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The Current State of the Insect Industry and Direction for Fostering Policy

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▪ "KREI Agricultural Policy Focus" relates to analysis and description of the trend of and policy for agriculture and rural areas.

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◇ Abstract ◇

○ The global insect market is growing with the noteworthy potential of the insect industry, and along with this trend, the insect market in Korea has expanded to be valued at KRW 300 billion as of 2015. The market is expected to grow further by 1.7 times from the present scale (2015), reaching KRW 540-560 billion by 2020. In particular, the market for insects for feed and as medicine is predicted to grow dramatically over the coming years. Nevertheless, the awareness of the domestic insect sector as an industry is still very low, calling for proper measures to deal with such limitations.

- The insect markets for feed, medicine, and development of insect-based biomaterials are forecasted to drastically grow.
- The size of the pollinating insect market is also expected to expand by 33% from the current state to KRW 57.5 billion. The market for insects as natural enemies is predicted to grow by 33% to KRW 4-6.7 billion, thanks to an increasing interest in health and the environment and the government policies for fostering eco-friendly farming.

○ However, the burden of investment in facilities for insect-related business and difficulties in managing diseases undermine the willingness of farmers to produce insects. Consumers of insects in urban regions also complain about poor accessibility to purchase insects and hardships in rearing management.

- Producers of insects point out the problems in operating expenses, disease control techniques, and prediction of demand for insects. Farms that use insects for pollination (for growing vegetables and fruits) tend to show a negative perspective on the quality and effect of insects.
- People who consume insects for the purpose of education or as pets point out the complexity of insect rearing management, the lack of diversity of species that is limited to rhinoceros beetle and stag beetle, and unreasonable prices.

○ It is needed to increase the income of insect producers, set the direction of policy for increasing the satisfaction level of consumers of insects, and improve relevant laws and regulations.

- In order to foster the insect industry that is still in the early stage, it is necessary to build a medium- and long-term policy for development of the industry, to continuously implement government policies and invest in R&D projects, to define the role of each stakeholder of the industry, and to make efforts to accomplish such goals.
- It is crucial to register the types of edible insects or those for medicine, and design various promotion measures to improve the awareness of insects. The import of harmful insects should be strictly managed, in particular, to remove any factors that weaken the potential of the insect industry.

○ This study provides a priori approach to explain the direct and indirect effects of the production and use of insect resources. If there is an opportunity to quantitatively analyze the effects in the future, such a study will contribute significantly to the growth of the insect industry.

1. Need for Fostering the Insect Industry

□ The global insect market is growing and new light is shed on the value of insects.

○ The insect market is growing every year around the globe. In Japan, the market for insects as pets was formed in the 1980s, and the industry has grown in earnest since then. The insect market is on the rise, particularly focusing on insects for pollination in Europe, those as natural enemies in Canada and the US, and edible insects in Asian countries such as China and Thailand.

○ In major countries, attentions are turning again to the value of insects as a medium of pollination and natural enemies and for purification of the environment, with an increasing significance of green farming. These nations have designated and nurtured the insect sector as one of their strategic industries.

○ Such a trend is attributed to emerging problems in the existing pesticide application methods, a growing importance of eco-friendly pollination with consideration for climate change, and the sector of functional food and medicinal insects being recognized as a new market with the well-being trend. The importance of insects for purifying livestock manure and food waste and for feeding livestock is also on the rise.

□ The insect market in Korea has grown to be valued at KRW 300 billion as of 2015.

○ It is assumed that the Korean insect market continued to flourish to be valued at KRW 168 billion in 2011 and at KRW 300 billion in 2015

(with the scale of the relevant forward and backward industries excluded). The markets in the agricultural sector in such a scale (KRW 300 billion) are for pear, cucumber and green chili. The insect market is smaller than that of chili or garlic, but larger than that of bell pepper or peach. While these vegetable markets are expected not to grow dramatically over the medium and long term, the insect market is more likely to experience exponential growth.

○ Given the growth of environmentally friendly farming methods and protected agriculture, the market for insects as natural enemies and for pollination seems to be promising. The new markets of insects for feed and medicine in connection with biotechnology are expected to have high growth potential.

