, the lighting system is necessary because chickens are territorial animal and fight against other chickens. This system is also able to keep best condition for chickens' eating and sleeping to gain their weight.

Feed and water is automatically sent into the house from the silos beside the house therefore chickens can eat whenever they want to eat. The house and other facilities are connected and controlled by computer system. For instance, radiators and fans attached on the house walls automatically work for cooling down inside air when the temperature is over 28 degrees C. Thus the workers are not necessary to enter the house except in case of emergency. This computer system saves work force also prevents occurring infections at same time.

The convention of the house structure and 24 hour computer controlling system protect chickens from infections and adjust their growth at the speed.

3.4. Organization

CPF integrates broiler production stages form “upstream” to “downstream.” The “upstream” stage is parent chicken production, egg production, artificial hatching, and chicken feeding.⁸⁾ The company also involves independent farmers by contract framing. The company promotes competition of the farmers to choose well skilled farmers as its processing input suppliers. Moreover, the company keeps relational production sectors such as animal feed, animal medicine, feeding equipment, feeding technique, and fund. The company offers these resources to farmers who do not have equipment, experiences, and/or capital to start feeding.

The “midstream” stage is slaughter and meat processing. CPF built a new plant in Nakhon Rachashima in 2005. This plant produces 86,400 tons of processed chicken meat and 40,500 tons of chicken sausages per year. In contrast, Betagro Group's new plant built in 2007 produces 9,600 tons of processed chicken meat per year.⁹⁾ Betagro Group is second largest chicken meat producer in Thailand. The difference between CPF's plant and Beta-

gro Group's one is nine times only in processed chicken meat. This gap describes CPF's production scale. This CPF's plant has upstream and midstream production stages at a same area such as an "Industrial Complex."¹⁰⁾ The company also has two more Industrial Complexes in Thailand. Each of three complexes produces specific chicken products mainly for domestic market, export to EU, and export to other countries, respectively.

The "downstream" stage is retail. CPF has a supermarket chain, a convenience store chain, and outlet stores for retail. The company also keeps wide selling channels in domestic by wholesale to large supermarket chains. Moreover, the company is highly-motivated to extend selling channels through the foreign direct investment (FDI). For example, CPF's target in 2010 is expansion its overseas operations by FDI in 9 countries such as Turkey, Malaysia, India, China, Russian Federation, Lao People's Democratic Republic, Taiwan, UK, and Philippines.¹¹⁾ Thus the company's selling channels will spread to overseas.

As growth of CPF's production scale, the organization has been larger and more complicated. At the beginning of start-up broiler production, the company produced chicken meat by direct feeding. However, in the direct feeding, a producer has to have all of the production goods. Therefore the cost and risk increases with expansion of production scale. For this reason, the company introduced contract feeding to obtain live chickens as a production input for its processing sector. The company avoids wholly owned production and increases its production scale by contract feeding. The result of this change, the company owned 225 subsidiaries and grew as a large conglomerate in 16 years from the beginning of broiler production.¹²⁾ On the other hand, contract feeding tends to lead sloppy management at farm level. In fact, this caused the nitro furan antimicrobial problem in 2002. Because of this kind of management problems, the company built the Industrial Complex in Nakorn Rachashima.

This Complex has recent facilities by satellite communications technology. This system isolates chickens from workers by remote operations and protects chickens from outside infections.¹³⁾ A worker also can care of 100,000 heads of chicken by this system. In an ordinal contract farm, two workers work for a chicken house of 20,000–22,000 heads of chicken, and this is the limit of farm feeding capacity. Therefore CPF has been changing the production strategy from contract forming to direct feeding, again. However, the cost and risks of direct farming are much higher than contract framing. Thus the company chooses to sell its production facilities and rent them from the owner to continue to production.¹⁴⁾

From these CPF's operations, it can be said that CPF organizes itself to link all of its production stages interdependently. By this organization, the company rationalizes its productivity and flexibility to adapt market conditions and consumers' needs. The company also adjusts itself suitable for top-down management to maintain the flexibility. This is one of the ways to survive market competitions. In other words, to survive market competitions, companies have to find original management strategies that are adequate to the condition of market and the needs of consumers.

4. Native chicken production system : the case of CRC

On the other hand, RDP (Rural Development Project) creates unique organization. RDP is one of the governmental supports for small farmer and organized by CRC (Chiang Mai Research Center). RDP aims to improve agricultural income by introducing chicken feeding to small farmers as a sideline. CRC started RDP in northern areas where are relatively less developed in Thailand in 2008.

