# Chapter 1

# OVERVIEW, RESULTS AND CONCLUSION

FUMIHIRO KANEKO

## 1.1 INTRODUCTION

In this chapter, the development of the research project is outlined, results of the research are explained and a conclusion derived from those results is stated. The title of the project is "Socioeconomic Relations in Indonesian Agricultural Society on Technological Innovation and Research and Development - Toward Making a Norm and a Governance of a Society Compatible with an Economic Rationality -". The objective of the project is to expose the way how a norm and a governance of a rural agricultural community affects positively on the behavior of its members in pursuing their economic interest to improve their economic welfare through a technological innovation and a research and development. The project was started with five members in April 2014. Two graduate students took a leading role and engaged in surveys of numerical and/or descriptive data, a simulation of a business model, field studies in South Sulawesi of Indonesia and theoretical analysis. A student finds that the paddy rice production in uplands may become non-commercial after the market system is introduced there, and the incentive of farmers to continue it under such a circumstance comes from a strong motivation to preserve the traditional economic value of their real or intangible assets. Such a value has been formed in a close relation to the informal sector of the economic institution, in which trades of goods and services are made by agreements without a common knowledge of a formal rule. Therefore a new technology in paddy rice production can be adopted by farmers in such a circumstance only if it improves the traditional value of their assets in relation to the informal sector without discrediting a role of the traditional method of production as an insurance. Another student finds that an installment of a palm oil plantation integrated with research and development (R&D) and manufacturing of Polyhydroxyalkanoates (PHA) to a rural agricultural area can be feasible if a strong non-coercive peer effect is created by a local community in an interaction with its members through a community signal. For an installment to be successful, agricultural activities in the area should not be doing very well and the marginal utilities of income for farmers should be sufficiently high. However, sustaining the business requires a significant break-through by R&D in both a reduction of production cost and an introduction of various new commercial products made of PHA, so that a palm oil plantation firm must maintain a sufficiently high level of average efforts by R&D workers. A norm and a governance of a community affect greatly on how to determine a traditional value on assets owned by farmers and how a community signal works for creating a peer effect. Hence it is concluded that a good norm and/or a good governance of a community are prerequisites for both an adoption of a new technology in paddy rice production and a success of a palm oil plantation business that is integrated with R&D and manufacturing of PHA at the same site.

This chapter is organized as follows. A summary of the contents of this chapter is described in the section 1.1. The objective of research and the flow of tasks for this project is described in the section 1.2. In the section , the methods used in this research and the chronological development of the research are described in detail and an assessment on the methodology invented in this project is given. The methods and the development of research for the sub-project on an adoption of new technologies by paddy rice farmers are described in the section 1.3.1, while those for the sub-project on a feasibility of an agribusiness with R&D in a rural area are described in the section 1.3.2. The common methodology used in both sub-projects and an assessment on it are in the section 1.4. In the section 1.5, the results of each sub-project are described in detail. The conclusion of this research is given in the section 1.6.

# 1.2 THE OBJECTIVE AND THE FLOW OF THE RE-SEARCH

The objective of this research project is to examine a role of a community on coordinating the actions of its members who pursue their economic interest under the circumstance that either a new technology for an agricultural production is made available or an opportunity to engage in a research and development activity is brought by an agribusiness firm. A hypothesis is made that a norm and/or a governance of a community in a rural agricultural area, which is considered to be an obstacle to a so-called "modernization "in the development economics, can affect positively on the economic behavior of its members in improving their economic welfare through taking such opportunities. The idea comes from an intuition that a traditional value respected by farmers in a rural agricultural community is a result of their constant efforts to improve their technology for agricultural production, hence is made of entrepreneurship. It is unlikely that this entrepreneurship has been related to a commercial production in the market system, but its spirit may be adapted to a change of economic system surrounding them. The hypothesis is checked by a series of simulation, field studies and theoretical analysis. Due to the interests of graduate students among members of the project, two cases related to rural areas of South Sulawesi in Indonesia are studied extensively as mutually independent sub-projects.

One is an adoption of new technologies for a paddy rice production at uplands of South Sulawesi. It is well known that farmers there are very reluctant to adopt new technologies for paddy rice production. A survey on literature reveals 1) a standard argument for the reason in development economics is that farmers are short of capital to implement them, 2) a standard argument for that in socioeconomics is that farmers fail to achieve a coordination which is necessary to implement them, due to an insufficient and asymmetric information. A field study in this sub-project, with interviews on farmers at uplands of South Sulawesi, shows that none of them is significant in farmers' decision making, and that the technologies offered by their developers and the government are out of points in farmers' current management strategies for agricultural production. Following this result, decision theoretic models of a farmer with different focal economic sectors in an economic institution exposes the findings theoretically, which gives some theoretical background for them.

The other is a feasibility of installing a palm oil plantation that integrates R&D and manufacturing of Polyhydroxyalkanoates (PHA) at one location in a rural agricultural area of South Sulawesi. PHA is a class of plastics produced by a fermentation without any chemical use, as such it is fully biodegradable and biocompatible. A survey on literatures reveals that two major obstacles for a commercial production of PHA are 1) a hight cost for carbon sources used in the fermentation process to produce PHA, 2) a lack of a variety in commercial products made of PHA which have high added values. Palm oil products are produced at a cheap cost and are very efficient as carbon sources in the production of PHA. By integrating a palm oil plantation with R&D and manufacturing of PHA at a site, the cost for carbon sources in a production and R&D of PHA is minimized. Even if R&D for PHA does not achieve a desired level of cost reduction and/or introduction of new commercial products, a vast variety of commercial applications of palm oil products are already available for both edible and non-edible use in oleo-chemical industries, so that the business can be salvaged even in the case of a bad luck. In this sub-project, at first, a hypothetical business model for a standardized operation is constructed and evaluated for its feasibility under a reasonable uncertainty in CPO and PHA prices. The result shows that the business can be feasible but requires a significant break-through in R&D to avoid getting out of business. A high level of efforts on R&D must be sustained constantly for a possible success of R&D. It is hypothesized that a force to achieve it is a combination of diligence and cooperation brought by a strong peer effect in a rural community. A field study in this sub-project tests this hypothesis through a community symposium and interviews afterward in a village of South Sulawesi suitably located for installing the business. As a result, the hypothesis is rejected. The descriptive data so obtained suggests that a peer effect in the village is created by a coercion from the

old generation, hence a non-coercive peer effect may not contradict the hypothesis. To examine this point, a theoretical model of interaction among a firm, a local community and farmer groups in the community is constructed and its equilibrium is analyzed. In this model, the community signals publicly to each farmer group the level of efforts for R&D taken by other farmer groups, and each farmer group decides its optimal level effort for R&D given the signal from the community. The result shows that the interaction can be organized so that the relevant information for installing the R&D division to the area of a community is shared by both the firm and the local community through an identification of the local community with the firm, and that either the firm can guarantee the average level of efforts for a smooth operation of R&D by controlling its wage payment scheme or the firm comes to know that the installment of R&D is budget infeasible.