Table 1. Estimated Size of the Useful Insect Market in Korea

Purpose of Use	Type of Insect	Market Size (KRW 100 million)	
		2011	2015
Education & Pet	About 50 species including rhinoceros beetle, stag beetle, cetonia pilifera, etc.	778	421-545
Pollination	Bombus agrorum, upholsterer bee, honeybee	340	432
Natural Enemy	34 species including ladybug, aphidoletes aphidimyza, phytoseiulus persimilis, etc.	96	30-50
Local Festivals	Butterflies, firefly, etc.	400	1,816
Feed & Medicine	Ptecticus tenebrifer, larva of scarab, spider, leech, etc.	25	80-90
Others		41	200
Total		1,680	2,979-3,133

Source: Rearranged sources from Gyeongsangbuk-do (www.gb.go.kr/open_content/new-jamsa/new/pages/bug/bugIndustry_01.jsp: 2015.9.20.) and B. S. Kim (2007: 39-47).

☐ It is urgently needed to nurture the insect sector as a future industry with its huge potential.

○ Insects are utilized for various purposes at home and abroad, including prevention of harmful insects, pollination, education and keeping as pets. The production and sales of insects can increase the income of farm households, and the acceleration of the use of insects can contribute to fostering green farming methods.

○ The use of insects as resources for local tourism and festivals, such as the establishment of insect ecology experience centers and ecology education programs, can boost local economy. In addition, now is the time to take the advantageous position in the global bioindustry earlier than competitors by using new functional substances extracted from insects to develop functional food and medicinal ingredients, while coming up with measures to replace imported insects.

○ Despite such a potential of the insect industry, the awareness of the sector as an industry is still low in Korea. The country needs to develop new methods of using insects, and make effort and provide support for the use of them. It is also necessary to establish plans to foster the insect sector as a future industry.

2. Prospects for the Insect Market by Purpose of Use

□ The insect market for local festivals is the largest of its kind, followed by the market for pet insects and that for pollination.

○ The useful insect market is worth KRW 303.9-319.3 billion as of 2015. Among various subcategories, the market for insects used in experience centers and insect ecology learning centers is estimated to be valued at KRW 180 billion, that for insects for learning at KRW 4.9 billion, that for pet insects at about KRW 37.2-49.6 billion based on the market price (consumer price) of live insects, and that for pollinating insects at KRW 43.2 billion based on the required number of colonies of insects and the market price of each colony.

○ According to the study by B. S. Kim (2007), the market for insects as natural enemies was predicted to show the largest growth potential, but the market rapidly declined due to the cessation of the government-supported dissemination project in 2011, which is now stagnant at around KRW 3-5 billion.

○ The edible insect market is forecasted to have high growth potential, which is still in the early stage, valued at KRW 6 billion. The market for insects for feed is estimated to be worth KRW 6 billion, based on the result of previous studies. In terms of medicinal insects, the market size is valued at KRW 2-3 billion when counting only larvae of rhinoceros beetle and cetonia pilifera except for silkworm that is not included in the scope of the research.

○ The market for insects for local events and festivals is estimated to be worth KRW 181.6 billion, considering the scale of the Butterfly Festival in Hampyeong (KRW 30.2 billion), the Firefly Festival in

Muju (KRW 52 billion), and the Insect Bio Expo in Yecheon (KRW 99.4 billion).

□ The insect market is predicted to grow by 1.7 times compared to the current size, reaching KRW 540-560 billion by 2020.

○ This estimation of the size of the useful insect market, with sericulture and apiculture excluded, was drawn from the surveys of farms and companies specialized in handling insects, and interviews with insect experts. However, several sectors (e.g. insects traded at medicinal herb markets) are not reflected in this study due to the absence of official research and statistics of each subcategory and the limitations in research period and budget.

○ The size of the useful insect market is expected to increase by 1.7 times, reaching approximately KRW 536.3-558.2 billion by 2020, particularly with the rapid growth of the insect markets for feed, medicine, and insect-based biomaterials. The markets for educational purposes, pet insects, pollination, and local festivals are also forecasted to show a remarkable growth rate of 30-40%.

