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Government, policy-making and the development of agricultural innovation system:

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Abstract

This article focuses on the research of RTDI policies (research, technology, development and innovation), and the theme of this article is to link the three indicators together: agricultural RTDI policy-making process---the contents of agricultural RTDI policies---the appropriateness of RTDI policies on agricultural innovation systems. We assume the policy-making process would shape the contents of the agricultural RTDI policies. Once the contents of agricultural RTDI policies are implemented, the RTDI policies would influence, whether appropriate or inappropriate, on the agricultural innovation system. We use the Taiwanese agricultural biotechnology policies as the empirical cases. On the basis of the empirical cases of Taiwan, we find that the consistency and appropriateness of agricultural RTDI policies are shaped by four variables: the unity of the government, horizontal coordination, vertical coordination and the involvement of external stakeholders. The policy-making process indeed shapes the agricultural RTDI policies which further shape the development of agricultural innovation system.

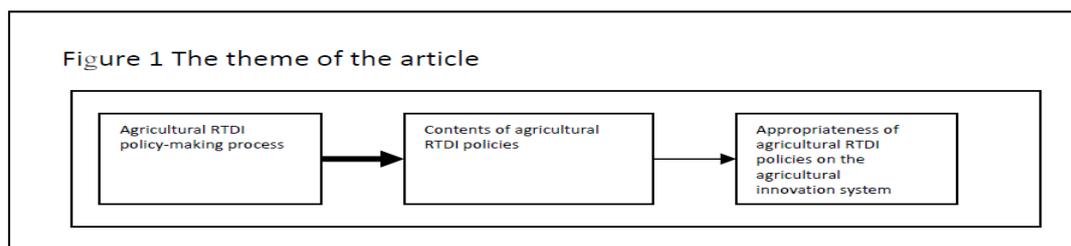
Government, policy-making and the development of agricultural innovation system:
The cases of the Taiwanese agricultural biotechnology policies (2000-2008)

1. Introduction

The sustainable development of agriculture calls for intensive innovation and requires long-term strategic political directions to boost basic science (Harvey and Pilgrim, 2011); yet while some governments promoted effective RTDI (research, technology, development and innovation) policies to appropriately support agricultural innovation, others fail (Wright, 2012). Scholars of agricultural innovation system have pointed out the ideal role which government should play to support agricultural innovation. Hall (2005) argues that the government policies need to take multidimensional approach to develop innovative capacities of the subsystems of agricultural innovation, and Clark (2002) that the government should improve institutions in order to effectively support agricultural research and development (R&D). However, since these scholars only treat policies as given and consider the policy-making process of agricultural RTDI policies as 'black-box', they could not explain the reasons why some government could play the ideal role but others don't. On the other hand, scholars of agricultural governance have recognized the different aspects of the policy process of agricultural RTDI policies. For example, Newell (2009) has described the leverage of business interest groups on the governance of agricultural technology, such as genetic modification (GM). Montpetit (2005) has explained how the network of the administrative agencies inside the government shapes the agricultural RTDI policies of the government. Nevertheless, until now since each scholar only expresses the policy-making of agricultural RTDI policies from particular perspectives, we could only gain limited insights into the whole picture of the agricultural RTDI policy process. Moreover, since the research of agricultural governance has limited linkage to the literature of agricultural innovation system, until now we could gain limited understanding towards the influence of the agricultural policy process on the development of agricultural innovation system.

This article thus searches for an integrated perspective towards the policy-making process of agricultural RTDI policies. On one hand, we tend to portray the whole picture of the policy-making process which shapes the policy contents, in terms of policy objectives and policy instruments, of the agricultural RTDI policies. On the other hand, once promoted we also tend to look at the influence of agricultural RTDI policies on the development of the agricultural innovation. In other words, the theme of the article as shown in Figure 1 is to link the three indicators together: agricultural

RTDI policy-making process—the contents of agricultural RTDI policies—the influence of policies on the agricultural innovation system. Since biotechnology is the core technology used by the agricultural sector, in this article we will focus on the analysis of agricultural biotechnology policies. Besides, biotechnology in this article includes both traditional and modern biotechnology. Modern biotechnology, following the definition of Laage-Hellman et al (2004), refers to the biotechnology developed in the post-genetic engineering era in the 1970s, and traditional biotechnology in this article is defined as the biotechnology innovated before the 1970s. We intend to explore the influence of agricultural biotechnology policy process on the development of agricultural innovation system.



We choose the experiences of Taiwan for empirical studies because the country provides an interesting example which is worth of further exploration. The public research institutes and the public company were the main forces of agricultural innovation, while local private small and medium enterprises (SMEs) played supplementary roles in the innovation of agricultural products. The knowledge base of most companies was biotechnology. Before the 1980s, most companies adopted the traditional biotechnology to develop products, and only after the 1980s the public research institutes, the public company and a small number of private SMEs started to adopt modern biotechnology to carry out the products of GM seeds, genetic modified organism (GMO), bio-fertilizers, and bio-pesticides. During 2000 to 2008, the Taiwanese government promoted lots of policies to support the development of agricultural biotechnology but did not fully achieve the intended policy objectives. In fact all the policies were launched in the conditions that the Taiwanese government was a presidential divided government, the elected politicians and administrators within the government faced serious problem for coordination (Wong, 2005), and policy stakeholders were not fully involved in the policy-making process. Through analyzing the unique policy-making process of the Taiwanese agricultural biotechnology polices, we will deeper understand how such policy process shaped the contents of agricultural biotechnology policies in Taiwan which further influence the development of the Taiwanese agricultural innovation system.

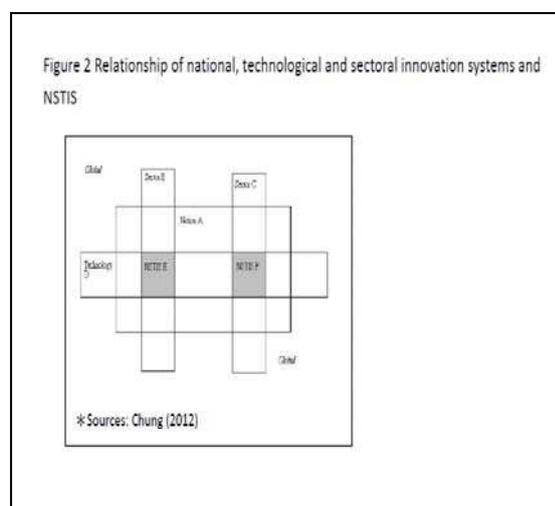
The article is structured as the following. Section 2 establishes the conceptual

framework to analyze the policy-making process of agricultural RTDI policies. Section 3 describes the methodology used to explore the empirical case studies. Among the various agricultural biotechnology policies promoted by the Taiwanese government from 2000 to 2008, we only choose the National Science and Technology Program for Bio agriculture (typically shortened to be the National Program) and the Agro-pesticides Management Act (typically shortened to be the Act) as the two cases. Section 4 analyzes the consistency and appropriateness of the two policies. Section 5 discusses the policy-making process of the two policies through the perspective of our conceptual framework. Section 6 reflects the conceptual framework and the existing literature with the empirical cases. Section 7 concludes the article.

2. The governance of agricultural RTDI policy: a conceptual framework of analysis

The conceptual framework of analysis is comprehensively established upon the literature of RTDI policy process which has an implication for the analysis of agricultural RTDI policies. In the following paragraphs, we will discuss the literature constituting the conceptual framework first and its implications for the agricultural RTDI policies afterwards.

It's the framework of Chung (2013) which makes one of the first attempts to link the RTDI policy process with the development of innovation system. In Chung's framework, innovation system is defined as national, sectoral and technological innovation system (NSTIS) which is the intersection of the national, the sectoral and the technological innovation systems (as shown in Figure 2). Moreover,



government is embedded in the network of governance of NSTIS, and the actors inside and outside the government would interact with each other through the policy-making process. Chung (2013) establishes four independent variables assumed to influence the consistency and appropriateness, the two dependent variables of RTDI policies through the policy-making process. The four independent variables are polity, horizontal coordination, vertical coordination and the involvement of external stakeholders. Each of the independent variables is established upon the literature of political science and RTDI policy studies. Among the independent variables, polity

particularly refers to the presidential divided government where the ruling party of the president is not able to control the majority of the congress. Following the analysis of Chung (2013), the divided government is assumed to be difficult to make consistent and appropriate RTDI policies, while horizontal coordination, vertical coordination and suitable involvement of external stakeholders are assumed to contribute to the consistency and appropriateness of RTDI policies (as shown in Table 1). Furthermore, Chung' framework also divides the policy-making process of RTDI policies into different stages. Since the network of governance change from stage to stage, the main actors of each stage also change. Each of the four independent variables also has different influence on the consistency and appropriateness of RTDI policies in the different stages of policy-making process. Chung's framework has been applied for the analysis of the Taiwanese pharmaceutical biotechnology policies and demonstrated that the policy-making process of pharmaceutical biotechnology policies did influence the development of bio-pharmaceutical innovation system in Taiwan.

Chung's framework is further reflected by the recent research of Cirone and Urpelainen (2013), particularly on the unity of the government which deeply influences the policy process, as well as the effectiveness of RTDI policies. Technology innovation can help the society to solve social problems, and the government plays the role to launch RTDI policies to incentivize technology