# 1.3 THE METHODS AND THE DEVELOPMENT OF THE PROJECT

The theme of the research is to prove that a norm and/or a governance of a local community in a rural area have a positive role in an enhancement of innovation thorough an adoption of a new technology for agriculture and an engagement on research and development activities for agribusiness. It consists of two separate sub-themes, each of which is extensively studied by a graduate student. One of them is to identify the socioeconomic reason why farmers in the uplands of South Sulawesi are reluctant to adopt new technologies promoted by their developers and the government. Mangilep Muhammad Agung Ady has taken charge of this line of research. The other is to assess a feasibility of installing a palm oil plantation integrated with R&D and manufacturing of PHA. Fitriwati has taken charge of this line of research.

The project was started with 5 members. Their identities and roles in the project are as follows.

#### Fumihiro Kaneko Ph.D.

Associate Professor of Economics, Faculties of Law, Politics and Economics, Chiba University,

Director and Organizer of the Project, Direction of Simulation, Field Study in the Chiba Prefecture of Japan, Building and Analysis of Theoretical Models.

#### Hikaru Ishido Ph.D.

Professor of Economics, Faculties of Law, Politics and Economics, Chiba University, Assistant Supervisor for Directing Research.

#### Rie Ono Ph.D.

Associate Professor of Economics, Faculties of Law, Politics and Economics, Chiba University,

Assistant Supervisor for Directing Research.

#### Fitriwati M.A.

Graduate Student in the Ph.D. Program for Social Sciences, Graduate School of Humanities and Social Sciences, Chiba University,

Survey, Simulation, Field Study, Construction and Analysis of a Theoretical Model for the Sub-theme Related to Research and Development.

#### Mangilep Muhammad Agung Ady M.A.

Graduate Student in the Ph.D. Program for Social Sciences, Graduate School of Humanities and Social Sciences, Chiba University,

Survey, Field Study, Construction and Analysis of a Theoretical Model for the Subtheme Related to Adoption of New Technologies.

In the following, the methods and the development of this project is explained for each line of research with a different sub-theme, then the common methodology for them is explained and assessed.

# 1.3.1 THE METHODS AND THE DEVELOPMENT OF THE SUB-PROJECT ON ADOPTION OF NEW TECHNOLOGIES IN A PADDY RICE PRODUCTION

For the sub-project about an adoption of new technologies for paddy rice production in uplands of South Sulawesi, at first, Mangilep surveyed literatures extensively from April 2014 and September 2014. The survey was to list up new technologies that could be implemented at uplands and to identify major explanations by economists for the reason why many farmers in Indonesia had been reluctant to adopt new technologies for paddy rice production though doing so was advocated to increase their income. First, he found a variety of technologies such as a genetic control of production, a planned control of weeds and soil fertility, an integration in farming and crop management, a method of intensification in planting and a mechanization with small equipments. He then sought to identify a standard explanation in development economics and that in sociological economics. The findings of this survey is elaborated in Mangilep (2015b). In short, he finds that the standard explanation in development economics is a shortage of capital for farmers due to a limited access to loans from financial institutions, and that in sociological economics is an insufficient and asymmetric information on new technologies for farmers. In relation to both explanations, a role of middlemen who are a seed producer and/or seller, a grain trader, a rice mill owner and a private loaner is emphasized in controlling financial needs of paddy rice farmers and information on new technologies such as new varieties of rice and new equipments.

To check the reality of these explanations, a comparative study on a motivation to adopt new technologies for paddy rice production between the Chiba prefecture in Japan and the uplands of South Sulawesi in Indonesia was planned. In this plan, Kaneko collects a descriptive data about an adoption of new technologies by farmers in the Chiba prefecture, then Mangilep builds several theoretical models to rationalize the findings in the data, whose validity is checked by the descriptive data about an adoption of new technologies by farmers collected by Mangilep in South Sulawesi. To collect meaningful descriptive data, field studies in both the Chiba prefecture and South Sulawesi were planned.

From October 2014 to February 2015, Kaneko performed a field study on that theme in the Chiba prefecture. The method was a free-style interview in which an interviewed farmer took an initiative in the conversation and talked freely about the topic he chose from the list of six topics prepared by Kaneko in a sheet. These topics are 1) an experience of a significant change in the production method of paddy rice, with focuses on the social and economic environment surrounding the farm before it was done, the expectation on the influence of the change on the management of the farm at that time, the information about the nature of the new method or technology to be implemented before it was done, the way how the change was carried out, the result of the change and the assessment of it on the expectation held before the change etc., 2) deciding factors in motivating a change in the production method and the way how the consciousness and feeling about the change was evolved, 3) physical and/or financial aids for the change of the production method such as a supply of labors and/or equipments and special loans or grants, with focuses on the way how they were made available and the assessment of their usefulness, 4) the experience of engaging in activities which aim to improve the technology for paddy rice production, directly or indirectly, with focuses on the way how they were made available, the reason why the farmer has decided to participate in them, and the assessment of its usefulness, 5) the way how the motivation to continue an agricultural production is maintained and the way how it is related to an attitude toward adopting new technologies, with focuses on the consciousness and feelings for them, 6) the expectation to change a production method and/or to introduce a new production method in the future and the way how it is rationalized under the current state of the management of the farm and the information about the change and/or the new method, or the reason why such an expectation cannot be rationalized under the current circumstance surrounding the farm. After contacting the farmer in person by phone and obtaining an acceptance of getting interviewed, Kaneko sent a package of documents for the field study by mail, and by fax on the request by the farmer. The package included a letter to introduce Kaneko, a letter to introduce Mangilep, a guidance for the interview, the sheet of topics and the prescribed sheet for external attributes of the interviewed farmer. It had been sent to the Farmer at least a week before the interviews was taken place. Each interview started with filling in a sheet, prescribed by Kaneko, about external attributes of the interviewed farmer. Specifically, this sheet asks the scale of the paddy rice production, that of the entire agricultural production, the size of the firm, the ratio of income from the agricultural production to the entire income, the style of a farm management, varieties of agricultural products that are currently produced and the ratio of income from the paddy rice production to the income from the entire agricultural production. Kaneko promised in the guidance for the interview that the information obtained in the sheet would be used only to characterize the interviewed

farmer and never been used to reveal his identity. After that was over, the interview proceeded into a free talk on the topic chosen by the farmer. Kaneko conducted all of interviews and Mangilep sat with Kaneko quietly in most of them except two. Mangilep was not available for those two interviews because of his injury.