○ To be specific, the insect market for the purpose of education is predicted to grow by 40% from 2015, reaching KRW 6.9 billion, while the pet insect market is expected to expand by 40% to KRW 52.1-69.4 billion.

○ The pollinating insect market is forecasted to grow by 33% to KRW 57.5 billion, according to the estimation based on the current required number of colonies of insects and the market price per colony. In terms of insects used as natural enemies, the market is expected to expand to be worth KRW 4-6.7 billion with the reduced use of pesticide and

chemical fertilizers (a 40% decrease) due to growing attention to health and environment issues and eco-friendly government policies.

○ The edible insect market is predicted to grow by 16.9 times to be valued at KRW 101.4 billion, as seven species of insects have been officially registered as food. The market for insects for feed, which have potential as alternative products replacing animal feed, is expected to grow by a whopping 205%, reaching KRW 18.3 billion.

○ The medicinal insect market is forecasted to reach KRW 3.9-5.8 billion, growing by 93% from the current size. The market for insects used in festivals is expected to be valued at KRW 254.2 billion, an increase by 40% from the current scale of KRW 181.6 billion. The market for insect-based useful materials is also predicted to grow by 93% to KRW 38 billion, given the current market size and the growth of relevant medicines, including arazyme－a type of enzyme originated from indigenous garden spider, dermatitis medicine using peptide coprisin from dung beetle, atopic dermatitis medicine originated from scolopendrid, and Tong Xin Lou－a type of herb medicine for cardiovascular diseases.

Table 2. Estimation and Prospect for the Size of the Useful Insect Market

Purpose of Use	Type of Insect / Material / Region	Market Size (KRW 100 million)	
		2015	2020
Education	Experience centers, insect ecology learning centers, etc.	49.4	69.1
Pet	About 50 species including rhinoceros beetle, stag beetle, cetonia pilifera, etc.	372-496	521-694
Pollination	Bombus agrorum, upholsterer bee, etc.	432	575
Natural Enemy	34 species including ladybug, aphidoletes aphidimyza, phytoseiulus persimilis, etc.	30-50	40-67
Food	Grasshopper, pupa, tenebrio molitor, larva of protaetia brevitarsis seulensis, larva of rhinoceros beetle, cricket, etc.	60	1,014
Feed	Ptecticus tenebrifer, cricket, mealworm, etc.	60	183
Medicine	Larva of protaetia brevitarsis seulensis, larva of rhinoceros beetle, etc.	20-30	39-58
Local Festivals	Hampyeong-gun, Muju-gun, Yecheon-gun, etc.	1,816	2,542
Insect-based Useful Materials	Arazyme, coprisin, scolopendrid, Tong Xin Lou, etc.	200	380
Total		3,039-3,193	5,363-5,582

3. Issues in the Production and Use of Insects and Direction for Improvement

3.1. Issues in the Production of Insects and Direction for Improvement

□ Insect producing farms are faced with the heavy burden of expenses for facilities and difficulties in disease control.

○ The survey of insect producers (the members of the Korea Insect Industry Association) shows that insect producing farms struggle mostly with the shortage of expenses for facilities and operation (29.1%) and the lack of techniques for insect rearing and disease control (20.3%).

○ The burden on insect producers in estimating the total output is also huge because the forecast of demand for insects is demanding. In particular, the oversupply of insects for education and pet insects has lowered the market price of the products, leading to bankruptcy of a number of farms and companies.

Table 3. Difficulties in Insect Rearing Experienced by Producing Farms

Issue	No. of Responses	Proportion (%)
Lack of expenses for facilities and operation	76	29.1
Shortage of techniques for insect rearing and disease control	53	20.3
Difficulties in estimating the proper amount of output for selling insects	46	17.6
Low income	32	12.3
Shortage of labor force	17	6.5
Difficulties in obtaining information about the source of feed for each type of insect	9	3.4
Others	28	10.7
Total	261	100.0

Source: The result of the survey of the members of the Korea Insect Industry Association (multiple responses).

☐ It is urgently needed to support the expenses for production, manage the import of harmful insects, and utilize insects as supplementary materials for education.