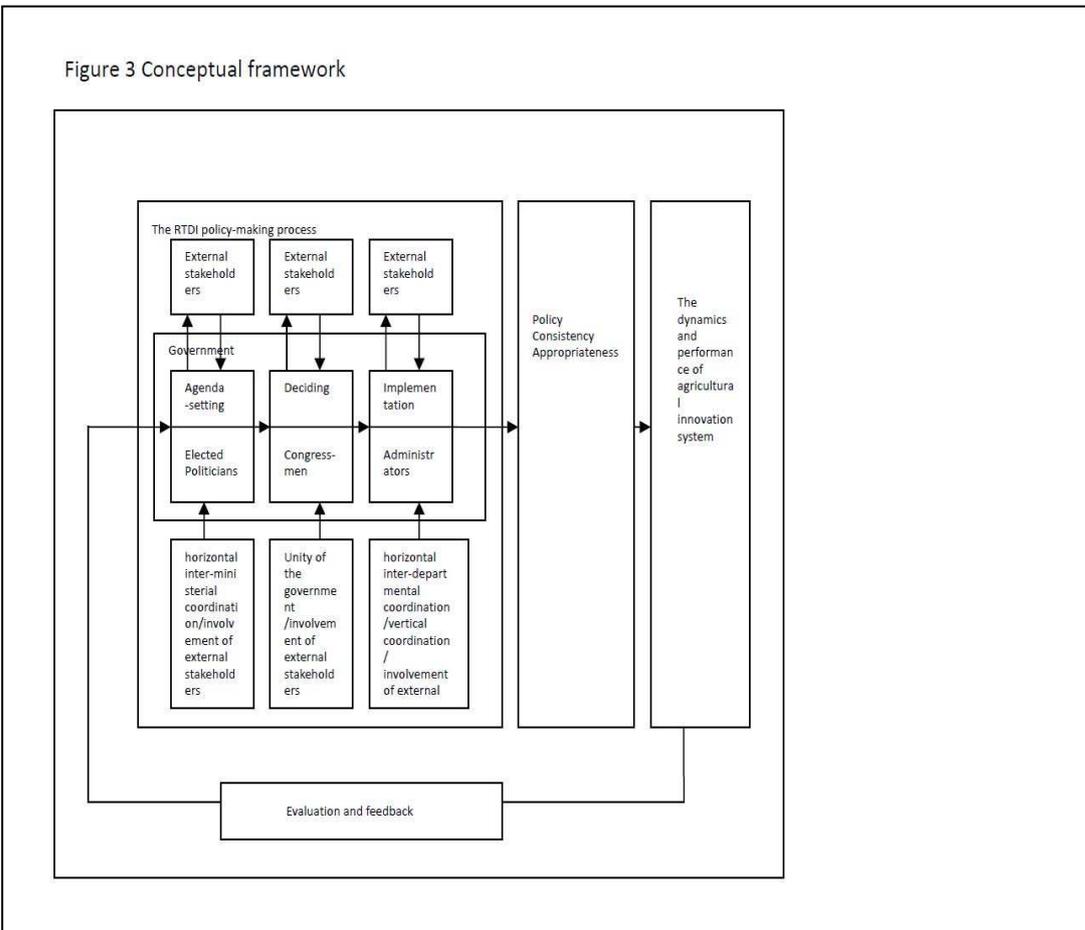


Table 1 The theoretical background and assumptions of the independent variables

Independent variables	Theoretical background	Assumptions related to the consistency and appropriateness of RTDI policies
Foily	A presidential divided government is defined by (Elgie, 2001: p. 3) as the situation when the president's party fails to control a majority in at least one house of the legislature. In the divided government, the congress controlled by the opposition party usually has different policy priorities from the president (Smith et al., 2006: p. 275) and frequently votes for the policies which are against the president's policy preferences (Morina, 1969). The president is analyzed by many political scientists (Samuels, 2007; Cox and McCubbins, 2000; Pfiffner, 1994; Weatherford, 1994) should then employ his/her leadership to persuade and to bargain with the congress to maintain the consistency of policies.	The discussions of the divided government have seldom been applied for the analysis of RTDI policies. According to the existing literature, we further assume the divided government is difficult to make consistent and appropriate RTDI policies. The congress which may have different judgments for the appropriateness from the president may have incentives to change the contents of RTDI policies. Once the contents of RTDI policies are changed by the congress, not only the consistency of RTDI policies may be broken but the appropriateness may be ill-defined due to the disagreement between the two branches.
Horizontal coordination	It is the cabinet in the presidential polity which decides and implements the majority of policies (Moe, 2005: p. 208; Pfiffner, 2005: p. 244), even though all the policies are issued in the name of the president. There are two levels of actors in the cabinet: elected politicians at the cabinet level who play the role to set up the policy objectives and policy instruments and administrators on the agency level who play the roles to implement the contents of policies. Although Six et al. (2002) clearly speculate that the collaborative organizational relationship is the precondition for policies to be consistent with each other, the departmental egotism on both the levels is very difficult to avoid (Laver and Shepsle, 1995; Elmore, 1997) ⁴ except building common interests and facilitating exchanges of interest-sensitive concern (Laurenson and O'Toole, 2003). In the context of RTDI policies, Reiss (2008) describes that to induce the elected politicians and administrators could enlarge or secure their benefits, such as authority or resources, they have no incentives to horizontally coordinate with each other ⁵ .	However, the existing literature doesn't provide clear linkage between horizontal coordination and the consistency and appropriateness of RTDI policies. Following the literature above, we further assume: If horizontal coordination is difficult, the policy objectives and policy instruments of a set of interrelated RTDI policies may not be consistently and appropriately decided and implemented. Different departments without consensus for interrelated RTDI policies may decide and implement those policies towards the directions which minimize the interests of each department but neither consistent nor appropriate.
Vertical coordination	Vertical coordination is defined as the cooperation between elected politicians and administrators. The policies decided by elected politicians are usually not 'perfectly' executed by administrators (Hogwood and Gunn, 1991). As speculated by Lindblom and Woodhouse (1993: pp. 69-70), compared with the vast scope of administrators' activities elected politicians only have limited time and energy to supervise the implementation of administrators. Administrators who work with a policy everyday are in a much better position to perceive what is working in the field and adjust the details of policies. Yet, even if the adjustments of implementation are distorted, elected politicians are unable to fix the distortion spontaneously.	Since the existing literatures don't clearly link vertical coordination with the consistency and appropriateness of RTDI policies, we thus assume as below: If vertical coordination is difficult to be achieved, even though the elected politicians have coordinated the policy objectives and policy instruments of RTDI policies to be consistent and appropriate, the administrative implementation of these policies may be neither complementary to the policy objectives nor appropriate to the development of NSTIS.
Involvement of external stakeholders	Policy stakeholders are the actors outside the government whose interests are influenced by policies but are without formal government positions (Kingdon, 2003: p. 45). Since these stakeholders are outside the government, we also refer them to be external stakeholders. Business interest groups and scientists are considered by the existing research as the most important external stakeholders and both involve in the RTDI policy-making process out of self interests (Bennedson and Feldman, 2002; Scott and Cornelius, 2005; Tournois, 1993; Schooner, 1991; Hove, 2007). The influence of interest groups and scientists is different due to their different capabilities or the way the government is organized. The presidential polity which allows the interest groups and scientists to affect RTDI policies through lobbying both congressmen and executives yields enormous power to these external stakeholders (May et al., 2005; Steinmo and Watts, 1995; Rich, 2005: pp. 204-220). Due to the unequal access of the external stakeholders to the government, the involved interest groups (Inzelt, 2008; Moege, 1988) and scientists (Pollitt, 2006: pp. 260-261; Barker and Peters, 1993) may positively increase the government's understanding towards the general interests of the whole industry and scientific community or negatively lead the government incline to the partial interests of particular larger companies or influential scientists ⁶ .	Based on the discussions of the existing literature, we assume only the 'suitable involvement' of external stakeholders should have positive influence on the consistency and appropriateness of RTDI policies. We assume if the involved interest groups and scientists could present the general interests of the whole industry and the whole scientific community to all elected politicians, congressmen and administrators, the involvement of these external stakeholders would positively help the government as a whole to promote consistent policies. If the interest groups and scientists are able to increase the government's understanding towards the dynamics of the whole industry and scientific community and push the government to link such general interests to RTDI policies, the likelihood of the appropriateness of RTDI policies may also rise.

⁴ In fact elected politicians, especially ministers, particularly play the roles in coordinating policy objectives and policy instruments of policies, yet, as depicted by Laver and Shepsle (1996: pp. 30-32) each minister who institutionally takes the mission to coordinate on his/her own business and lead the department proposing policies in the particular policy area in the reality has little time and energy to concern the policies outside their ministry's jurisdiction. In addition, since resources in most of the cases are allocated along the ministerial lines, the allocation of resources even deepens the departmental egotism of each minister. Moreover, administrators also have their own departmental egotism. As speculated by Elmore (1997: pp. 249 and 261), when the institutions of bureaucracy becomes larger and more complex, the administrators in each agency only specialize in the tasks of their own sector and frequently competes with each other for the relative advantages in power and resources.

⁵ According to Braun (2008), the horizontal coordination in the field of RTDI policies is in many occasions unstable and partial. While the elected politicians play the fundamental roles in the coordination at the level of policy formulation, administrators play essential roles in the coordination at the level of policy implementation. To achieve a set of encompassing innovation policies, elected politicians would demand 'policy integration' to coordinate policy objectives and at best 'strategic coordination' to develop common vision and strategies for the whole government. Besides, administrators should not only have 'negative coordination' to derive the mutual adjustments but ideally the 'positive coordination' to cooperate with each other. Nevertheless, in the reality elected politicians only develop a common strategy through bargaining; and for administrators, negative coordination which would not suffice for an encompassing policy exists much more often than the positive coordination which is necessary for implementation coordination. Indeed positive coordination can be restricted to only limited domains and last only for a certain period. Braun further articulates five institutional options for policy coordination: external coordination, internal coordination, coordination at agency level, leadership at the cabinet level and the strategy intelligence. However, from his perspective each institutional option is only able to be practiced if elected politicians' benefits are higher than costs and agencies' identity and organizational routines are fully respected. The perspective of Braun echoes to Laurenson and O'Toole (2003) who consider horizontal coordination as the results of the establishment of common interests as well as the exchanges of interests among elected politicians or administrators.

⁶ The capabilities of interest groups are influenced by the size and characters of memberships of the groups, the financial resources, the capabilities of the groups to make coalitions with others, the length of the groups' history and the access of the groups to the government (Golobetin, 1999; Herbenar and Scott, 1982: p. 22; Scott, 1997: pp. 328-330; Rothberg, 1991). Besides, according to Schooner (1991: pp. 7-8) there are several factors to shape the influence of scientists. The scientists who do not face the hostile competition of other scientists belonging to particular scientific field and have a higher degree of expertise in this field have higher influence than others.

⁷ For the influence of interest groups, while Inzelt (2008) uses the empirical case of Hungary to explain how does the involvement of the private sector positively contribute to the government's policy-making process of STI policies, Moege (1988: p. 41) uses the empirical experiences of the United States' regulatory, tax and antitrust policies to argue that the diversity and the power of interest groups make it difficult to achieve the necessary consensus of establishing consistent innovation policies and stimulating innovations which are beneficial to all affected parties. For the influence of scientists, Pollitt (2006: pp. 250-261) considers scientists' positive impacts on policies, because scientists play the roles to provide innovative solutions to existing problems to help policy makers to clarify policy issues and so on. Yet, Tournois (1993: p. 91) and Barker and Peters (1993: p. 9) point out the negative impact of scientists on RTDI policies. Tournois (1993) explains how scientists' advisors could lead the states to be 'blind investors' in funding research. Barker and Peters (1993) also describe that if a government chooses to accept the status quo of activities in the reality it harms the government's policy at an earlier stage of scientific development.

innovation and respond to social problems. From the perspective of the two authors, it is the government unity which exerts significant efficacy on the RTDI policies. The unity of the government is defined by the authors as 'the homogeneity of interests within the ruling coalition'. If the interests of the political parties in both the executive and legislative branches are homogeneous, the government is unified. A unified government could easily strike the bargains required to secure the political supports for the new RTDI policies and thus strengthen its policy response to the social problem. Contrastingly, a fragmented government encounters more veto players in the ruling coalition. Since the executive in the fragmented government should simultaneously cater to the multiple preferences of political parties in the legislature, the executive usually pay more transition cost for the formulation and implementation of a RTDI policy and therefore delay the whole government's response to the social problems. Through investigating the public energy expenditures of research and

development (R&D) in 22 OECD countries from 1980 to 2006, the authors conclude that the unification of the government not only influence the RTDI policy process but provides a new reason to explain the effectiveness of RTDI policies.