The interviewed farmers were sampled by the snow-balling method with five independent routes. One of them involved eight farmers with two sub-routes. It started from the largest-scale paddy rice farmer in the northern part of Chiba prefecture, then picked up a fellow young farmer in the same area who had accepted foreign workers from the Eastern South Asia, then a farmer in the Tokyo Bay side of the middle part of the prefecture whose income comes mainly from the production of a vegetable on paddy rice fields in autumn and winter. The route was separated into two sub-routes there. One of them involved three farmers in the South of the prefecture. Two of them lived close to each other in the same area, one of whom had produced a variety of rices which have high industrial demands, and vegetables on paddy rice fields in winter. The other had cut back the variety of agricultural products and concentrated on a production of the most popular variety of paddy rice. These two were interviewed at the same time. Another farmer among them lived also in the same area but had sifted his main production to that of fertile eggs. The other sub-route involved two farmers in the Tokyo Bay side of the middle part of the prefecture, one of whom had a management similar to the one who had introduced him and was a main adviser of the regional farmers' COOP. The other produced a paddy rice on a traditional fields without a significant land improvement from the Edo era and combined it with a dairy farming. Except for the last farmers in each of the sub-routes, everyone in this route sought aggressively an expansion of fields through a land accumulation and its improvement by civil engineering. One of the other routes started from the largest-scale farmer in the Pacific Ocean side of the middle part of the prefecture who had produced a renowned premier rice of the prefecture, and picked up a young farmer in the same region who once cooperated closely with the regional government to introduce a variety of rice particular to the prefecture. Yet one of the other routes started from a young farmer in the center of the prefecture who had been involved in the management of a rice center, then picked up two farmers in an area of the southern part of the prefecture, one of whom had produced a prize-winning rice with a true traditional method of a century ago but had also produced a fruit and a mushroom to support the income. The other was a young farmer who had suddenly inherited a large farm in an isolated area and managed a large-scale production of paddy rice with scattered landholdings. Yet one of the other routes started from a young farmer in the north-east of the prefecture who was the most advanced among young farmers in civil engineering of fields, then picked up a large-scale farmer who produced paddy rice on the largest-size paddy rice field in the prefecture with an advanced underground pipeline system for irrigation and drainage, and a farmer in the same region who had not been born in the family of a farmer but had made his wish to become a farmer come true in the age 30s and had been successful in producing paddy rice in a traditional no-chemical method. Yet another route involves only one farmer who

had been renowned to be the most skilled among paddy rice farmers in the prefecture and had many innovative ideas in cutting the production cost.

Hence total seventeen farmers were interviewed. Interviews were taken independently for each farmer except for two in the South of the Chiba prefecture. For the interview of these two farmers, Kaneko contacted only one of them, who invited another to the interview by his own decision.

On the permission by the interviewed farmer, each interview was recorded by a voice recorder. Then all recorded conversations were written down on notebooks precisely by Kaneko. To inform the contents to Mangilep, then, Kaneko wrote a report about the contents of the interview in English and this report was shared by Mangilep and Kaneko. This procedure was repeated for each of seventeen interviews. In the guidance for an interview, Kaneko promised to each interviewed farmer that the contents of the interview would be shared only by Kaneko and Mangilep, with the latter informed by the former only through briefings about them written in English. Kaneko has managed the data strictly so that it is never been obtained by anyone except Kaneko himself. In one of the interview, the memory of the voice recorder was used up so that its contents in the last 10 to 15 minuets were recovered by the memory of Kaneko. Kaneko promised that the interviews would take for 30 to 60 minuets, but most of interviews took more than 90 minuets and majority of them took more than 3 hours.

A characterization of the data up to the first 13 interviews is explained in Mangilep (2015a), but the paper lacks critically an assessment of the findings in the survey. According to the data, there has been no shortage of capital for implementing new technologies. Some farmers finds a difficulty to obtain a timely information for subsidies and incentives offered by the government, but most farmers manage to get the information adequately and is able to use them strategically. Yet there are farmers who refuse to produce new varieties of paddy rice invented by the prefecture and to invest on an advanced machine and a large-scale civil engineering. Hence two explanations in the survey do not explain the reluctance for implementing new technologies by some farmers in the Chiba prefecture of Japan.

The analysis of the data reveals that a farmer makes a strategic decision on the adoption of new technologies on the ground that he needs to maintain the income of his farm enough to continue its agricultural production. Based on this observation, Mangilep tried to theorize findings of the data in several possible ways, from April 2015 to September 2015. However, all attempts by Mangilep to do so failed and no theoretical models to be subjects of an empirical test in the next field study in South Sulawesi was developed by Mangilep. Hence the purpose of the field study in South Sulawesi was modified just to obtain the descriptive data comparable with that obtained by Kaneko in the Chiba prefecture, postponing a comparison to be followed after all field studies were completed.