○ The survey of insect producing farms was conducted by dividing the direction for development of the industry specifically for educational purposes and pet insects into production, distribution and consumption. According to the result, the demand for expanding support for producing farms (and companies) is highest (46.4%) in the production sector. A large number of respondents also call for boosting the production of insects by implementing policies for increasing demand.

Table 4. Demands of Insect Producing Farms for Development Plan for Each Function of the Edible and Medicinal Insects Industry

	Development Plan	Proportion (%)
Production	Accelerating the production of insects by establishing the policy for expanding the demand for edible and medicinal insects	20.7
	Expanding the dissemination of techniques for mass production of edible and medicinal insects	6.9
	Distributing the techniques for preventing disease and pest and rearing insects	17.2
	Promoting the effect of edible and medicinal insects towards consumers	10.3
	Easing the regulations on the production of edible and medicinal insects	3.4
	Providing partial support from the central and local governments to insect producing farms (and companies)	41.4
	Total	100.0
Distribution	Reorganizing the laws and regulations on the sales of edible and medicinal insects	35.7
	Expanding the demand for edible and medicinal insects by indicating their effects and outcome	32.1
	Loosening the regulations on the distribution of edible and medicinal insects	32.1
	Total	100.0

	Development Plan	Proportion (%)
Consumption	Promoting the effects of edible and medicinal insects	31.0
	Opening and operating stores specifically for edible and medicinal insects	24.1
	Mitigating the regulations on the consumption of edible and medicinal insects	20.7
	Developing new items to pioneer new markets for edible and medicinal insects	24.1
	Total	100.0

Source: The result of the survey of the members of the Korea Insect Industry Association (multiple responses).

○ In the distribution sector, various responses take up similar proportions, including the reorganization of the laws and regulations on the sales of edible and medicinal insects, the indication of the effects and outcome of these insects, and the mitigation of the regulations on the distribution of edible and medicinal insects.

○ In the consumption sector, the demand is high for the promotion of the effect of insects and the operation of insect stores.

○ In terms of the direction for development of the industry, farms producing edible and medicinal insects in the production sector, like the farms producing insects for education and pet insects, put an emphasis on the support and demand policies of the central and local governments.

○ In the distribution sector, the proportions of the following answers were almost equal: the reorganization of laws and regulations on the sales of edible and medicinal insects, the indication of the functional effects of the insects, and the mitigation of distribution-related regulations. There is an issue in the distribution sector, in which insects are often traded

outside the legal boundary. Therefore, it is crucial for edible and medicinal insects to be recognized as legal food products as soon as possible based on research on their ingredients and effects, thereby facilitating the industry of edible and medicinal insects.

3.2. Issues in the Use of Insects and Direction for Improvement

□ Farms that utilize insects have a negative perspective towards the quality and effect of insects.

○ Farmers who cultivate crops using insects as natural enemies point out "the uncertain quality and effect (33.3%)" and "high price (22.2%)" as the biggest problems in the use of insects. Among other issues brought up are the increase in purchasing price and the lack of information about the method of using insects as natural enemies and their effects.

○ A majority of farms that use insects for pollination point out that "it is hard to purchase insects at the proper timing" and that "companies selling insects do not provide proper after-sales service." In addition, each company provides a different number of bees per hive, and some companies even use exaggerated advertising. It is also challenging for farmers to obtain sufficient information about management techniques for pollinating insects.

Table 5. Difficulties in the Use of Insects as Natural Enemies and for Pollination