On the basis of the contributions of Chung (2013) and Cirone and Urpelainen (2013), we synthetically establish the conceptual framework for the analysis of agricultural biotechnology policies which modifies Chung's framework by the perception of Cirone and Urpelainen (as shown in Figure 3). According to the synthetic framework, innovation system is defined as NSTIS. Since the innovation system of agricultural biotechnology is the system constructed by a sector (agriculture), a technology (biotechnology) and dominantly governed by the state (nation), we consider NSTIS which examines the intersections of a nation, a sector and a technology is the suitable framework for the analysis of agricultural biotechnology innovation system.

Moreover, we assume the government is embedded in the network of governance of the NSTIS of agricultural biotechnology. Both the factors inside and outside the government would influence the policy process and formulate the contents of agricultural biotechnology policies. Following the literature of Chung (2013) and Cirone and Urpelainen (2013), we assume there are four independent variables, i.e. the unity of the government, horizontal coordination, vertical coordination and the involvement of external stakeholders to shape the consistency and appropriateness of agricultural RTDI policies and constitute the government's response to social needs. The consistency of RTDI policies following the definition of Chung (2013) should be defined from two aspects. First, the policy objectives and policy instruments of a set of interrelated agricultural RTDI policies are not contradictory even ideally complementary to each other and offer no contradicting incentive structures to feed the dynamic development of agricultural innovation system. Second, the direction for the implementation of each single agricultural RTDI policy is complementary to the policy objectives of the policy. Furthermore, appropriateness is defined as the RTDI policies which not only match the dynamics and structures of the agricultural innovation system but further shape and foster its development, including the knowledge accumulation in the field of biotechnology), the network of actors and the set of products carried out by the agricultural innovation system.

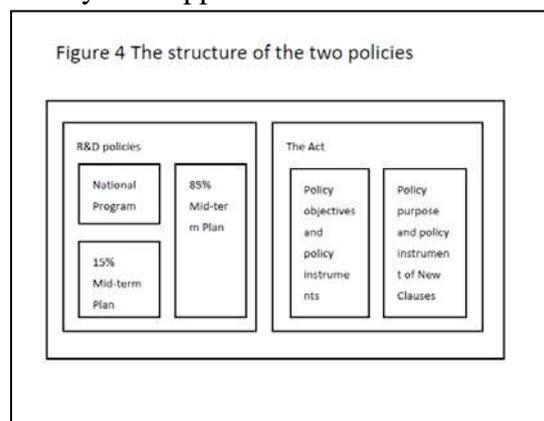
3. Methodology

The research methodology and research techniques are designed to operationalize the conceptual framework for the analysis of the empirical cases. We adopt the research design of 'two case studies'. The analytical unit is policy as described by Herriot and

Firestone (1983), the evidence derived from multiple case studies is usually recognized to be more persuasive than the single case study. In our ‘two case design’, each of the two cases is examined as a particular policy which is frequently chosen as analytical units for the comparisons with each other (Ammons et al, 2001; Fernandez and Fabricant, 2000). The National Program and the Act are chosen as the two cases, because both policies have been promoted from 2000 to 2008 and have continuously accumulated appropriateness during the eight years. Since a part of our conceptual framework is to analyze the appropriateness of agricultural RTDI policies on the agricultural innovation system, the two policies provide suitable empirical examples for us to survey the appropriateness of both and analyze it.

We mainly adopt the qualitative research method, in-depth personal interview, to collect the first-hand resources. The selection of interviewees following the suggestion of Carlsson (2000) is through two processes, document based analysis and snowballing sample survey. Document based analysis is applied as our main method

to select interviewees, as many actors participated in the two policies are clearly listed on the official websites of the two policies or the implementation bodies. Nevertheless, there are still some potential interviewees who are not listed on the documents. For these interviewees, we use the snow balling survey to identify them.



We have in sum interviewed 19 interviewees (shown in Table 2). As shown in the Table 2, there are five kinds of interviewees: elected politicians (4 people), congressmen of the opposition party (3 people), administrators (4 people), agricultural companies (6 people) and scientists (2 people). All the interviews were semi-structured and guided by our conceptual framework. In practice, each interview lasted between 30 minutes to 2 hours, recorded by MP3 players and typed to be transcripts.

4. The consistency and appropriateness of the National Program and the Act

The National Program and the Act were not consistent with each other. The National Program, as shown in Figure 4 was the policy framework over the 15% of the Mid-term R&D Plans (typically shortened to be the Mid-term Plan) of the three

Table 2 Interviewees in Taiwan

Name	Code	Organization	Position	Dates of interviewing
Elected politicians				
Lee, Chong-chou	Intex1	Science and Technology Advisory Group	Director of Biotechnology Office	20/01/2009
Anonymous	Intex2	National Science Council	Ex-minister	15/05/2008
Anonymous	Intex3	National Science and Technology Program for Bio agriculture	Leader	06/02/2009
Congressmen of opposition party				
Tsao, Shou-min	Intleg1	Legislative Yuan	Ex-congressmen of Kuomintang	08/05/2008
Lai, Shyh-Bao	Intleg2	Legislative Yuan	Congressmen of Kuomintang	03/11/2008
Anonymous	Intleg3	Legislative Yuan	Ex-congressmen of Kuomintang	05/03/2009
Administrators				
Chen, Jen-pin	Intad1	Pintung Agricultural Biotechnology, Council of Agriculture	Director General	19/11/2008
Chen, Chei-Hsiang	Intad2	One-stop-service for Biotechnology Industry, Ministry of Economic Affairs	Director	13/05/2008
Anonymous	Intad3	Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture	Vice-Director, Plant Protection Division	09/06/2010
Anonymous	Intad4	Agriculture and Food Agency, Council of Agriculture	Project Director, Seed and Seedling Section	08/06/2010
Firms				
Peter Jiang	Intcomag1	Hanaqua	Chief Executive Officer	29/10/2008
Anonymous	Intcomag2	Agricultural public company A	Director, R&D	08/04/2010
Anonymous	Intcomag3	Agricultural SME A	Chief Executive Officer	30/04/2010
Anonymous	Intcomag4	Agricultural SME B	Chief Executive Officer	29/04/1020
Tseng, Ming-Pao	Intcomag5	Advanced Green Biotechnology	Assistant Manager	12/26/2008
Lin, Fisher	Intcomag6	Taikong Corporation	Vice president R&D	10/02/2009
Academics				
Sun, Julie	Intac1	Taiwan Institute of Economic Research	Chief of Biotechnology Industry Study Center	08/05/2008
Anonymous	Intac2	National Taiwan University	Professor of Horticulture	24/10/2008