Before starting RDP, CRC began to study indigenous chicken species of Thailand. It is thought that there were twelve species of indigenous chickens in Thailand, but all of them vanished by crossbreeding. This crossbreeding brings some problems in rural chicken meat production.

In rural areas, ordinal chicken meat is made from free-range chicken. Free-range chicken is kept mainly for self-sufficiency. However, there is no broiler chicken meat in small villages because the market scales are too small to supply for broiler meat producers. Therefore small farmers produce chicken meat by their free-range chicken and supply it to the local markets by themselves. However, free-range chicken is crossbreed chicken, and there are no rules or regulations for the production. Therefore the meat quality is unstable, and there is no product information. If the meat is made from dead or sick chicken, there are no prevention rules or regulations for the circulation.

From this reason, CRC decided to use pure breed chicken species for RDP. CRC started to find indigenous northern chicken in 2002 and restored four pure breed chickens by 2007. Only these pure breed indigenous chicken species are called “native chicken” in this paper. In RDP, one of the native chickens “Prado Hang Dum Chiang Mai Nung (PDCM1)” is used. RDP is characterized by this native chicken's bloodline, production system, certification system, and transaction prices.

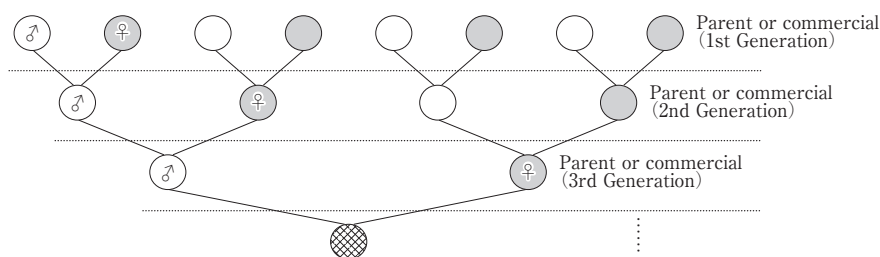
4.1. The difference and similarity between broiler and native chicken in bloodline

Producing broiler commercial chick, it is needed to keep three generations of the parents and one more previous parent called “elite stock” to get the first generation (see figure 3.1). Thus the chick production or bloodline improvement needs enormous cost and very long time. As the result, a few breeding companies dominate the market and major broiler producers obtain connections with these companies to get the chicks to produce chicken meat exclusively.

On the other hand, native chicken is pure breed and the bloodline is kept as far as pure breed parents have their chicks (see figure 4.1). In other words, keeping native chicken's bloodline keeps the meat quality. In the point of view of quality control, RDP uses native chicken PDCM1 because it is not only northern indigenous species, but also considered that the meat quality is relatively higher among the chicken species in Thailand.

In RDP, someone who wants to buy the parent chickens easily buys the parent chickens

Figure 4.1. Native chicken's bloodline



Source : Chiang Mai Research Center

because RDP aims to support small famers.¹⁵⁾ That is way there is no limitation for purchasing. Everyone can also easily produce commercial native chickens because of the bloodline. However, some problems occur by the ease of entry into this production.

One of the problems is inbreeding. Excessive inbreeding makes chicken weak. Avoiding this risk, CRC pairs one male chicken to five female chickens and keeps 70 sets of these pairs. These 70 sets includes 350 female chickens, thus 350 bloodlines of pure breed chicks are produced. Each chick is put a small tag that shows the birthday, number of the blood-line, and serial number and sold to farmers avoiding mingle with same or near bloodline chicks.

Another problem is crossbreeding with other species. Meat quality of native chicken is kept by pure breed bloodline. Therefore if the bloodline is changed by crossbreeding, the meat quality is also changed. Both of broiler and native chicken production, bloodline management is one of the most important things for quality control. Preventing this problem, broiler breeding companies set artificial breeding procedures and strictly manage these processes by total quality control systems. In RDP, on the other hand, CRC sets original production system and certification system to prevent this problem.

4.2. Native chicken production system

In RDP, CRC sets original production system to introduce chicken feeding to small famers easier. The system also produces higher meat quality than broiler. The production system consists of two different types of producers such as “a farm style producer” and “farmer style producers.” The farm style producer is mainly produce parent chickens as a full-time breeder, and farmer style producer is mainly produce commercial chickens as a sideline (see figure 4.2). There are five farm style producers and 57 farmer style producers in December 2009.