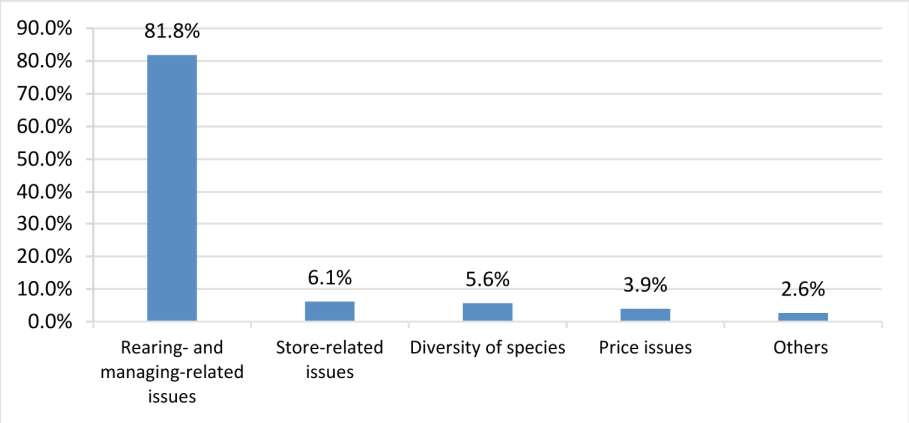
	Difficulties in the Use of Insects	Proportion (%)
Farms using insects as natural enemies	Uncertain quality and effects	33.3
	Excessively high price of insects as natural enemies	22.2
	Increased purchasing price of insects due to the suspension of government support and loans	18.5
	Insufficient information about insects as natural enemies proper to tackle disease and pest	11.1
	Insufficient information about the use and management of insects	14.8
	Total	100.0
Farms using insects for pollination	Excessively high price of insects as pollinators	35.0
	Uncertain effect of pollinating insects	14.0
	Deficient information about the use and management of insects for each type of crop	11.5
	Difficulties in purchasing pollinating insects at the proper timing	7.0
	Others	32.5
	Total	100.0

Note: Data estimated by applying 200% weighting to the first responses and 100% weighting to the second responses.
Source: The result of the survey of sample farm households producing fruits and vegetables, conducted by the Agricultural Outlook Center at KREI (multiple responses).

□ Insect consumers in urban regions complain about difficulties in rearing and managing insects.

○ According to the responses regarding problems in rearing insects for education and pet insects, ordinary consumers (475 households as consumer panels of KREI) point out the difficulties in rearing and managing insects as the biggest problem (81.8%). Other issues take up similar proportions to one another, including store-related issues, diversity of species, and price issues.

Figure 1. Problems in Rearing Pet Insects (Large Category)



Source: The result of the survey of KREI consumer panels (1,000 respondents; the response rate at 47.5%; multiple responses).

○ According to the responses to more detailed questions regarding problems in rearing pet insects as mentioned above, 60.9% of the respondents, the largest proportion, point out that there are not various stores out there to buy insects. In terms of price issues, a majority of consumers find it expensive to buy required equipment (50.0%), including feed (and feeding tools), pieces of wood for play, and rearing boxes.

Table 6. Problems in Rearing Pet Insects

	Issues	Proportion (%)
Store	Difficult to purchase insects due to the lack of stores nearby	60.9
	Hard to trust companies selling insects	21.7
	Need to rely only on online search due to the lack of store information	8.7
	Frequent closure of insect stores	8.7
	Total	100.0
Price	Expensive equipment including feed (and feeding tools), pieces of wood for play, and rearing boxes	50.0
	Expenses for consultation regarding purchase and rearing of insects (communication and transportation expenses)	25.0
	High price of insects	15.0
	Others	10.0
	Total	100.0

	Issues	Proportion (%)
Manage-ment	Insects easily die	41.3
	Lack of comprehensive guidelines for insect rearing	20.6
	Hard to keep multiple species of insects as the rearing methods are different for each type of insect	17.5
	Disposal of excrement of insects is demanding	12.2
	Shortage of feed-related information	5.8
	Others	2.6
	Total	100.0

Source: The result of the survey of KREI consumer panels (multiple responses).

○ In terms of rearing- and management-related issues, 41.3% of the respondents point out the short life span of insects and their vulnerability to death, and 20.6% complain about the lack of comprehensive guidelines for insect rearing. Other issues include difficulties in rearing multiple species of insects due to the different characteristics (17.5%) and challenging excrement disposal work (12.2%). Some responses are related to demanding rearing works, the occurrence of other bugs, and difficulties in giving insects to others when their numbers increase due to breeding.

□ It is necessary to improve the accessibility to rearing-related information and develop new insect-based theme industries.