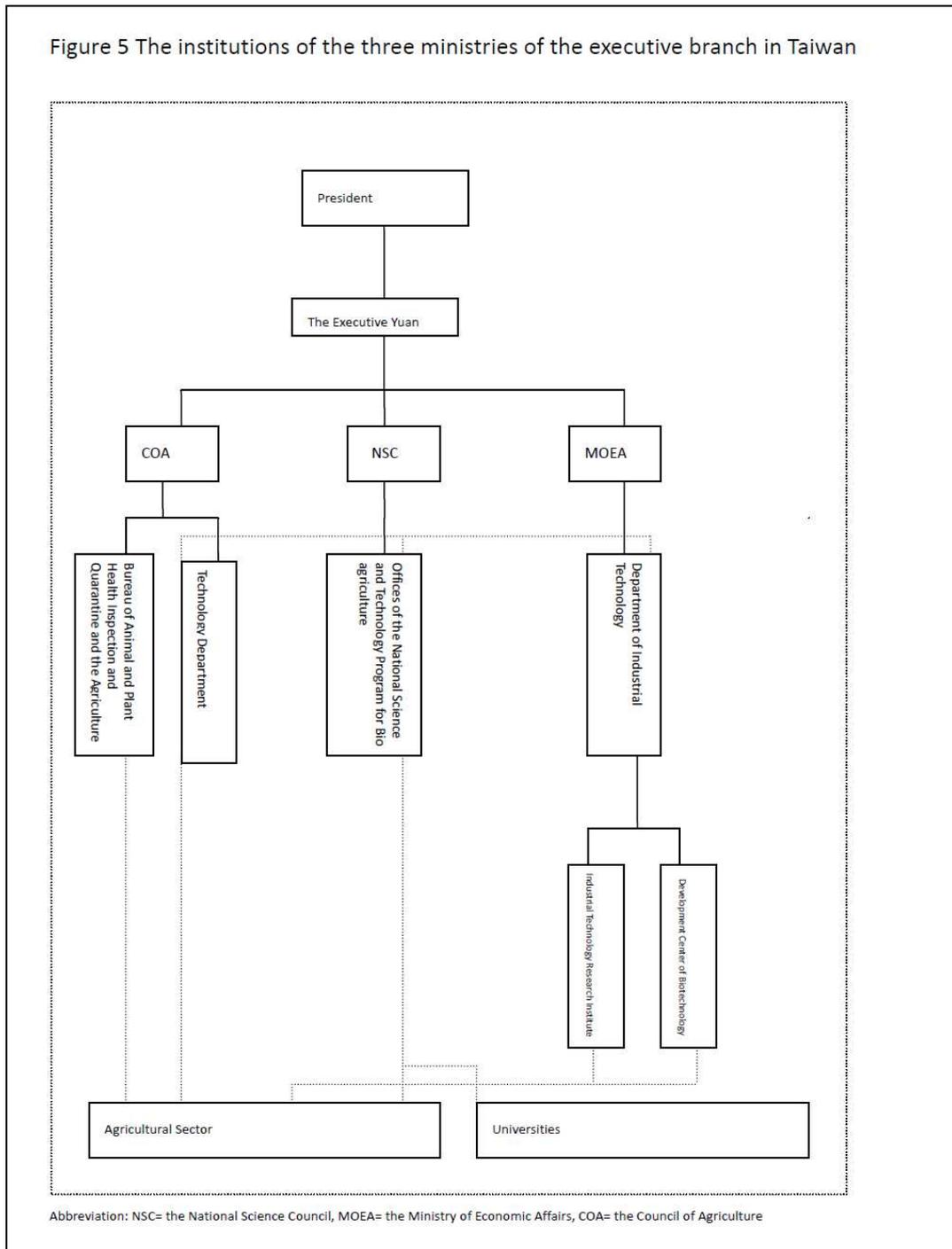
Table 3 Contents of the two policies

Policy Names	Policy Type	Policy contents
National Science and Technology Program for Bio-agriculture	R&D	<ul style="list-style-type: none"> * Ministries: NSC (coordinator), COA, MOEA * Year of promotion: 2000 * Policy objectives: to 'fully utilize all existing R&D resources to develop cutting-edge agricultural biotechnology in the Asian-Pacific regions, to develop value-added agricultural products and to direct academic/industrial interaction and cooperation' * Policy instruments: funding * Targets: 15 bio-agricultural products, such as genetic modified orchids, animal vaccines etc.
Mid-term R&D Plans	R&D	<ul style="list-style-type: none"> * Ministries: NSC, MOEA, COA * Year of promotion: 1960 * Policy objectives: <ul style="list-style-type: none"> ※ NSC: 'to support advanced fundamental biological research in the academic community, to develop outstanding researchers, and to improve the infrastructure of research in universities' (NSC, 2010b) ※ MOEA: 'to encourage domestic SMEs to invest in biotechnology, to build up competitive biotechnology clusters and to support advanced applied biotechnological research' (National Applied Research Laboratories, 2008: 463,464). ※ COA: to 'enhance the competitiveness of domestic agricultural products in the domestic and international markets' (National Applied Research Laboratories, 2008: 463,464). * Policy instruments: funding
Agro-pesticides Management Act	Regulation	<ul style="list-style-type: none"> * Ministries: COA (Bureau of Animal and Plant Health Inspection and Quarantine) * Year of promotion: 1972 * Policy objectives: to 'strengthen the management of pesticides' * Policy instruments: penalties and license

Abbreviation: NSC= the National Science Council, MOEA= the Ministry of Economic Affairs, COA= the Council of Agriculture

ministries (the National Science Council, the Ministry of Economic Affairs and the Council of Agriculture). Since the institutional structure of the three ministries is very important for us to understand the contents and the policy-making process of the two cases, we also show in Figure 5 the institutional structure of the three ministries and their positions in the executive branch. Moreover, as shown in Table 3 each ministry promoted its own Mid-term Plan. As long as the Mid-term Plan of each of the three ministries had different policy objectives and had limited connections to each other, the National Program was promoted in 2000 to make the policy objectives and policy instruments of the 15% Mid-term Plans of the three ministries to be complementary to each other. The detailed policy objectives of the National Program are shown in Table 3, the policy instruments are funding. While the National Science Council was responsible for funding the fundamental bio-agricultural research in universities, the Council of Agriculture and the Ministry of Economic Affairs should fund local agricultural companies to transfer the results from the projects funded by the National Program. Moreover, the Act was promoted by the Council of Agriculture in 1972 to regulate the safeties of pesticides. The initial policy objective of the Act is shown in Table 3, and the policy instrument was penalty. Indeed the policy objectives of the National Program which tended to encourage the innovation of agricultural biotechnology were not complementary with the policy objective of the Act which did not prioritize the development of agricultural innovation. In addition, while the National Program used the policy instruments of funding to support the development of agricultural sector, the policy instruments of the Act, penalty, may increase the difficulties of agricultural innovation. Once the two policies were promoted together, the appropriateness of the two policies, as shown below were very limited.

Figure 5 The institutions of the three ministries of the executive branch in Taiwan



The appropriateness of the two policies should be analyzed in the context of the agricultural innovation system in Taiwan. The products of the agriculture sector included seeds, food, pesticide and fertilizer. Between 2000 and 2008, public research organizations, such as Agriculture Station, were the pillars of innovation and manufacturing, and local SMEs gradually emerged in the agricultural sector. The main business of the public research organizations was to use the traditional biotechnology of hybridization to innovate new seeds and younglings and then delivered to farmers

for free. These public research organizations also used modern biotechnology of GM to develop new seeds, yet the GM seeds were cultivated in field trials only and were not allowed to be disseminated outside the research organizations. Besides, the private seed companies also adopted traditional biotechnology of hybridization to innovate new seeds and sold to farmers. While these private seed SMEs were reluctant to adopt modern biotechnology of GM for the innovation of new seeds because of market, it was the new agricultural SMEs set up after 2000 and the agricultural trade companies to invest in the innovation of GMO, especially in the non - edible GMO. Moreover, in the industries of food, pesticide and fertilizer, Taiwan Sugar Corporation was the public and the largest company of food, pesticide and fertilizer. The new private SMEs of pesticide and fertilizer which were set up after 2000 continuously utilized modern biotechnologies, such as fermentation, in their products of bio - pesticide and bio - fertilizer (STRIC, 2006: 31). The majority of these new SMEs targeted the domestic market. However, some of the firms gradually started to search for the opportunities in the foreign markets, including Japan, European Union, China and South East Asian countries (Intcomag5). With stronger research capabilities, the new agricultural companies had more cooperation with academics. Indeed universities played the significant roles to do research and transfer biotechnologies to local SMEs. Since the majority of local SMEs were too small to do the agricultural related research by themselves, the universities burdened the responsibilities to do the majority of research.

The National Program was promoted while modern biotechnology was gradually spilled over in the agricultural sector; yet, even though the policy objectives and policy instruments of the National Program were appropriate, it was not effective. As we have described in Table 3, the policy objectives of the National Program were to ‘fully utilize all the existing R&D resources to develop cutting-edge agricultural biotechnology in the Asian-Pacific regions’, ‘to develop value-added agricultural products’ and ‘to direct academic / industrial interaction and cooperation’. The extent for the National Program to ‘fully utilize all existing R&D resources’ will be discussed in section 5.3. However, the National Program, which aimed to develop value - added agricultural products and to direct academic / industrial interaction and cooperation, in fact intended to encourage the innovation of agricultural products and to cluster the networks between actors. The agricultural sector was strongly guided by the public sector. Yet, the private agricultural companies played more and more important roles in the innovation and commercialization of agricultural biotechnology. Since the universities in Taiwan have accumulated rich knowledge of modern biotechnology and the majority of private agricultural companies were too small to do

R&D by themselves, the policy objectives of the National Program which tended to cluster networks between universities and companies in order to accelerate the knowledge accumulation within the agricultural SMEs indeed appropriately matched the development of agricultural innovation system in Taiwan. The policy instruments of the National Program which funded both the universities and agricultural companies were appropriate, because the policy instruments encouraged the knowledge accumulation of modern biotechnology of both of the actors. Yet, after being implemented, the National Program didn't fully achieve its policy objectives. Table 4 shows the economic index of the National Program published by the National Science Council in terms of the numbers of papers published, patent obtained, technology transfer, academics conferences and the agricultural companies. As shown in the table from 2003 to 2007, every year, the National Program transferred 7 to 29 biotechnologies to agricultural companies. The number of agricultural firms which got technology transfers weighted as much as 3 to 40 % of the overall agricultural companies. Under the condition that in the particular years there were 40 % agricultural companies that transferred biotechnologies from the research projects funded by the National Program, the National Program, to some extent effective, 'to direct academic/industrial interaction and cooperation'. There was no clear economic index to show the extent for the agricultural companies to 'develop value - added agricultural products'. Therefore, we are unable to judge if the National Program achieved its policy objective to 'develop value-added agricultural products' or not. However, besides the economic index, we also collected qualitative data through our interviews. According to our interviews with the leader of the National Program (Intex3), three agricultural companies (Intcomag2, Intcomag5, Intcomag6) and one academic (Intac3) involved in the National Program, all the interviewees explained that the National Program positively encouraged their coordination with each other. Therefore, in the long term, such cooperation between academics and industry may contribute to the agricultural innovation system to develop value - added products. In short, after being implemented, the National Program did not perfectly realize its policy objectives, but to some extent, appropriately matched the development of agricultural innovation system.

Table 4 The performance of the National Program from 2003 to 2007

Year	Papers published	Patent obtained	Technology transfer	Academic conferences	Number of pharmaceutical companies
2003	246	5	2	10	63
2004	413	4	11	7	57
2005	202	9	29	15	73
2006	286	9	16	30	--
2007	392	13	22	27	--

* Sources: Science and technology Yearbook (2008), Biotechnology industry in Taiwan (from 2001 to 2009)

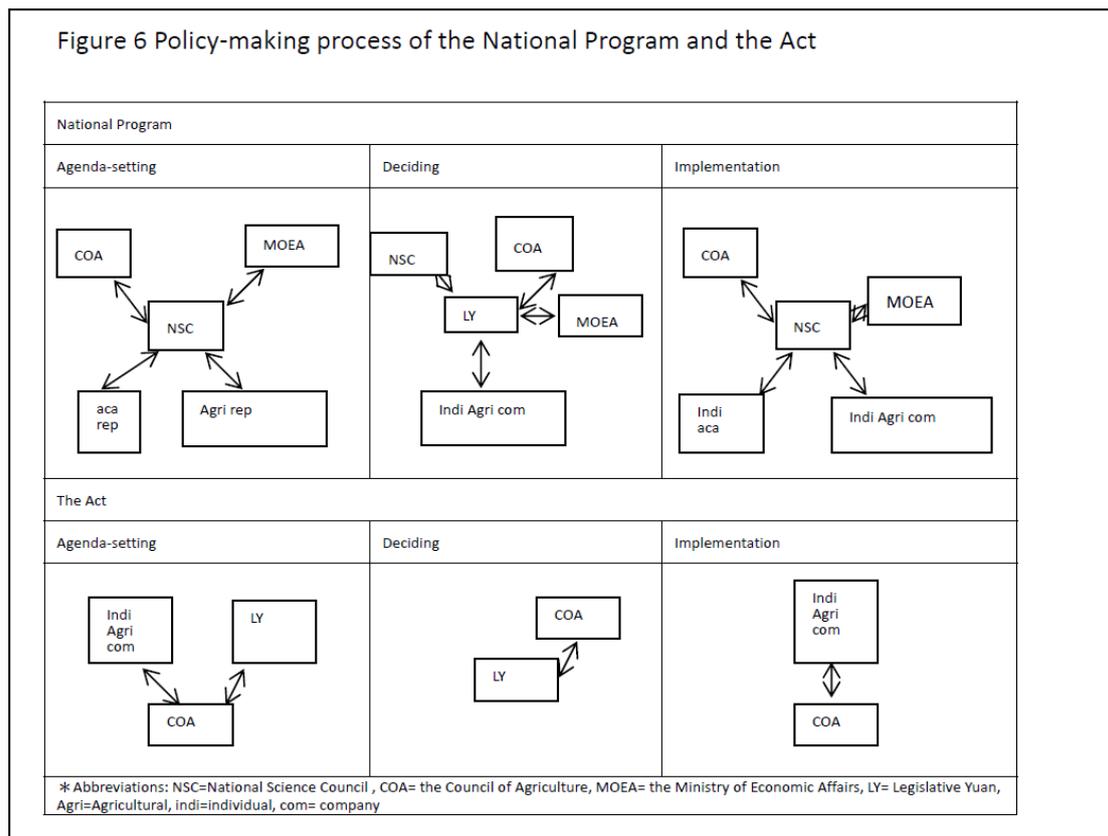
The Act, as we are going to analyze below, didn't process appropriate policy

objectives and policy instruments and generate appropriate supports. As we have described in Table 3, the Act was to ‘strengthen the management of pesticides’ through the policy instruments of penalties and license. As we have described in section 4, the Act was legislated in 1972 to control the quality of chemical pesticide. At the time, there was no bio-pesticide. However, the Act was not adjusted for the development of bio-pesticide. The policy objective and policy instruments in fact had no intention to support the knowledge accumulation and diffusion of modern biotechnology in the agricultural sector. Once being implemented, according to the descriptions of our interviews with the Assistant manager of Advanced Green Biotechnology (Intcomag5), the Act in fact increased the barriers of cooperation between actors and discouraged the innovation of the bio - pesticides.