From October 2015 to December 2015, Mangilep prepared for his field study at uplands of South Sulawesi by making up a questionnaire for interviews and contacting colleagues in Hasanuddin University on arranging interviews. From December 2015 to February 2015, Mangilep went to the uplands of South Sulawesi and performed his field study. Specifically, he went to the Enrekang regency, the North Toraja regency and the Tana Toraja regency, and took interviews of total seventeen farmers. The methods of the study, the characterization and the analysis of the obtained descriptive data are summarized in Mangilep (2016a) and are incompletely elaborated in the section 3.3 of Mangilep (2016b). In them, Mangilep claims that he has followed strictly the methods used by Kaneko in his field study in the Chiba prefecture, though evidences are currently not sufficient to confirm the claim. Mangilep asserts in them that the main findings are 1) in all regencies, farmers find no commercial value for a paddy rice production compared with the production of other commercial agricultural products, 2) in the Enrekang regency, farmers maintain a paddy rice production as a subordinate technology to the production of red onions, which have a much higher commercial value than paddy rices, in order to avoid their bad harvest caused by a consecutive production, 3) in the North Toraja regency and the Tana Toraja regency, a paddy rice production is an intangible but significant part of the family asset, and it is continued by farmers to protect the traditional value of their family asset. In them, Mangilep also finds that there is a peculiar system of the rotating ownership of land for the members of a family in the Enrekang regency. Kaneko suspects the continuation of a paddy rice production in this regency is related more to this system than the production of red onions, but so far Mangilep has not been able to find any such connection. If Kaneko's hypothesis is true, then the continuation of the paddy rice production is related to the informal sector of the economic institution in uplands of South Sulawesi. The informal sector is a system of trading goods and services based on the agreements whose contents are kept to partners of each trade and is not based on any common knowledge of a formal rule. It does not include a trading by a market system, which belongs to the formal sector of the economic institution.

About the comparative study, Mangilep tried to have some result for it in March 2016. What he calls as a comparative study appears In the section 3.4 of Mangilep (2016b). There Mangilep attempts to give a very short and half-arsed comparison of data based on a notion of "modernization", without defining the meaning of this terminology. In reality, the word "modernization" is solely used by the governing body which prioritizes the second and the third industries by characterizing the first industry to be obsolete unless a close connection to the second and/or the third industries is present. Such a comparison disgraces all interviewed farmers, especially those in South Sulawesi, and is completely inadequate since such a comparison is about the governments, not farmers. (It is clear that the government has failed to promote an adoption of new technologies by advocating a modernization of agriculture in South Sulawesi, while it has succeeded in the Chiba prefecture. )The comparative study by Mangilep is still ongoing under a thorough and careful review of all data.

To develop formally the intuition that the continuation of the paddy rice production is related to the informal sector of the economic institution in uplands of South Sulawesi, a expository decision model of a farmer on an adoption of a new technology was proposed by Kaneko. In this model, a farmer has his focal sector which can be either the formal one or the informal one. If it is the formal one, his notion of economic welfare is dominated by the moving average of monetary returns on a commercial production, so that a crop that has less return than others on average is not produced commercially. To make a farmer to adopt a new technology for the production of such a crop, it is required that its commercial production without implementing the new technology must be made to have more return than that of others. On the other hand, if the focal sector of a farmer is the informal one, so-called commercial agricultural products are worthless and the economic welfare of his family is determined solely by the stock of rice and other agricultural products that is related to a traditional value in the region where he lives, which forms an asset with a traditional value. The rice production must be continued in this case since the stock of rice is the most essential part of the asset. A farmer adopts a new technology if his experiment on it for many years gives an empirical distribution of his confidence on its adoption that behaves good enough to decide toward its adoption. The details were worked out by Kaneko and Mangilep from April 2016 to September 2016. Their description is written in the chapter 4 of Mangilep (2016b). However it is full of English errors and bad writings of mathematical expressions. A version on which Kaneko edits throughly is reproduced as the section 2.2 of the chapter 2 in this report.

# 1.3.2 THE METHODS AND THE DEVELOPMENT OF THE SUB-PROJECT ON FEASIBILITY OF PALM OIL PLANTATION IN-TEGRATED WITH R&D AND MANUFACTURING OF POLY-HYDROXYALKANOATES

This line of research was also started with a survey of literatures on the production of Polyhydroxyalkanoates (PHA) by Fitriwati. From April 2014 to September 2015, she surveyed scientific research articles and industrial technical reports on PHA which are related to its commercial production, and the website on a pilot automated plant to produce PHA in Malaysia. The results of the survey are described in the chapter I of Fitriwati (2016a). In summary, they show that a high cost for carbon sources necessary for a fermentation process to produce PHA and a lack of varieties in PHA products with a high added value are major obstacles for its commercial production, and palm oil products are the most efficient carbon sources among vegetable oils and also the cheapest to produce. From these, Fitriwati asserts that, to perform R&D and manufacturing of PHA efficiently, a palm oil plantation should be integrated with R&D and manufacturing of PHA at one location.

To check the feasibility of such an operation, from October 2014 to March 2014, Fitriwati built a hypothetical business model of a palm oil plantation that operates at a site of South Sulawesi and integrates R&D and manufacturing of PHA with it at the same site. The model consists of a plan for evolution of R&D for PHA and a plan for business operation of a plantation and of a production of palm oil products and PHA products. It is just a list of what is to be done in starting up and operating the business for 9 years, which is published as Fitriwati (2015a). Fitriwati began to quantify various aspects of the model toward a simulation on feasibility around March of 2014. The quantification is based on several simple assumptions. A palm oil plantation firm starts to operate in 2018 and continue to operate until 2026. Harvesting of fresh fruit bunches starts at the beginning of the 5th year of the operation, so as the production of palm oil products and PHA products. Crude Palm Oil (CPO) is used for a production of raw edible oil, and Kernel Palm Oil (KPO) and Palm Oil Mill Effluents (POME) are used for R&D and production of PHA. The size of the plantation is assumed to be 10,000ha, and all figures associated with the production, including set-up and operating costs. are drawn from an unidentified industrial source. From April 2015 to September 2015, Fitriwati built a simulation model of the business plan based on her quantification on the production, and simulated for expected Net Present Values (NPV), expected Internal Rate of Returns (IRR) and Values at Risk (VaR) of expected net present values on estimated yearly net revenues. The uncertainty of yearly prices of CPO and PHA was set up as an event tree, with the CPO price follows a binomial tree and PHA price is taxed with a conditional probability 10% only if the CPO price goes up. The initial CPO price at the begigning of 2018 was estimated by the long-term trend of the historical monthly CPO prices. In calculating the long-term trend, an unusula inflation of CPO price was detected from 2007 to 2012. Kaneko and Fitriwatri regarded it as a biofuel buble and Fitriwati eliminated the infalationary effect by repalcing the data with 3-months moving avarages during that period. The size of price-up or price down was estimated as an avarage percentage of ups or downs in the historical CPO price data. The probability of price-up or price-down was estimated as a frequence of ups or downs in the historical data. It is assumed that the R&D for Ph.D is fruiteless in the peiods of operation and no revenue is broght by it. The results of the simulation on NPV and IRR are shown in Fitriwati (2015b), which imply that the feasibility of the business is in a grey zoon. Then Fitriwati brought an idea to introduce a biomass power generation from POME into the buisiness plan, and Kaneko pointed out that it should work as a dummy for a sucess of R&D needed by the firm to sustain the business. From August 2015 to September 2015, Fitriwati made another simulation for NPV and IRR similar to the former one with a change that POME was used as fuels for the power generation. The details are in the chapter II of Fitriwati (2016a). In the simulation, she used an estimation for the amount of power generated from the mill with its capacity 30t/hour by a scientific article in the reference of Fitriwati (2016a). The results of the simulation tell that the buisiness is made feasible due to the largest contribution to the profit from the biomass power generation. In late September of 2016, Fitriwati brought to Kaneko the results of the simulation for yearly VaR at 5% as a part of the section 2.5 of Fitriwati (2016a). They tell that a quite large sum of money is at risk in 2022 and 2023, since the full operation of the business starts in 2022. Since the distribution of NPVs is discrete, the computation of its 5% lower quantile requires a formula, but it is not shown in Fitriwati (2016a). Hence Kaneko has not been able to confirm the results for VaRs.