○ The consumption of insects in urban regions can be accelerated by increasing the number of specialized stores and improving accessibility. It is needed to utilize current large-scale distributors across the country or establish insect shops in key regions. Such efforts would contribute to alleviating the burden on insect producers to distribute products. However, given the current system where producers take charge of distributing their products, measures to minimize the damage to such farmers should be implemented in phases.

○ In addition, it is crucial to make continuous efforts to develop insect-based amenities and theme parks in an efficient way, along with teaching plans and training programs. The insect rearing kits and insect specimens as accessories should be diversified, and measures to safely remove harmful features of insects are also needed.

4. Policies Fostering the Insect Industry and Implications

4.1. Basic Direction

□ **With the rapid growth of the insect industry, it is necessary to establish medium- and long-term development strategies and define roles of the stakeholders of the industry.**

○ The insect sector is an emerging industry, with its market worth KRW 300 billion, which is similar to those of other crops (pear, cucumber, green chili, etc.). But while the markets of these other crops are expected to be stagnant or grow slightly over the next five to ten years (according to the KREI-KASMO model estimation), the insect market size is predicted to double or triple by 2020 compared to 2015.

○ Accordingly, such a remarkable growth of the insect industry, which is still in the early stage, should be backed by medium- and long-term development plans, continuous government policies and investment in R&D, along with the allocation of roles for all stakeholders in the industry and proper efforts to achieve such goals.

□ **It is crucial to set the direction for policies that can enhance both the income of insect producing farms and the satisfaction level of consumers.**

○ The policy for the growth of the insect industry should be focused on increasing the income of both insect producers and farmers engaged in controlled horticulture (vegetables and fruits) that use insect resources (as natural enemies or for pollination). Moreover, the income of farm

households producing pet insects, edible insects and those for education and feed should increase with the enhancement of consumer satisfaction level considered. It is also needed to utilize insects in connection with the stable supply of food for public interest, the provision of green and safe agricultural products, improvement of the environment, and the sixth industry of local governments.

○ To this end, it is crucial to set "the increase of farm household income and reinforcement of the function of public benefit by nurturing the insect industry" as a policy goal. In order to accomplish this goal, implementation strategies should be designed specifically for each sector of production, distribution, consumption, R&D and education, and promotion, with clearly defined roles of stakeholders of the industry.

4.2. Plans for Improving Insect-related Laws and Regulations

□ Registering specific insects as edible resources and improving the awareness of insects

○ Currently, several species, including tenebrio molitor, larva of protaetia brevitarsis seulensis and imago of rhinoceros beetle, are temporarily recognized as edible ingredients. But since these species are recognized as food only for the limited period of time, they need to be registered as food permanently for the long-term growth of the edible insect industry. To this end, there should be support for promotion and sales of edible and medicinal insects, and related institutions should take charge of inspection of edible insects that is hard to be conducted by farmers, or support the process of certification of edible insects. In addition, edible insect rearing should be strictly managed to guarantee

high quality, while research for registration of insects as food should be accelerated.

○ The result of the survey of consumer panels, conducted by the Agricultural Outlook Center at KREI, shows that the first impression of insects is unfavorable as follows: creepy, scary, dark and terrifying. Despite their high inherent values, aversion to edible insects serves as a major stumbling block to the growth of the industry. Therefore, it is necessary to improve the awareness of insects through on-site education and tasting programs, excluding the existing audiovisual materials for education and promotion. As part of such efforts, the Rural Development Administration recently conducted the contest for naming two edible insects, tenebrio molitor and protaetia brevitarsis seulensis, and selected familiar names for them: *gosoae*, meaning "a savory larva," and *ggotbaengi*, a word combining "flower" and "larva."

□ Providing efficient support for government projects

○ In order to prove the usefulness of insects, financial support should be granted to pilot and empirical projects at the level of local governments or the Rural Development Administration. Efficient policy support is also needed, including selective support for farmers as beneficiaries and agricultural products cultivated by using insects. In terms of farming, insects used as natural enemies and those as pollinators cannot be considered separately. Accordingly, it is necessary to design an integrated support program combining two types of insects and create synergy effect of eco-friendly agricultural products.