While the National Program and the Act were promoted together, on the basis of our interviews, the appropriateness of the National Program, which in general was appropriate to the dynamics of the agricultural sector, was to some extent reduced by the promotion of the Act. After the promotion of the two policies the Taiwanese government in fact had only limited appropriate support to the development of agricultural innovation system.

5. The policy-making process of the National Program and the Act

We analyze the policy process of the National Program and the Act through the lens of our conceptual framework. The policy-making process of the two policies is summarized in Figure 6.



5.1 The policy-making process of the National Program

5.1.1 The agenda-setting of the agricultural National Program

The stage of agenda-setting of the National Program was the stage for the leaders of the National Program to decide the agendas of the policy proposals of the National Program. According to our conceptual framework, the stage of agenda-setting is deeply influenced by two independent variables, the horizontal inter-ministerial coordination and the involvement of external stakeholders. In this section, we will focus on the influence of the two independent variables on the consistency and appropriateness of the National Program.

The agendas of the National Programs were first initiated on the ministerial level, even though the leaders of the National Program were the most important elected politicians to decide the agendas of the National Programs. As described by the Minister of the National Science Council (Intex2), it was the Minister of the Council to initiate the agendas of the National Program in order to better integrate the R&D resources of the Mid-term Plans of the three ministries and to invest these resources in the research which had the potential to be transferred to the agricultural industry. According to the proposition of the Minister of the Council, each ministry should appropriate 15% budgets of its own Mid-term Plan to the National Program. The National Science Council was responsible for coordinating the other two ministries to form the inter-ministerial consensus for the policy objectives and the policy instruments of the National Program and to horizontally coordinate with each other under the framework of the National Program. The proposition of the Minister of the National Science Council, as described by the Minister of the Council (Intex2), got the agreements of other Ministers. The inter-ministerial consensus was achieved that the resources of the National Program should be invested in the bio-agricultural research and the results of the research should be transferred to local agricultural SMEs. However, as expressed by the Minister of the Council (Intex2), the Ministers of the three ministries only decided the general directions for the National Programs. In practice, it was the leaders of each National Program to decide the detailed agendas of each National Program, including the concrete policy objectives, policy instruments, and the targets of each National Program. Each leader was nominated and delegated by the Minister of the Council to represent the Council to formulate inter-ministerial consensus and to select agendas. The leaders, according to the name

lists published on the official websites of the National Program, were originally the senior scientists in universities, public research institutes and Academic Sinica. They played the role as the elected politicians and served in the National Programs on a part-time base. They held no formal positions within the government or the agricultural sector.

The decisions of the leaders of the National Program were deeply influenced by the Steering Committee and the Project Committee. The Steering Committee was chaired by the Minister of the National Science Council and recruited 9 government officials, including vice-Ministers of the National Science Council, the Ministry of Economic Affairs, and the Council of Agriculture. The Project Committee which reviewed the detailed agendas of the National Program was co-chaired by the vice-Minister of the National Science Council and the vice-Minister of the Council of Agriculture and was composed of 9 government officials, 3 academics and 3 agricultural representatives. The 9 government officials included the heads of the implementation bodies under the three ministries, such as the Director of the Bureau of Industrial Development under the Ministry of Economic Affairs. The 3 academics were recommended by the National Science Council and included the heads of universities and the research organizations participating in the National Program. Moreover, the 3 agricultural representatives included the CEOs of one larger seed company and one company of aquaculture, and one ex-CEO of larger feeding company. The agricultural representatives were recommended by the Council of Agriculture because of the affiliation of their business with the National Program. As described by one of the agricultural representatives (Intcomag4), he was invited because of the company's outstanding performance in the innovation of seeds. The other representative (Intcomag3) explained that he was invited because of his long-term international experiences in the agricultural sector. No companies of food, pesticide and fertilizer were recruited.

The two Committees played the significant role in forming inter-ministerial consensus. The Steering Committee was chaired by the Minister of the National Science Council and involved the vice-Ministers of the three participating ministries, i.e. the National Science Council, the Ministry of Economic Affairs and the Council of Agriculture. The Steering Committee not only secured the inter-ministerial consensus for the consistency of the National Program but also secured the inter-ministerial consensus for the appropriateness of the National Program. The inter-ministerial resources should be invested in the bio-agricultural research which had the potential to be developed to be the high value-added agricultural products. Through technology

transfer, the universities and agricultural companies were encouraged to establish the network which was important for the development of modern biotechnology. Moreover, since the vice-Ministers of the National Science Council and the Council of Agriculture were also involved in the Project Committee, the inter-ministerial consensus formed in the Steering Committee was able to be further secured in the detailed agendas of the National Program, including the targeted products. As described by the leader of the National Program (Intex3), many targeted products selected by the National Program were decided through the mutual agreements between different ministries. The agricultural products which were export-oriented, such as orchids and groupers, were especially selected. However, besides the coordination of the Mid-term Plans, there was no sufficient inter-ministerial consensus formed for the regulation policies related to the National Program. As described by one of the agricultural representatives (Intcomag3), although the vice-Ministers of the National Science Council and the Council of Agriculture have once tried to set up the regulations of GMO in the meetings of the Project Committee, there was no actual inter-ministerial consensus formed for the regulation of GMO. The vice-Ministers at best agreed to fund the research of non-edible GMO and allowed the trade of non-edible GMO in the domestic market without any regulation. Also there was no inter-ministerial consensus formed for the amendments of the Management Act. In other words, there was no inter-ministerial consensus for the consistency and appropriateness between the National Program and other interrelated agricultural regulations. While the general advise and the advise for the detailed agendas of the National Programs were given by the Steering Committee and the Project Committee to the leaders, the advise was instrumental for the inter-ministerial consensus. As long as the leaders followed this advise, they were able to make the concrete policy objectives and policy instruments of the National Program not only consistently coordinated the 15 % Mid-term Plans of the three ministries but also appropriately match the development of agricultural innovation system. In addition, once the detailed agendas of the National Program, such as the targets of the National Program, were implemented by different ministries, these details were able to be consistently implemented by each ministry. Yet, because there was no inter-ministerial consensus for the consistency and appropriateness between the National Program and interrelated regulation policies, the implementation of the National Program was not consistent with other regulation policies, such as the Act; and once being implemented together, the combined effects of the National Program and regulation policies were limited and did not support adequately the development of agricultural innovation system.

The two Committees also played a significant role in involving external stakeholders. Since the Steering Committee involved no external stakeholders, the external stakeholders were unable to influence the policy objectives and policy instruments. However, it was the Project Committee which played the most important roles in involving the external stakeholders. The numbers of academics and agricultural representatives in the Project Committee were almost the same, and the two kinds of external stakeholders were usually able to achieve the consensus for the development of agricultural innovation system. As described by one agricultural representative (Intcomag3), he usually achieved the consensus with academics easily. Since the consensus of both kinds of representatives were able to be presented to all elected politicians of the National Program, such as the leaders and the vice-Ministers of the three ministries, the involvement of these external stakeholders positively contributed to the consistency of the agendas of the National Program. Nevertheless, both the academic and the agricultural representatives were recommended by the government officials as individual scientists and individual companies. As individuals recommended by the government, they were in fact unable to represent the general interests of the scientific community or the general interests of the agricultural sector. They were also unable to let the elected politicians fully understand the dynamics of the agricultural innovation system and increased the appropriateness of the National Program. They at best presented the partial interests within the scientific community and the agricultural sector to the elected politicians. For example, one of the agricultural representatives (Intcomag4) explained that he once suggested the vice-Ministers that the National Program should increase the funding for the research of seeds of fruits and vegetables. Such suggestion was involved in the detailed agendas of the policy proposal of the National Program.

The leaders of the National Program, as described by one of the leaders (Intex3), followed the advise of the Steering Committee and the Project Committee and decided the concrete policy objectives, policy instruments and the details of policy proposals. Since the agendas of the National Program were designed through the inter-ministerial consensus, and the National Program was able to make the policy objectives and the policy instruments of the 15% Mid-term Plans of the three ministries consistent with each other. Moreover, the policy objectives which encouraged the bio-agricultural research within the universities and encouraged the technological diffusion from the universities to agricultural companies were also appropriate. In addition, since the inter-ministerial consensus for the detailed agendas of the National Program was achieved, the National Program was expected to be consistently and appropriately implemented by different ministries. Yet, because of

the absence of the suitable involvement of external stakeholders, the representatives of the external stakeholders were unable to increase the appropriateness of the National Program. Once the details of the National Program were implemented, even though the general direction of the National Program was still appropriate, the effect was unavoidably limited as the National Program had been captured by the interests of particular groups of scientists and agricultural companies.

5.1.2 The deciding of the National Program

The stage of deciding of the National Programs was the stage for the congressmen of the opposition party, Kuomintang, to authorize the policy proposals of the National Programs to be formal policies. According to our discussion in section 2, the decision making stage in the Taiwanese polity is deeply influenced by two independent variables, the divided government and the involvement of external stakeholders. In this section, we would especially focus on the influence of the two independent variables on the consistencies and appropriateness of the National Program.