The results of simulation suggest that a firm must be able to maintain a high average level of effort by lab workers for a smooth operation of R&D. Kaneko and Fitriwati identify that a reliable institutional arrangement that exists in rural agricultural areas and would contribute to that purpose is a peer effect created by a local community for its members. Here a peer effect means a consequence of an automated process with hearsay that makes a private information of a community to be (almost) instantly known by each of its members privately. In October 2015, Fitriwati formed a hypothesis that a strong peer effect would make her business model feasible in a rural area of South Sulawesi which is suitable for a palm oil plantation. To check the validity of the hypothesis, from November 2015 to January 2016, Fitriwati conducted a field study in the Kamiri Village of the Barru District, in South Sulawesi. The method of the field study consisted of a community symposium and follow-up interviews on farmers after that. In the community symposium, a researcher at Hasanuddin University on the scientific development of PHA presented about material properties and a production mechanism of PHA at first, then Fitriwati presented about the business model of a palm oil plantation integrated with R&D and manufacturing of PHA at one location in a rural area. After these presentation, a feasibility to install the business in the area was discussed extensively by participants in three separate consecutive sessions. Total 45 framers in the village, five from each farmer group, participated. All presentations and discussions, including exchanges of questions and answers, were recorded with a voice recorder. After the symposium, follow-up interviews on a feasibility to install the business in the area for five farmers were conducted by Fitriwati and the researcher. Each of these farmers was a representative person of a different farmer group. Either they had not been able to attend the symposium or they had attended one but not expressed any opinion. The method used for the interviews has not been fully revealed by Fitriwati, but she claims that it is a kind of free-talk style. All exchanges between the two and farmers were recorded with a voice recorder. All these records made up the primary descriptive data of this field study. Because of the confidentiality promised to farmers, the data has not been made public.

Fitriwati worked on the characterization and analysis of the data from January 2016 to March 2016. A description on the method of the field study and the characterization and analysis of the data is in Fitriwati (2016b). A detailed description is in the chapter III of Fitriwati (2016a), though it is incomplete and under a significant revision. The analysis shows that the Fitriwati's hypothesis is rejected. Fitriwati suspects that a peer effect in the area is created by a kind of coercion from the old generation to the young generation, which generally affects negatively on morale and entrepreneurship, hence a strong peer effect which is not coercive could be still effective in installing her business model in a rural area. A theoretical justification for this intuition was studied from April 2016 to September 2016. In this period, Kaneko made a proposal to build a model of economic interaction among a firm, a local community and farmer groups where the firm wishes to install an agribusiness in the area of the community by employing locals for R&D, and solve it for an equilibrium. In this model, a firm informs its will to install the

business to both the community and the farmer groups. To both the local community and farmer groups, the firm offers publicly a wage payment scheme for lab works at its R&D division, in which the payment is based on the observed level of efforts for R&D

and is determined by the starting wage as a sole parameter. To the local community, it offers an incentive payment for sharing the information on the average efforts for R&D put by farmer groups. The objective of the firm is to sustain the average of efforts put by lab workers to be the level which guarantees a smooth and efficient operation of R&D. The community and the farmer groups interacts bidirectionally. The community makes a signal to farmer groups that indicates to each farmer group the level of efforts for R&D that the other groups are supposed to put. Fitriwati suggests that there is a status quo level of efforts that can be implemented without any community social cost, and a positive deviation from that level can be seen both positively and negatively by the community. On Kaneko's suggestion, the objective of the community is to optimize the trade-off between the positive side and the negative side based on the community's utility function. Each farmer group can choose a level of efforts for R&D without giving up its agricultural production. An agricultural production needs services of an agricultural infrastructure maintained by the community without a cost. A congestion in its use by farmer groups results in a degradation of services. The technology of agricultural production possessed by each farmer group is know to the other groups, so that a farmer group can calculate the utility on its choice of the level of agricultural activity since the community signal indicates the levels of agricultural activity supposed to be chosen by other groups. The objective of a farmer group is to optimize the trade-off between the utility from its agricultural activity and the utility of monetary income obtained by working for R&D. Once a level of efforts for R&D is chosen by each farmer group, it is reported to the community. Their average becomes the level of status quo for the next round of interaction between the local community and the farmer groups. The interaction continues until a time-limit imposed by some force comes. The firm interacts only with the local community directly. The interaction is bidirectional and takes a form of a bargaining. At first, the firm sets the starting wage in its wage payment scheme to be that corresponding to the level of efforts that guarantees a smooth operation of R&D, and informs its budget size honestly to the community in order to make the community identify itself with the firm later on. The firm offers an incentive payment to the local community for sharing the information on the average level of efforts put by farmer groups and a waiting time for an answer from the community. The community either accepts the offer of incentive payment and informs either the average level of efforts or the profile of the level of efforts put by each farmer group or rejects it before the waiting time expires. The incentive is paid only after the firm observes the efforts for R&D put by the farmer groups, and the firm retains the right to refuse the payment if the average efforts informed by the community is different from its observed level. This arrangement makes the community to inform honestly if it accepts the offer of the incentive payment. On the acceptance, the firm makes an follow-up offer of maximal incentive payment that its budget allows in estimate, with no waiting time.