The farm style production method produces chicks by artificial insemination and incubation. When the chicks turn 21 days old, they are feed in an open chicken house. The house doors are opened in the daytime and the chicks can freely come and go. The doors are locked at nighttime to protect the chicks from predators. The chicks grow to chickens and female chickens lay eggs by 190 days old. The farm style producer chooses some chickens

as parent chickens at this time. The parent chickens are fed in small cages and gave artificial insemination once a week. The parent chickens are replaced by new one almost every 12 months to prevent excessive laying.¹⁶⁾ However, in this production method, culled chickens are sold as same as other chickens rather than processed for meat.

The farmer style method produces chicks by natural insemination and incubation. This method saves labor force because the chickens reproduce themselves. CRC sets this method based on extensive feeding because extensive feeding is familiar with small farmers. Therefore this method makes introduction of the native chicken production easier to the farmers. In fact, extensive feeding is still popular and many small farmers keep their chicken by extensive feeding in rural areas. This is free-range chickens. However, farmer style production method is not exactly same with extensive feeding. In farmer style production, the producer has to follow the rules set by CRC (these are mentioned late section).

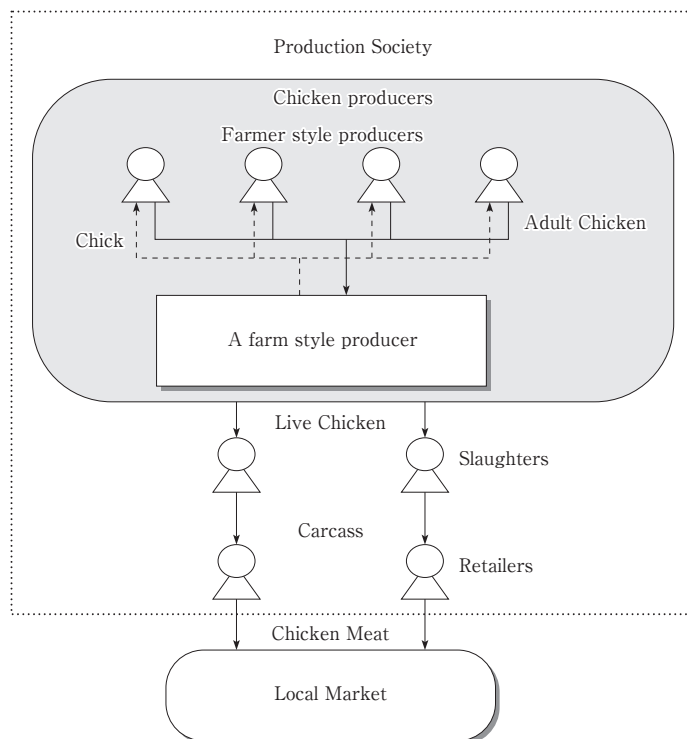
When the chicken reproduced itself enough, the producer decides chickens for sell. At this moment, there is no sales contract between farmer style producers and farm style producers in RDP. Thus farmer style producers can sell their chicken anywhere they want. However, almost all the farmer style producers choose to sell the chicken to farm style producers in tree reasons.

The first is low productivity of the farmer style production method. The main purpose of RDP is to improve small farmers' incomes by sideline. Therefore farmer style production method is necessary for easier introduction of native chicken production and for better chicken meat production. For this reason, the farmer style production method is based on extensive feeding method. Thus this method has low productivity because it concentrates more on saving labor force and increasing meat quality at same time. Actually, in farmer style production, the yearly chicken reproduce number is only 24 heads.¹⁷⁾ Therefore this method is impossible to supply large-scale consumers or retail stores continuously. If farmer style producers want to sell their chicken by themselves, they must create original selling channels.

The second is existing free-range chicken meat market. The "free-range chicken" means the chicken that is raised by extensive feeding method. In rural areas of Thailand, many farmers still sell their free-range chicken as fresh meat by themselves. The farmer style producers also can sell their chicken as same as free-range chicken producers. However, initial cost of native chicken production for farmer style production is 1500 baht. It is needed that two sets of parent chickens that include a male chicken (150 baht/head) and five female chickens (120 baht/head). On the other hand, initial cost of free-range chicken production is almost free because the chicken is crossbreed and reproduces itself. Thus farmer style producers do not start native chicken production if they do not care about bloodline. In addition, when farmer style producers choose independent production, they must have a slaughter house and retailers or must to do these works by themselves. It is risky and too heavy to run as a sideline.

The last is selling channel of the farm style producers. The farm style producers keep relationships not only with the farmers but also with slaughters and retailers as a produc-

Figure 4.2. Native Chicken Production Society



Source : Chiang Mai Research Center

tion society. Therefore when a farmer style producer chooses to sell their chicken to a farm style producer, the farmer does not need to have other stages of the production and can concentrate chicken feeding.