The congressmen of the opposition party, according to a congressman of Kuomintang (Intleg1), had different policy preferences and priorities from the ruling party and had high incentives to change the contents of the National Program; yet, there were two reasons which reduced the oversight of the congressmen. First, biotechnology was too technical to congressmen. Once the policy proposals of the National Programs were full of professional terms, congressmen were unable to understand, to monitor the policy proposals and to judge the consistency and the appropriateness. Second, the congressmen should face the pressures from their districts. The majority of voters of the opposition party supported economic development, and the development of biotechnology was considered to be an important part of the economic development. With the pressure from the voters, the congressmen of the opposition party hesitated to change the policy contents and cut the budgets of the National Programs which aimed to support the growth of biotechnology and related sectors. One further congressman of Kuomintang (Intleg2) shared the same opinion that since his voters had limited opposition to the development of biotechnology, he had no incentives to cut but authorized the majority of the budgets of the National Program.

The external stakeholders, especially the agricultural companies, interacted with the congressmen of the opposition party through the participation of congressional public hearings. One of the agricultural representatives in the National Science and Technology Program for Bio agriculture also once participated in the public hearings

to express the general interests of the agricultural companies (Intcomag3). According to his experiences, the public hearing was an effective mechanism to express the interests of the agricultural companies to the congressmen. However, both the individual companies and interests groups were involved in the public hearings. From our perspective, these companies and interest groups did not necessarily present the general interests of the agricultural sector to the congressmen but in many cases the interests of particular companies and small groups of companies only. Therefore, the external stakeholders involved in the congressional public hearings were in most of the cases unable to help the congressmen to understand the dynamics of the modern biotechnology, pharmaceutical and the agricultural sectors in Taiwan and authorized the National Programs towards the direction which was appropriate to the development of the agricultural innovation system.

However, according to the experiences of the congressman of the opposition party (Intleg1), the involvement of the companies of the agriculture was not influential to the judgment of the congressmen towards the National Programs. Therefore, the involvement of the companies had limited impacts on the deciding process of the National Programs.

The policy proposals of the National Program were smoothly authorized by the congressmen of the opposition party; neither the policy objectives and policy instruments nor the details of the policy proposals were changed while being transformed to be formal policies. As described by the leader of the National Program (Intex3), since many congressmen of the opposition party were elected by agricultural counties, these congressmen easily understood the importance of bio-agriculture. Some congressmen of the opposition party even suggested the leaders of the National Program to do more research related to their counties.

While the National Program was decided by the congressmen of the opposition party, the contents of the National Program remained the same. The divided government in fact didn't change the consistency and appropriateness of the National Program.

5.1.3 The implementation of the agricultural National Program

The Office of the National Science and Technology Program for Bio agriculture played essential roles to coordinate the implementation bodies under the Ministry of Economic Affairs (the Bureau of Industrial Development) and the Council of Agriculture (Technology Department) (see Figure 5). Nevertheless, the Office

encountered the problems of horizontal and vertical coordination and the involvement of external stakeholders.

First, the Office encountered the problem of horizontal inter-departmental coordination. As described by the leader of the National Program (Intex3), the implementation bodies under different ministries were very difficult to coordinate with each other. In the stage of agenda-setting, the three ministries have achieved the inter-ministerial consensus for the detailed agendas of the National Program and decided to coordinate the R&D funding derived from the 15% Mid-term Plans of the three ministries to fund the targeted bio-agricultural research and agricultural products. Therefore, in the stage of implementation, the implementation bodies under different ministries had no problem to horizontally cooperate with each other in funding the innovation of bio-agricultural products. However, since there was no inter-ministerial consensus formed for the agricultural regulation in the stage of agenda-setting, the Bureau of Industrial Development and the Technology Department always competed for the leadership of regulations of the agricultural sector. For example, the Bureau of Industrial Development executed the 'Factory Rules' to regulate pesticide factories, and the Bureau of Animal and Plant Health Inspection and Quarantine of the Technology Department also executed 'Agro-pesticides Management Act' to regulate the same factories. While the Bureau of Industrial Development considered some of the factories not to be the pesticide factories and should only get one license from the Bureau, the Technology Department insisted that all factories related to pesticide should get the second license from the Department. Even though the inter-departmental competition already delayed the technology transfer, especially the technology transfer to the companies of bio-pesticides, the two bodies were still very difficult to coordinate with each other.

The Office also encountered the problem of the vertical coordination. As described by the leader of the National Program (Intex3), the Minister and the vice-Ministers of the three ministries had severe difficulties to monitor the details for the implementation of the National Program. As long as the implementation bodies were able to persuade that the implementation was proper, the Minister and the vice-Ministers simply believed the agencies and no longer supervised the implementation. Even when the leaders discovered the direction of implementation was distorted and far from the policy objectives, the leaders who only represented the National Science Council was unable to fix the distortion of the implementation of the implementation bodies of the other two ministries from top-down.

The Office also encountered problems to involve the external stakeholders in the technology transfer. As described by the leader of the National Program (Intex3), the larger agricultural companies were very indifferent to transfer biotechnologies from the National Program, and it was the new small companies which were more willing to transfer the biotechnologies. In fact, none of the agricultural representatives transferred biotechnologies funded by the National Program. As described by one of the agricultural representatives (Intcomag4), as he already knew that the government was unable to solve the regulation problem of GMO, he hesitated to transfer biotechnologies of GM. The new agricultural company of bio-pesticide and agricultural trade company (Intcomag5, Intcomag6) transferred biotechnologies from the universities funded by the National Program because the targets of the National Program, as expressed by the Assistant Manager and the Vice president R&D of the two companies, coincidentally fitted to their business of bio-pesticide and GMO ornamental fish. However, as described by the leader of the National Program (Intex3), the National Program finally transferred the majority of technologies to small companies.

After being implemented, as we described in section 4, the National Program did not fully achieve its objectives. The inter-ministerial resources have been consistently invested in the targeted bio-agricultural research and products and have encouraged some academics and small agricultural companies to establish networks through technology transfer. Yet, because of the three problems of implementation, the policy had only limited participation and mobilization.

5.2 The policy-making process of the Act

5.21 The agenda-setting of the Act

The Director-General and other high level managers of the Bureau of Animal and Plant Health Inspection were the most important elected politicians to decide the agendas for the bills of the Act. As described by one of the high level managers of the Bureau of Animal and Plant Health Inspection and Quarantine and the Agriculture (Intad3), the Minister of the Council of Agriculture only gave the general directions to the Bureau, and it was the high level managers of the Bureau to decide all the agendas of the Act. As we have described in section 5.1.1, there was no inter-ministerial consensus formed as to what should be the most appropriate objectives and instruments of the Act and as to the consistency of the policy objectives and the policy instruments between the Act and the National Program. Rather, it was indeed the

involvement of external stakeholders that mainly influenced the selection of the agendas of the Act.

The Bureau held regular public hearings to involve the interests of agricultural companies, especially the pesticide companies. However, the companies participated in these public hearings were not recommended by the agricultural associations but were involved as individual companies. As individual companies, they were in fact unable to represent the general interests of agricultural sector. As described by the high level manager of the Bureau (Intad3), since some companies suggested that the Act which adopted the policy instruments to regulate the manufacturing machines of bio-pesticides in detail seriously reduced the flexibility of these companies, the Bureau accepted the suggestions and then set up the agendas for the amendments of the policy instruments of the Act to delete the detailed regulations for the manufacturing machines.

Next to the pesticide companies, the congressmen of the opposition party also played significant roles in the agenda-setting process of the Act. Yet, the congressmen merely pushed the Bureau to amend policy instruments of the Act to stricter control the safeties of the pesticides rather than to appropriately encourage the innovation of bio-pesticide. As described by the high level manager of the Bureau (Intad3), since the poisonous pesticide was frequently misused for commit suicide, in 2007, under the suggestion of the congressmen, the Bureau initiated the new agendas for the amendments of the Act and revealed the new policy instruments that only the farmers were qualified to buy the poisonous pesticides.

While the new agendas of the policy instruments of the Act were selected by the Bureau, these new agendas strengthened the policy objective of the Act which tended to control the food safeties. These agendas were selected without inter-ministerial consensus and with unsuitable involvement of external stakeholders. Because of lacking inter-ministerial consensus, the policy objective and the policy instruments of the Act which didn't tend to encourage the innovation of bio-pesticide was in fact un-appropriate to the development of agricultural sector and horizontally inconsistent with other interrelated policies, such as the National Program which tended to encourage the innovation of bio-agricultural products. Furthermore, without the suitable involvement, the participation of the pesticide companies in the public hearing was very difficult to positively increase to the consistency between the Act and the National Program, as well as the appropriateness of the Act.

5.2.2 The deciding of the Act

The stage of deciding of the Act was the stage for the congressmen of the opposition party to legislate the bills of the Act to be laws. Since we have assumed in section 2 that the stage of deciding is deeply influence by two independent variables, the divided government and the involvement of external stakeholders, in this section, we emphasize the influence of the two independent variables on the consistencies and appropriateness of the Act.

The congressmen of the opposition party played important roles in the legislation of the Act. As described by the high level manager of the Bureau of Animal and Plant Health Inspection and Quarantine (Intad3), since it was the congressmen who suggested to amend the policy instrument of the Act and to strictly control the status of the buyers of the poisonous pesticide, the congressmen of the opposition party smoothly legislated the bill to be law.

While the congressmen of the opposition party legislated the bills of the Act to be laws, according to the discussions above, the policy objective and the policy instruments of the Act remained un-appropriate and inconsistent with the National Program. Since the policy preference of the congressmen of the opposition party was involved in the agendas of the Act, the congressmen consistently authorized the bills to be laws. Even if the executive branch and the legislative branch have established high consensus, this consensus was established upon without the suitable involvement of the external stakeholders (especially the agricultural companies of pesticide) and without the clear understanding on the dynamics of modern biotechnology and the agricultural sector. The consensus was in fact unable to positively increase the appropriateness of the agricultural sector.

5.2.3 The implementation of the Act

The stage of implementation of the Act was the stage for the administrators of the regulatory bodies to implement the clauses of the laws. The implementation body the Act was the Bureau of Animal and Plant Health Inspection and Quarantine. Since we assume in section 2 that the stage of implementation is deeply influenced by three independent variables, the vertical coordination, the horizontal inter-departmental coordination and the involvement of external stakeholders, in this section, we will focus on the influence of these three variables on the consistencies and appropriateness of the Act.