The community accepts it since it knows the total budget size and the wage payment scheme of the firm, and the contract for payment is finalized between the firm and the community. If the offer is rejected by the community, it indicates that the average level of efforts by farmer groups is below that for a smooth operation of R&D. Then the firm raises the starting wage in the wage payment scheme by a pre-specified rate and initiates the next stage of bargaining. The bargaining ends at the stage where either a contract is finalized or the estimated wage payment exceeds the total budget and the firm give up the installment of the business. The equilibrium of the model therefore makes the business of the kind that Fitiriwati advocates feasible if the firm affords it on its budget.

Details of the model were worked out by Kaneko and Fitriwati from April 2016 to September 2016, and they are described in the chapter IV of Fitriwati (2016a). However, the description is full of English errors and bad writings of mathematical expressions. A version on which Kaneko edits throughly is reproduced as the section 2.3 of the chapter 2 in this report.

## 1.4 THE METHODOLOGY AND ITS ASSESSMENT

In both sub-projects, a common methodology for a theoretical research invented by Kaneko is used. The two graduate students just followed literally the methodology which Kaneko had suggested.

The methodology consists of three parts in the order, neglecting an obvious pre-stage of surveys on literatures. After finding unsolved problems on the subject of the research by surveying literatures, the research is planned to proceed as follows.

- Step 1. An empirical evaluation of published numerical data on the problems and/or a field study to characterize the problems in reality and/or a simulation about an idea to solve problems and/or a theoretical assessment on the problems is conducted to pin down the factors causing problems and to assess a feasibility to solve the problems.
- Step 2. Hypotheses on a solution of problems are formed and their validity is tested by a field study in which qualitative descriptive data relevant for the hypothesis is collected and organized for its characterization, and then analyzed for the test.
- Step 3. If the test confirms the validity of the hypotheses, a theoretical model whose solution embodies them in a unified way is made and solved. If the test fails some or all of the hypotheses, failed hypotheses are replaced by new hypotheses on a solution of the problems which are made by a careful reexamination of the data obtained in the filed study, and a theoretical model whose solution embodies them in a unified way is made and solved.

A significant characteristics of the methodology may be seen as an involvement of field studies in the step 2, but that is just an appearance. The most significant characteristics of this methodology is the building and solving of a theoretical model to embody the viable hypotheses in a unified way. The field studies in the step 2 are made subordinate to the theoretical study in the step 3, hence this methodology is for a theoretical study, not for an empirical study.

In the sub-project on an adoption of new technologies, Mangilep failed to make theoretical models for the assessment on the problems from what he found in the data obtained by Kaneko's field study in the step 1. Hence the hypotheses to be tested by a field study was not formed and the step 2 is modified to a comparative study for two data obtained in the Chiba prefecture and in South Sulawesi by field studies. In the step 3. Mangilep could not come up with a model of interaction to be solved so that the analysis is replaced with a building of expository decision models for a farmer that embodies a roughly formed hypothesis on the role of the informal sector in an economic institution n the farmer's decision. The step 3 was performed under very comprehensive suggestions by Kaneko.

In the sub-project on a feasibility of installing an agribusiness with R&D to a rural area, the step1 was performed by a simulation on Fitriwati's business plan. In the step 2, the test on her hypothesis failed by the field study in South Sulawesi. Hence the hypothesis that a strong peer effect would make an installment of her business model in a rural area feasible was replaced by a new hypothesis that a strong non-coercive peer effect would make an installment of her business model in a rural area feasible.

In both sub-projects, an assessment on the significance of findings in the corresponding field study is not strong. This was the first time to conduct a field study for both graduate students, and a lack of experience made the methods of the field studies to be too loose to have a fully reliable data. In each of the sub-projects, the graduate student could not come up with a satisfactory theoretical analysis. In the sub-project on an adoption of new technologies, the study was done mostly by Kaneko and Mangilep just wrote it down. In the sub-project on a feasibility of installing an agribusiness with R&D to a rural area, Fitiriwati contributed only to the modeling of the local community's behavior and the set-up of a wage payment scheme with a single parameter as the starting wage, and the rest of the study was done by Kaneko.

## 1.5 RESULTS FROM SUB-PROJECTS

In the sub-project on adoption of new technologies by paddy rice farmers, it is revealed that a farmer behaves strategically to sustain the economic welfare of the members of his farm, and the notion of this economic welfare is closely related to the traditional value in the community to which he belongs.

Standard explanations for the reason why the paddy rice farmers in Indonesia are reluctant to adopt new technologies in development economics and sociological economics are rejected plainly by the field study at uplands of South Sulawesi. The field study in the Chiba prefecture actually predicts it. In Japan, the national government has offered a variety of subsidies and tax breaks for " improving " the management of a farm and the technology of agricultural production, the regional government has offered financial aids such as the modernization fund for financial needs to renew equipments and start a civil engineering of fields, and a governmental financial institution called as Japan Finance Corporation (JFC) has offered various loans that are lucrative to farmers. Most farmers interviewed do not concern to put money into an investment for improving the technology, which amounts to some 30 to 50 million yen at once, a relatively large sum for an individually owned business. Yet there are some farmers who have refused to invest as the government promotes, and the reason is that such a style of production does not fit into what they believe to be the best management of their farm. These farmers are among the most successful ones in the prefecture. A flow of information is supported by a newspaper for the agricultural industry and the department for agricultural information in the regional government such as a city hall. The farmers who have refused to follow what the government advocates are among the most informed and skilled, and are respected for that.