Thus the farmer style producers depend on selling channels of the farm style producers and the other members of the society depend on the scale economy of the farmer style producers. This interdependence gathers each producer together.

4.3. Production control and certification system

However, when a farmer style producer sells his or her chicken to a farm style producer, he or she has to follow production control rules. CRC sets three types of the rules to organize RDP. The first is related to keeping bloodline such as no feeding other species in a same chicken house, surrounding the yard by fence, and some other rules to prevent crossbreeding. The second is related to keep and increase meat quality such as using open chicken house to keep inside clean, release chicken outside of the house in daytime, and some other rules to raise healthy chicken. The third is related to the producers' morals such as isolating sick chickens, keeping dead chicken for the inspection by CRC, taking observation record, and some other rules to prevent selling chickens with sanitation problems.

A farm style producer always checks and controls the other members of the society.

When the organization of the society well developed, CRC gives native chicken certification to the society and registers the society as “a certified farm.”

The certified farm is given a registration number, allowed to use the certification label issued by CRC, and obligated to show the producer and the product information such as the name of the production society, pure breed native chicken or not, the date of the meat processing, the weight, and the price. In case of free-range chicken meat, there is no production information, therefore the consumers never know about the meat information. However, in case of this certification system, production societies disclose production information and Thai government guarantees the meat quality. Thus this system increases consumers' feeling of safety for the meat, and this effect motivates producers to create production societies and promotes their cooperation.

4.4. Transaction prices in native chicken production societies

In RDP, CRC sets transaction prices to allocate incomes and risks fairly among native chicken production societies. At first, a person who wants to start-up native chicken production will buy parent chickens from a farm style producer. The price of start-up sets (the minimum is two sets for start-up) are 1,500 baht as mentioned above. When the person produces commercial chickens following the rules of RDP, he or she can become a part of a native chicken production society as a farmer style producer. In a society, a farm style producer buys commercial chickens from farmer style producers, and the price is fixed on 70 baht per head. According to CRC' record, average of yearly egg laying number is 35, and 24 of them become chicks, and 18 heads of them grow to adult chicken. Thus the yearly income per female chicken is around 1,000-1,500 baht. The start-up sets include 10 heads of female chicken therefore the total income per year is around 10,000-15,000.

A farm style producer sells 100 heads of adult chicken per slaughter once a week, and the price is fixed on 70 baht per kilogram. Average weight of the chickens, in RDP, is around 1.2 kilogram, thus the income of the farm style producer is 14 baht per head. A farm style producer also produces commercial chickens by him or herself and the production cost per kilogram is 56 baht. Therefore the income per kilogram is 14 baht, and the income per head is 16.8 baht (see Table 4.1).

A slaughter processes live chickens to chicken carcasses following requests from retailers six days a week. The processes are slaughtering, blood draining, feather removing, and body washing. In these processes, weight of live chickens reduces to 88 percent. However, the selling price is fixed on 95 baht per kilogram, thus the income per kilogram is 13.6¹⁸⁾ baht, and the income per head is 16.3¹⁹⁾ baht.

A retailer sells around 20 heads of chicken per day six days a week. The sales amount is drastically changed by special events such as New Year holidays, festivals, and customs from religions. Therefore the retailer decides selling amount depending on situations. The selling price is fixed on 120 baht per kilogram, thus the income per kilogram is 25 baht, and the income per head is 26.4 baht.

Table 4.1. Transaction Prices

Item	Buying price (baht/kg)	Selling price (baht/kg)	Income/kg baht)	Income/head (baht)
Farm	56 ^{*1}	70	14	16.8
Slaughter	70	95	13.6 ^{*2}	16.32 ^{*3}
Retailer	95	120	25	26.4

Source : Chiang Mai Research Center

*1 : Production cost.

*2 : Carcass is 88% of live chicken. $\langle 1\text{kg} \times 0.88 \times 95\text{B} - 1\text{kg} \times 70\text{B} \rangle$ *3 : Average weight of live chicken is 1.2kg. $\langle 1.2\text{kg} \times 0.88 \times 95\text{B} - 1.2\text{kg} \times 70\text{B} \rangle$

The retail price of native chicken meat is fixed as same as the average retail price of free-range chicken meat which is sold at rural farmer's markets because of promoting RDP. The native chicken is considered to have higher quality of meat than not only broiler but also free-range chicken. Thus many consumers probably choose the native chicken meat when the meat and free-range chicken meat are sold for the same prices.