The Bureau of Animal and Plant Health Inspection and Quarantine which implemented the policy instruments of the Act also established no horizontal inter-departmental coordination with other interrelated implementation bodies. According to the description of the high level manager of the Bureau (Intad3), the high level management of the Bureau has discovered that lots of the agricultural companies of bio-pesticides which were funded by the National Program to transfer single ingredients for fermentation were not able to get the license of manufacturing bio-pesticides. The reason was that these companies of bio-pesticides were unable to provide the Bureau sufficient documents of toxicology. From the Bureau's perspective, if the research organizations or the universities provided the documents of toxicology to the companies while they transferred biotechnologies, the companies should be easier to get the licenses. Yet, besides communicating with the research organizations under the Council of Agriculture., the Bureau had no plan to coordinate with the implementation bodies of other ministries, such as the implementation bodies of the National Science Council or the Ministry of Economic Affairs.

The problem for vertical coordination increased the difficulties for the implementation of the Act. As we have described in section 5.2.1, the vertical coordination between the Minister of the Council of Agriculture and the Bureau was in fact very limited. There was no inter-ministerial consensus to coordinate the policy objectives and the policy instruments of the Act to be horizontally consistent with other policies, like the National Program. Once being implemented, the implementation of the Act was towards the direction which was neither vertically consistent with the general policy objectives of the Promotion Plan nor horizontally consistent with the National Program. Furthermore, there was no inter-ministerial consensus for the appropriateness of the Act. After being implemented, the Act was difficult to appropriately match the development of agricultural sector.

Moreover, the agricultural companies were only able to be involved in the implementation of the Act as individual companies. As described by the Assistant Manager of Advanced Green Biotechnology (Intcomag5), there was no association formed by the companies of bio-pesticides. As individual companies, the interests of these companies were difficult to be accepted by the Bureau. The point of view was shared by the high level management (Intad3). For example, some companies once suggested the Bureau to set up the agendas to initiate a new law especially to regulate the bio-pesticide. Such suggestion was rejected by the Bureau. In short, as individual companies, the companies of pesticides were unable to represent the general interests

of the agricultural sector to the Bureau and increase the Bureau's understanding to the dynamics of the agricultural sector. Therefore, these companies were unable to increase the appropriateness of the Act. In addition, since these companies only explained their situations to the Bureau, they were not able to contribute to the consistency between the Act and the National Program.

To sum up, the policy objectives of the Act were inconsistent and inappropriate, because they hampered the establishment of the network between different actors. However, once being implemented, both policies were not complementary with the National Program. The two policies were in fact difficult to appropriately match the development of the agricultural innovation system. The vertical coordination, horizontal coordination and involvement of external stakeholders, were the key variables which shaped the stage.

6. Discussion

We analyze the influence of the four independent variables on the consistency and appropriateness of agricultural RTDI policies through discussing the empirical cases of Taiwan. While in section 2, we only recognize one conceptual framework for all the policy-making process of agricultural RTDI policies within one government, as shown in Figure 6 there were in fact multiple policy-making processes within one government. Even if the two policies were both promoted towards the agricultural innovation system, their policy-making processes were different. Since the actors involved in the National Program had very limited connections to those involved in the Act not only that the policy objectives of the two policies were not consistent with each other, but once being implemented the appropriateness of the two policies also was not thoroughly complementary to each other. After being implemented, the two policies were limited to foster the development of agricultural innovation system in Taiwan. In the following paragraphs, we discuss the four independent variables first and reflect the conceptual framework later.

The unity of the government does influence the consistency and appropriateness of agricultural RTDI policies; and the divided government as shown by both the cases of the National Program and the Act is capable to make consistent and appropriate agricultural RTDI policies. In the case of the National Program, once the elected politicians have decided the policy proposals of the National Program to be consistent and appropriate, the congressmen of the opposition party approved the policy proposals and didn't change the consistency and appropriateness of the National

Program. In addition, in the case of the Act, the congressmen also authorized the bills of the new clauses of the Act without change. Yet, the new clauses authorized by the congressmen, as we describe in section 5.2.2, was un-appropriate to the development of agricultural innovation system. According to the empirical cases of the National Program and the Act, we consider that the congressmen of the opposition party under the divided government did influence the consistency and appropriateness of agricultural RTDI policies. Moreover, we recognize that there are two factors which influence the extent for the congressmen of the opposition party to change the consistency and appropriateness of the agricultural RTDI policies. First of all, the extent for the elected politicians to persuade and to form the consensus with the congressmen deeply influenced the judgments of the congressmen towards the consistency and appropriateness of the agricultural RTDI policy proposals. While many political scientists (Weatherford, 1994; Cox and McCubbins, 2000; Pfiffner, 1994) perceive that it is the president who needs to employ his/her leaderships to persuade the congressmen of the opposition party to get approvals of policies, we find that it is in fact the elected politicians rather than the president who need to form the consensus with the congress. Moreover, even though Cirone and Urpelainens (2013) describe that the unity of the government deeply influence the government's response to the social problems, they didn't express that the persuasion of the elected politicians towards the congressmen could facilitate the establishment of consensus within the government and thus increase the government response to social needs. Yet, in the case of the Act, as we have described in section 5.2.1, it was the high level management of the Bureau of Animal and Plant Health Inspection and Quarantine, as elected politicians, to form the consensus with the congressmen. As long as the policy priorities and preference of the congressmen which tended to increase the controls of the pesticide safeties through controlling the status of buyers was involved in the bills of the new clauses of the Act in the stage of agenda-setting, in the stage of deciding, the congressmen smoothly authorized the bills to be laws. However, as we have described in section 5.2.1, even the new clauses of the Act was legislated, these new clauses merely strengthened the policy objective of Act which was neither consistent with other interrelated policies, such as the National Program, and was not appropriate to the development of agricultural innovation system. Indeed only under the condition that the consensus between the elected politicians and the congressmen is established upon the understanding towards the dynamics of the agricultural innovation system, the divided government is able to make consistent agricultural RTDI policies which match the development of agricultural innovation system. Second, the pressures from the voters and the involvement of external stakeholders facilitate the formation of the consensus between the congressmen and the elected politicians. In the case of the

National Program, because many congressmen of the opposition party were elected by agricultural counties, all the budgets of the National Program were smoothly authorized. The pressure from the voters is able to shape policy preferences of the congressmen of the opposition party and the elected politicians to be similar to each other and facilitate the executive and legislative branches to form a consensus for the policy objectives and the policy instruments of agricultural RTDI policies.

The horizontal coordination deeply influences the consistency and appropriateness of agricultural RTDI policies. The two cases not only confirm but extend the analysis of political science literature to the field of agricultural RTDI policies (Laver and Sheples, 1996; Elmore, 1997) that departmental egoism is one of the most important factors which makes the horizontal coordination of agricultural RTDI policies difficult. In the case of the National Program, although the National Science Council played the role to coordinate other ministries, the Steering Committee involved the vice-Ministers of the other two ministries, and the Project Committee was co-chaired by the vice-Minister of the National Science Council and the vice-Minister of the Council of Agriculture. None of the ministries lost interests because of the participation of the National Program, and in fact all ministries shared the authority to decide the policy objectives and policy instrument of the National Program. The policy objectives and policy instrument of the National Program which were decided through inter-ministerial coordination were consistent and appropriate. However, the National Program was implemented without full inter-departmental coordination. Since the implementation bodies of the Ministry of Economic Affairs and the Council of Agriculture both considered their missions towards the regulations of bio-pesticide, they were competing for the leadership. With insufficient inter-departmental coordination, the National Program was not consistently and appropriately implemented. Besides, the Council of Agriculture was the single ministry to execute the Act, and the Bureau was the single implementation body of the Act. If the Minister and the Bureau coordinated with other ministries or other implementation bodies for the promotion of the Act, they may lose their authority to be the single ministry. Under the condition that there was no benefit, such as increasing resources or authority for horizontal coordination, we are not surprised that the Minister and the Bureau had no incentives to form inter-ministerial consensus for the Act and implement it through horizontal inter-departmental coordination. As a result, the policy objective and policy instruments of the Act were not fully consistent with the National Program, and after implementation the appropriateness of the Act was not complementary to the National Program. According to the empirical cases, we agree with Prince (2000) that the departments which set up the agendas and implement

agricultural RTDI policies are full of autonomy. We also agree with the perspective of Braun (2008) and extend his perspective to the field of agricultural RTDI policies unless the elected politicians and administrators could gain or at least secure their benefits through coordination, they have no incentives to horizontally coordinate with each other.

Vertical coordination also deeply influences the consistency and appropriateness of agricultural RTDI policies. Both the National Program and the Act encountered difficulties of vertical coordination. In the case of the National Program, the elected politicians have coordinated the policy objectives and policy instruments of the National Program to be consistent and appropriate. Yet, because of the problem of vertical coordination even though the implementation bodies of different ministries didn't consistently and appropriately implement the National Program, none of the elected politicians were able to amend the distortion. Moreover, in the case of the Act even though the implementation was neither consistent nor appropriate, the Minister didn't fix the distorted implementation. From our perspective, the administrators who worked for the National Program and the Act everyday in the reality were in the much better positions to observe what was going on in the field and had their own judgments for the implementation of the two policies. Since the National Program and the Act were just a small part of the policies which were promoted by the Ministers or the vice-Ministers and in practice each of the Ministers and vice-Ministers had too many policies to monitor, it was almost impossible for them to scrutinize the implementation of the two policies. However, according to the empirical case of the National Program we also find that the improvement of institutions is one of the possible ways to overcome the limitation of Ministers and therefore to improve vertical coordination. If the leaders were nominated by the Ministers of the three ministries, rather than the Minister of the National Science Council, they should be able to supervise and fix the distortion of the implementation of the National Program. Thus, we agree with Moar (2010) that the autonomy of agricultural administrative agencies is high and lots of the administrative adjustment may even against the directions of elected politicians. We also agree with Lindblom and Woodhouse (1993) and extend their perspective to the field of agricultural RTDI policies that the limitation of the elected politicians to supervise implementation is one of the reasons for the difficulties of vertical coordination. Nevertheless, we also consider that the improvement of institutions is one of the possible ways to improve the vertical coordination.

The involvement of external stakeholders is another variable which has deep

influence on the consistency and appropriateness of agricultural RTDI policies. Both cases confirm that only the suitable involvement of external stakeholders has positive contributions to agricultural RTDI policies. The National Program didn't suitably involved the general interests of agricultural academics and companies. After being implemented, the National Program didn't generate sufficient appropriate supports to the development of agricultural innovation system. Moreover, in the case of the Act since the agricultural companies, especially the companies of pesticides, were unable to suitably present their general interests to the actors inside the government, they were very difficult to help the government to make the Act consistent with the National Program and appropriate to match the development of agricultural innovation system. Furthermore, we find two points which extensively deepen the analysis of external stakeholders.