The sub-project reveals that farmers take the management of their farms to be very important and are seriously looking for the best decision in it with regard to their concept of economic welfare which, in many ways, is closely related to their traditional lives with fellow farmers in the communities. The decision can be for or against what the government advocates, and that must be obvious from the fact that the government cannot have a comprehensive information about the situation of every farms so that its decision is made on a "standard" case. This case assumes that a paddy rice is produced commercially, and that does not fit into the management of farmers at uplands of South Sulawesi. Farmers who do not adopt new technologies are not those who are under-informed and unskilled. Instead, they are well informed about new technologies and have skills enough to make an income that sustains the economic welfare of the members of their farms at a sufficiently high level. Farmers at uplands of South Sulawesi made a rational decision quite different from that of many farmers in the Chiba prefecture. In the Chiba prefecture, a commercial production of paddy rice make sense in the farmers' optimal decision on the management, while that does not at uplands of South Sulawesi. Farmers at uplands of South Sulawesi have found commercial agricultural products whose monetary returns are much higher than that of paddy rice, by their own efforts on the management of farms. In the Enrekang regency, it is red onion. In both Toraja regencies, they are plantation products such as cloves, cacaos and coffees. In all regions, a breeding of water buffalo brings a large revenue to farmers by selling them in the market. Yet none of them has abandoned nor is willing to abandon the production of paddy rice, which means that it is worth maintaining for reasons other than a commercial purpose.

Though Mangilep has failed to explore in depth, from his oral report on the contents of interviews, the purpose to maintain a paddy rice production in the North Toraja regency and the Tana Toraja regency is to maintain the value of the tangible (agricultural land and houses) and intangible assets (a paddy rice production and a funeral ceremony) owned by the family, where the value is determined by an intra-evaluation of the assets by all members of the family based on a social norm and/or a governance the rural agricultural community. The holding of assets is symbolized as so-called Tongkolan, which is marked by a horn of water buffalo put on the top of the house. Although it is not directly revealed by Mangilep's oral report on the contents of interviews taken in the Enrekang regency, there is an indirect evidence that the purpose in the area is similar to that in the Toraja regencies. Farmers in the Enrekang regency follows a rotated ownership of agricultural land, in which members of a family rotate the right to cultivate the agricultural land owned by the family. Kaneko suggests that this system drives both an incentive to find commercial products with high returns (since the period for the agricultural production is limited for a farmer) and that to maintain the agricultural land properly. The reasoning for the latter is that the management of the agricultural land by a farmer is checked by the member of the family following him. It has been revealed by the interviews in the Chiba prefecture that a strong motivation to continue a paddy rice production comes from that it is believed by many farmers to be the best way to preserve the agricultural land in a good condition, so that the reasoning does not contradict the findings in Kaneko's field study.

It is impossible to figure out whole aspects of a norm and/or a governance of rural areas where Kaneko or Mangilep conducted a field study simply because it is too complex and too specific to each area (only a sketchy nature of them can be observed). Therefore Kaneko and Mangilep restrict a focus on social norm and/or a governance to the relationship of the farmers' management of agricultural production to various economic sectors that makes up an economic institution of an area. The sectors are simplified to be the formal one and the informal one. The former operates trading of goods and services by a common knowledge of formal rules, and Mangilep identifies it as the market system. The latter operates them by agreements among trading partners whose contents are kept to partners and is not based on any common knowledge of a formal rule. Mangilep simplifies it as a combination of a self-consumption of rice and an execution of funeral ceremonies. The expository decision model for each case of the farmer's focal sector is followed by a hypothetical model case for an adaption of new technologies in a paddy rice production. When the focal sector of the farmer is the formal one, it suggest that making the return of the commercial production of paddy rice without implementing the new technologies dominate those of other crops must be a prerequisite for it. If the condition is achieved and a farmer adopts new technologies, he continue to adopt them unless an unforeseen defect in them is found. When the focal sector of the farmer is the informal one, it suggest that the farmer's confidence on new technologies through his own experiments on them with the traditional method used as a benchmark must yield an empirical distribution that is judged to be favorable in the mean-variance trade-off. On the contrary to the former case, this explains only a one-time adoption. Kaenko and Mangilep have not come up with a theoretical model to rationalize an adoption of new technologies for a long period of time, though Kaneko has made a conjecture that new technologies must be absorbed into the traditional method gradually if a farmer continue to adopt them and a successive adoption of them would be justified if the confidence on them with the modified traditional method as a benchmark is lower but

sufficiently close to 1, the full confidence. It must be lower than 1 otherwise the modified traditional method loses the role of a status quo or a benchmark, which would be achieved by a careful but efficient absorption of new technologies into the traditional production method. The conjecture is still open to a scrutiny.

In the sub-project on a feasibility of an agribusiness with R&D to a rural area, it is revealed that a strong non-coercive peer effect created by a local community to its member farmers makes an installment and a successive operation of a palm oil plantation integrated with R&D and manufacturing of PHA to be feasible at least theoretically, though a significant break-through by R&D must be brought to sustain the business according a simulation.

The choice of PHA as the commercial product combined with edible CPO is crucial in the idea. Most R&D for oleo-chemical products require a significant scientific knowledge on chemistry as a prerequisite, so that farmers who are undereducated in schools cannot be qualified. On the other hand, a fermentation used in the production of PHA has a close connection to what farmers observe daily in their agricultural production so that a scientific knowledge on it is far more accessible to farmers than those on others. Currently R&D for PHA is not going very well on business base, and a firm which contemplates to produce PHA commercially from palm oil products must take into account seriously an integration of a palm oil plantation with R&D and manufacturing of PHA at one location, in order to reduce the R&D and production cost of PHA as much as possible. The farmers are supposed to be employed as lab workers to conduct experiments as a research planner directs and produce scientific reports of their results to the research planner. The employment of local farmers for R&D cuts the labor cost significantly for the firm, since bringing qualified workers in urban areas to a remote rural area requires a large payment of benefits for the firm. Fitriwati and Kaneko assume that such a firm can operate R&D smoothly relying on diligence, morale and cooperation of workers with a basic qualification which farmers can manage to acquire.