The transaction prices are set by amount of differences between the average price of free-range chicken meat and the production price of farm style producer (that is $120 - 56 = 64$ baht per kilogram). The income of a farm style producer is set a slightly higher than a slaughter because of complication of the production process. The income of a retailer is set much higher than the other producers because of the risk of unsold.

According to Yamamoto (2004), in contract feeding of broiler production, a company and brokers have contract in writing, but the brokers and farmers have only verbal promises. Therefore when the demand decreases, the brokers press lower price or refuses to buy the chickens from the farmers.²⁰⁾ In RDP, on the other hand, CRC fairly keeps the incomes and risks of entire production society by setting transaction prices. Thus the power relationship balances, and risks are dispersion in the society.

5. Conclusions

RDP is an opening up a niche market by a differentiated commodity called pure breed native chicken meat. It is difficult for a small farmer to create a differentiated commodity also to open up a niche market. In this point of view, RDP achieves a certain result because it has created five native chicken production societies and keeping fairness of allocating the incomes and risks by setting transaction prices. In market economy, this kind of fairness is never create therefore this result is a positive aspect of governmental supports. However, RDP has some negative aspects.

RDP is one of the governmental projects, and CRC operates native chicken production societies as an organizer. However, each of the society finally has to organize itself independently. Therefore making independence of the societies will be the next step to develop RDP. For this challenge, keeping fairness among the members of the society will probably

be the biggest problem. For example, CRC now sets transaction prices, but the societies have to set the prices to become independent organizations. However, when someone in a society has pricing power, it probably causes unfairness. For instance, a farm style producer has relationships with many farmer style producers, slaughters, and retailers, also has a selling channel. This means that the farm style producer has advantages for negotiations with any other members of the society. That is why it is difficult to keep fairness among the production society authorizing the society to decide the transaction prices.

Another problem is keeping production and quality control. Four of the societies became citified farms (the last one is under training for the citification), but CRC still visits them for collecting technical data regularly. This visitation prevents the degeneration of morals. However, the number of citified farm will increases, and it will be impossible to visit every citified farm in the future. Thus it is needed to set up self-control systems in each society or observation agencies to substitute for CRC.

From this analysis, it can be safely said that making independence of small farmers and making management systems of sustainable productions are needed to RDP.

Notes

- 1) Suehiro and Nanbara, 1991, p. 82.
- 2) Suehiro and Nanbara, 1991, p. 75.
- 3) Suehiro and Nanbara, 1991, p. 85.
- 4) Retrieved from CPF web site (2010. 10. 12).
- 5) Arbor Acars, 2007, pp.3-4. Male chicken grows 1.6kg in 30 days and female chicken in 32days. In broiler production, there is no male and female selection, therefore the average of 31 days is used in this paper.
- 6) CPF, 2010, p. 14, 18.
- 7) Suehiro and Nanbara, 1991, p. 77.
- 8) CPF buys grandparent chickens to obtain parent chickens from Arbor Acars (CPF, 2010, p. 16).
- 9) Yoshimura, Sasaki, 2010.
- 10) According to Yoshimura (and Sasaki, 2010), this Industrial Complex includes 1 feed mile, 12 parent stock breeding plants, 1 hatching plant, 30 feeding farms, 1 slaughter house, 1 chicken meat processing plant and 1 chicken sausage processing plant.
- 11) CPF, 2010, p. 6.
- 12) Suehiro, Nanbara, 1991, p. 78.
- 13) Yoshimura, Sasaki, 2010.
- 14) Yoshimura, Sasaki, 2010.
- 15) In RDP, the words "parent chicken" and "commercial chicken" is different from broiler production. The native chicken, PDCM1, is pure breed, thus there is no difference between parent chicken and commercial chicken. In RDP, when use PDCM1 to get chick, it is called "parent chicken" and when use it to get meat, it is called "commercial chicken."
- 16) According to CRC's records, average egg laying per year is 135 and 55 % of the eggs become chicks in farm style production.
- 17) According to CRC's records, average egg laying per year is 35 and 70% of the eggs become

chicks in farmer style production.

- 18) The calculation is $\langle 1\text{kg} \times 0.88 \times 95\text{B} - 1\text{kg} \times 70\text{B} \rangle$.
- 19) The calculation is $\langle 1.2\text{kg} \times 0.88 \times 95\text{B} - 1.2\text{kg} \times 70\text{B} \rangle$.
- 20) Yamamoto, 2004, p. 66.

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- Centaco Group, (<http://www.centaco.com>).
- CPF, (<http://www.cpfworldwide.com>).
- GFPT, (<http://www.gfpt.co.th>).
- Saha Farms, (<http://www.sahafarms.com>).