First, the organizations of government deeply influence the capabilities of external stakeholders to influence the consistency and the appropriateness of the agricultural RTDI policies. Various authors in the existing literature (Steinmo and Watts, 1995; May et al, 2005; Rich, 2005) have noticed that presidential polity shapes the organization of government and gives external stakeholders opportunity to influence policies through lobbying the congressmen. Yet, the case of the National Program shows that the presidential polity is not the only factor but the political institution also shapes the organization of the government and gives some external stakeholders more access than others. The institutions of the Steering Committee and Project Committee gave the academic and agricultural representatives special status to influence the agendas of the National Program. Thus, we recognize that it is not only the presidential polity but the political institutions which shape the organizations of the government and the influence of external stakeholders on the consistency and appropriateness of agricultural RTDI policies.

Second, the same external stakeholders have different participation in the different policies. The existing literature, such as Chubb (1983), Bennedsen and Feldmann (2002) and Scott and Cornelius (2005), only depicts that interest groups participate in the policy-making process out of self interests, and Newell (2009) and Fuchs and Glaab (2011) have described how external stakeholders could influence the agricultural RTDI policies. However, this literature doesn't discuss the reasons why the same interest groups have different participation in different policies. In our empirical cases, the agricultural representatives who were active in the policy-making process of the National Program didn't participate in the policy-making of the Act. The agricultural representatives of the National Program didn't participate in the

policy-making process of the Act, because they didn't recognize the interests of the Act. From our point of view, it is the different levels of awareness which influence the different participation of the same external stakeholders. Yet, what are the underlying factors which influence the different levels of awareness of the same external stakeholders? We need more research in the future to fulfill the gap.

To sum up, we confirm and sharpen the conceptual framework by the analysis of our empirical cases by two points. Above all, while our conceptual framework only assumes that the interactions between actors inside the government and external stakeholders would influence the consistency and appropriateness of agricultural RTDI policies, in Figure 6 it is shown by the empirical cases that the networks between the actors inside the government also deeply influence the consistency and appropriateness of agricultural RTDI policies. Second, we confirm the value of the conceptual framework that agricultural RTDI policy-making process is under the context of agricultural innovation system (say agricultural NSTIS). As shown in Figure 6, the Taiwanese government interacted with the external stakeholders in the agricultural innovation system. The interactions deeply influence the consistency and appropriateness of the two policies which further influence the development of agricultural innovation system.

7. Conclusion

This article makes one of the first attempts to open the black-box of agricultural RTDI policy-making process. We judge the roles of the government and the agricultural RTDI policies from the perspective of innovation system and provide the conceptual framework which shows the process to make consistent and appropriate agricultural RTDI policies to foster the development of the agricultural innovation system. The government should thoroughly understand the uniqueness and dynamics of particular agricultural innovation system before making policies. Agricultural RTDI policies copied from foreign countries or another national sector and technology are very difficult to be effective and generate appropriate supports.

However, we also acknowledge two limitations which need to be addressed by future research. First, we only apply the conceptual framework for the analysis of the Taiwanese pharmaceutical biotechnology, and we adopt the qualitative method. We actually need more international comparative studies with broader methodologies to further explore the conceptual framework and analyze how RTDI policies are shaped by different polity and actors' interactions. Second, we are only able to analyze the

influence of RTDI policy-making process on the appropriateness of RTDI policies. Yet, we are unable to at this moment analyze how the policy-making process of the two policies influences their effects and effectiveness in the long-term. The influence of policy-making process in the long-term needs the research in the future to explore it.

References

- AMMONS, D. N., COE, C. & LOMBARDO, M. 2001. Performance-Comparison Projects in Local Government: Participants' Perspectives. *Public Administration Review*, 61, 100-110.
- BARKER, A. & PETERS, B. G. (eds.) 1993. *The Politics of expert advice : creating, using and manipulating scientific knowledge for public policy* Edinburgh Edinburgh University Press.
- BENNESEN, M. & FELDMANN, S. E. 2002. Lobbying legislatures. *The Journal of Political Economy*, 110, 919-946.
- BRAUN, D. 2008. Organizing the political coordination of knowledge and innovation policies *Science and public policy*, 35, 227-239.
- CARLSSON, B. 2000. A systems framework for the study of economic and social dynamics of biotechnology. In: MOTHE, J. D. L. & NIOSI, J. (eds.) *The economic and social dynamics of biotechnology* London: Kluwer Academic Publishers.
- CHUBB, J. 1983. *Interest groups and the bureaucracy : the politics of energy*, Stanford, Calif., Stanford University.
- CHUNG, C.-C. 2012. National, sectoral and technological innovation systems: The case of Taiwanese pharmaceutical biotechnology and agricultural biotechnology innovation systems (1945–2000). *Science and public policy*, 39, 271-281.
- CHUNG, C.-C. 2013. Government, policy-making and the development of innovation system: The cases of Taiwanese pharmaceutical biotechnology policies (2000–2008). *Research Policy*, 42, 1053-1071.
- CIRONE, A. E. & URPELAINEN, J. 2013. Political market failure? The effect of government unity on energy technology policy in industrialized democracies. *Technovation*, 33, 333-344.
- CLARK, N. 2002. INNOVATION SYSTEMS, INSTITUTIONAL CHANGE AND THE NEW KNOWLEDGE MARKET: IMPLICATIONS FOR THIRD WORLD AGRICULTURAL DEVELOPMENT. *Economics of Innovation and New Technology*, 11, 353-368.
- COX, G. & MCCUBBINS, M. 2000. The Institutional Determinants of Economic Policy Outcomes *Weatherhead Center for International Affairs Conference* Harvard University: Harvard University.
- ELMORE, R. 1997. Organizational modes of social program implementation. In: HILL, M. (ed.) *The Policy process : a reader*. Harlow: Prentice Hall.
- FERNANDEZ, S. & FABRICANT, R. 2000. Methodological Pitfalls in Privatization Research: Two Cases from

- Florida's Child Support Enforcement Program. *Public Performance & Management Review*, 24, 133-144
- FUCHS, D. & GLAAB, K. 2011. Material power and normative conflict in global and local agrifood governance: The lessons of 'Golden Rice' in India. *Food Policy*, 36, 729-735.
- HAKIM, C. 2000. *Research design : successful designs for social and economic research*, London Routledge
- HALL, A. 2005. CAPACITY DEVELOPMENT FOR AGRICULTURAL BIOTECHNOLOGY IN DEVELOPING COUNTRIES: AN INNOVATION SYSTEMS VIEW OF WHAT IT IS AND HOW TO DEVELOP IT. *Journal of International Development*, 17, 611-630.
- HARVEY, M. & PILGRIM, S. 2011. The new competition for land: Food, energy, and climate change. *Food Policy*, 36, S40-S51.
- HERRIOTT, R. E. & FIRESTONE, W. A. 1983. Multisite Qualitative Policy Research: Optimizing Description and Generalizability. *Educational Researcher*, 12, 14-19.
- HOWLETT, M. & MIGONE, A. 2010. Explaining local variation in agri-food biotechnology policies: 'green' genomics regulation in comparative perspective. *Science and Public Policy*, 37, 781-795.
- INZELT, A. 2008. Private sector involvement in science and innovation policy-making in Hungary. *Science and public policy*, 35, 81-94.
- LAAGE-HELLMAN, J., RICKNE, A. & MCKELVEY, M. (eds.) 2004. *The economic dynamics of modern biotechnology*, Cheltenham: Edward Elgar.
- LAVER, M. & SHEPSLE, K. A. 1996. *Making and breaking governments : cabinets and legislatures in parliamentary*, Cambridge Cambridge University Press.
- LINDBLOM, C. E. & WOODHOUSE, E. J. 1993. *The policy-making process*, Englewood Cliffs, N.J., Prentice Hall.
- MAY, P. J., JONES, B. D., BEEM, B. E., A, E., NEFF-SHARUM & POAGUE, M. K. 2005. Policy Coherence and Component-Driven Policymaking: Arctic Policy in Canada and the United States. *Policy Studies Journal*, 30, 37-63.
- MOAR, M. 2005. Organizational Reputation and Jurisdictional Claims The Case of the U.S. Food and Drug Administration. *Governance*, 23, 133-159.
- MOGEE, M. E. 1988. Knowledge and politics in innovation policy design. In: ROESSNER, D. (ed.) *Government innovation policy : design, implementation, evaluation*. London Macmillan in association with the Policy Studies Organization.
- MONTPETIT, E. 2005. A Policy Network Explanation of Biotechnology Policy Differences between the United States and Canada. *Journal of Public Policy*, 25, 339-366.
- NEWELL, P. 2009. Bio-Hegemony: The Political Economy of Agricultural Biotechnology in Argentina. *Journal of Latin American Studies*, 41, 27-57.
- PIFFNER, J. 1994. *The modern presidency* New York St. Martin's Press.
- POLLITT, C. 2006. Academic Advice to Practitioners-What is its Nature, Place and Value Within Academia? *Public Money & Management*, 26, 257.
- PRINCE, M. 2000. Banishing Bureaucracy or Hatching a Hybrid The Canadian Food Inspection Agency and the Politics of Reinventing Government. *Governance* 13, 215-232.

- RICH, A. 2005. *Think tanks, public policy, and the politics of expertise* Cambridge, Cambridge University Press.
- SADOVNIK, A. 2007. Qualitative research and public policy. *In: FISCHER, F., MILLER, G. & SIDNEY, M.*
(eds.) *Handbook of public policy analysis : theory, politics, and methods*. UK: Taylor & Francis Ltd.
- SCOTT, R. F. & CORNELIUS, M. K. 2005. Interest Group Participation in Rule Making: A Decade of Change.
Journal of Public Administration Research and Theory, 15, 353-370.
- STEINMO, S. & WATTS, J. 1995. It's the Institutions, Stupid! Why Comprehensive National Health Insurance
Always Fails in America. *Journal @Health Politics, Policy and Law*, 20, 329-372.
- STRIC 2006. *Strategic planning on the development of Taiwan agricultural biotechnology industry* (台灣農業生
技產業發展策略規劃報告書), Taipei, Science and technology research and information center
- TOURNON, J. 1993. The state as blind investor in fundamental research *In: BARKER, A. & PETERS, B. G.*
(eds.) *The Politics of expert advice : creating, using and manipulating scientific knowledge for public
policy* Edinburgh Edinburgh University Press.
- WEATHERFORD, M. S. 1994. The Puzzle of Presidential Leadership: Persuasion, Bargaining, and Policy
Consistency. *Governance: An International Journal of Policy and Administration*, 7, 135-164.
- WONG, J. 2005. Re-Making the Developmental State in Taiwan: The Challenges of Biotechnology. *International
Political Science Review*, 26, 169-191.
- WRIGHT, B. D. 2012. Grand missions of agricultural innovation. *Research Policy*, 41, 1716– 1728.