As Fitriwati's simulation results suggest, the feasibility of such a business is far from a rosy one. The biomass power generation contributes the most to the profit of the firm, and R&D for PHA must bring a comparable profit to the firm without it. A management decision in reality is surely far more sophisticated than what the simulation assumes, and a mixture of a biomass power generation and R&D and manufacturing of PHA would appear. A good thing about the business revealed by Fitriwati's simulation is that the business can be sustained by eliminating R&D and manufacturing of PHA totally so that a firm would not need to take a risk of going out of business, though locals will be detached from R&D in such a circumstance. But it is not an intention of Fitiriwati or Kaneko to make R&D inaccessible to farmers in a rural area, so a way to sustain the firm with R&D and manufacturing of PHA operated must be found. On the assumption that Fitriwati and Kaneko make on the nature of R&D for PHA, their objective can be achieved by keeping the diligence, morale and cooperation among local farmers sufficiently high. Kaneko suggests that an institutional arrangement that is highly likely to exist in a rural agricultural community and is effective for that purpose is a peer effect created by a local community to its member farmers. Though a very strong peer effect may achieve a common knowledge of a private information held by the community among farmers, it is not necessary for the purpose of making the business feasible, and even hazardous. The firm is just an outsider with a technology which the community does not comprehend fully, so an information with full of errors will become a common knowledge, which the firm would not wish since it becomes surely a source of big trouble in its operation of R&D. A highly effective peer effect that makes a private information held by the community on its members that is related to the operation of the firm to become a private information of each farmer or each farmer group is desirable since the community does not need to take a responsibility for transferring an erratic information. The firm does not need to care a trueness of the information in the peer effect as far as it can guarantee a sufficiently high level of diligence, morale and cooperation among lab workers since Fitriwati and Kaneko assume that the effort on and the quality of work by a lab worker is perfectly observable to the firm. A hidden assumption made by Fitriwati and Kaneko is that neither a community nor a farmer is fully rational ex-post, since they do not correct the information they had at the time of decision making after the operation of the firm starts, even if it is wrong.

The results of Fitriwati's field study imply that a mere existence of such a strong peer effect is not enough to make the business feasible in a rural area. Although an assessment on the significance of the field study does not seem to be good, the results suggest that the local community should not be able to force a decision made on its private information to its members, since it causes the same problem as the case that the information becomes a common knowledge. After employing farmers for R&D, the firm would like to make them concentrate on their work at the workplace, and any interference on works caused by a relationship between the local community and local employees must be avoided. Fitriwati characterizes such a nature of a peer effect as coercive, based on her observation that participants in the old generation lead the discussions in the symposium and the younger participants rarely spoke out. Fitriwati finds that, though there are evidences that a strong peer effect exists in the community of the Kamiri village, neither a spirit of entrepreneurship for the business nor a morale for it is found among the young generation.

Hence an assessment on a strong non-coercive peer effect for a feasibility of the business model becomes an issue of a theoretical study about an interaction among a firm, a local community and farmer groups in the presence of an opportunity for farmers to be employed for R&D jobs. There are two properties peculiar to the model of interaction. One is the role of the community signal by which the local community indicates to each farmer group the level of efforts for R&D put by each of other farmer groups. According to Fitiriwati, the optimal choice of the signal by the local community is nothing to do with real R&D works or agricultural activities taken by farmer groups. Fitiriwati models the behavior of the local community so that it concerns only an abstract consequence of interaction among farmer groups if all of them follows the signal, which are captured as a positive side and a negative side of the mechanism creating a peer effect. Kaneko adds the property to the model that the signal is not respected by a farmer group for its decision but respected only as an information about the behavior of the other farmer groups, which makes the peer effect to be non-coercive. Secondly, no criterion to stop the interaction between the community and the farmer groups is proposed by the community or the farmer groups. The interaction is iterated potentially endlessly with the status quo level of efforts that the community believes to be implementable without any social cost being updated by the average level of efforts for R&D chosen by farmer groups in the previous round. The firm calls for the criterion as the waiting time for an answer from the local community on its proposal of incentive payment. Kaneko promotes such a nature since neither the local community nor the farmer group is responsible for the management of the firm. Though the result depends on structural assumptions on the internal rule on the wage determination in the firm and the number of farmer groups, the theoretical study justifies the hypothesis that a strong non-coercive effect makes the business feasible in a rural area. A nature of a peer effect is crucial to the result, which fits to the intuition developed by Fitriwati and Kaneko.

## 1.6 THE CONCLUSION OF THE RESEARCH

The sub-project on an adoption of new technologies by paddy rice farmers concludes that whether a farmer adopts new technologies or not is a matter of his strategic choice in the management of the farm, and the criterion for his decision is dominated by his notion of economic welfare for the members of his farm which is closely related to a traditional sense of value brought up by a social and economic relationship with farmers in the same community. In a rural economic institution, such a social and economic relationship is seen by a role of the informal sector in a farmer's decision on the management of his farm.

The sub-project on feasibility of an agribusiness with R&D in a rural area concludes that a strong non-coercive peer effect created by a local community in the area on its member farmers through a community signal enables a firm to guarantee a level of average efforts for R&D by local employees needed for a smooth operation of R&D, where local farmers can work for R&D without giving up their agricultural production. However, a significant break-through by R&D is needed to sustain the integration of a palm oil plantation with R&D and manufacturing of PHA, since a biomass power generation using POME for fuels can replace the PHA business in a very profitable way.

The informal sector of a rural economic institution is operated loosely on a social norm and/or governance of a rural agricultural community. Such a norm and/or governance is not made of rules that are common knowledge among members of the community. They are publicly known to them but the iteration of knowledge cannot be true indefinitely, which makes a trading to be based on agreements that only partners can comprehend. A traditional sense of value is also greatly affected by a norm and/or governance of the community since it comes from an intra-family assessment on the relationship with other farmers in the same community, though the expository decision model does not reflect it. A mechanism to create a peer effect in a rural community is clearly influenced by a norm and/or a governance of a rural community, as such it varies widely since how much a community puts an importance on the positive side or on the negative side in creating a peer effect is specific to a community and varies widely among communities. This may affect negatively on the firm in securing the average level of efforts for a smooth operation of R&D, but in the the theoretical model of this research a firm can at least secure an optimal level of efforts without the constraint on the use of agricultural infrastructure from each farmer group, so that what it should do is to make the average of them above the level of smooth operation by increasing the starting wage in the wage payment scheme. This is made possible by the structural assumptions imposed on the use of agricultural infrastructure services, which Kaneko does not regard restrictive. Hence an influence of a norm and/or a governance of a community is always favorable to the firm if it helps to realize a strong non-coercive peer effect.

On these consideration, Kaneko, Mangilep and Fitriwati conclude that a good norm and/or a governance of a community is a prerequisite to both an adoption of new technologies and a success of agribusiness with R&D in rural areas. The validity of this conclusion in reality remains to be seen in the so-called development of rural areas in many developing countries.