○ Moreover, the government should accelerate production and commercialization in insect producing farms by expanding the number of its specialized consulting experts in the insect industry. In this

regard, budget should be separately allocated to the insect industry as part of the agricultural and forestry technology development project.

☐ Supporting insect rearing and distribution facilities

○ The current insect industry is in a poor condition compared to other industries, implying that there are large gaps in technologies and systems within the industry across all sectors including production, distribution and consumption. It is crucial for the industry to achieve outcomes through the choice and concentration strategy rather than excessive support to a large number of beneficiaries.

○ To this end, it is important to select beneficiaries by comprehensively considering specific commodity producer groups and associations, and come up with plans to support common facilities. In terms of insects for feed, in particular, it will be easier for the government to accomplish the growth of the industry by operating facilities for producing and processing insects as food resources and supporting low-priced feed to farm households.

○ Furthermore, insect rearing facilities should be legally recognized as agricultural installations so that such facilities can benefit from support for electricity and tax-free oil for the agricultural purposes, which are already enjoyed by general farm households.

☐ Tightening the requirements for qualifications for insect rearing

○ In terms of pilot projects for farm households that are currently ongoing or expected to be implemented in the coming years, it is important to select promising farms. So it is essential to issue the certificate of permission for each purpose of insect rearing, and clarify the standards of permission for rearing, processing and distribution.

Such efforts will make it easier to identify the overall insect industry and provide more accurate information in the process of recording relevant statistics.

○ Further, the regulations on the sanitation management standards, the traceability system, and the self-inspection system should be newly established to secure the proper conditions for rearing and distributing insects, where safety and functionality are verified.

□ Reassessing eco-friendly methods of cultivation and handling import/export-related issues

○ It is necessary to establish institutions for certifying agricultural products cultivated by using insects as natural enemies and pollinators as eco-friendly products. In particular, a cultivation technique based on the use of insects should be recognized as one of the agricultural production techniques, not just as a pesticide-free or organic method. The Bee Friendly Farming Certification in the US is an exemplary case worth benchmarking.

○ In the case of rearing or distributing exportable indigenous natural enemies or edible and medicinal insects, the export expenses need to be supported within the available range. To boost the market of insects for education or pet insects which lack diversity of species in Korea, laws and institutions should be established first to import foreign pure breeds and disseminate or sell in large quantity around the country, while importing quality edible and medicinal insects and expanding the base of the domestic insect industry. Furthermore, indigenous insects and imported harmful insects need to be systematically managed.

☐ Improving the laws and regulations related to the insect industry

○ Oak sawdust, fermenting agent and oil, which are required for insect rearing, are not included in the list of duty free items, leading to an increase in operating expenses. It is necessary to expand the range of duty free items to encompass various tools required for insect rearing, including oak sawdust, fermenting agent, oil, sawdust fermentation mixer, agricultural air conditioner, and electric heater (Paragraphs 1 and 2, Article 14, Act on Fosterage and Support of the Insect Industry).

○ Most insect experience farms, except for several advanced ones, tend to largely rely on insect rearing, and farm households producing edible and medicinal insects also lack infrastructure. In terms of the production of rhinoceros beetle and protaetia brevitarsis seulensis, for instance, waste wood left after the cultivation of shitake mushroom is utilized, which is available only once a year in a natural way. Therefore, it is desperately needed to modernize the production facilities that allow production of edible and medicinal insects in large quantities all year round.

○ It is urgently needed to introduce the automated conditioning system in panel-type or assembled greenhouse facilities for insect rearing, large shelves for mass production, and the automated indoor temperature-humidity control system, and modernize feed (fermented sawdust) production facilities in a proactive way (Paragraph 1, Article 14, Act on Fosterage and Support of the Insect Industry). With such efforts, the production of edible and medicinal insects will be on the rise with breeding available three or four times a year, producing 12-15 kg per 3.3 m^2, compared to breeding once a year and producing 1-1.5 kg per 3.3 m^2 in a natural method.

○ Since there are no regulations on the succession of the status of farmers engaged in rearing, production, processing and distribution of insects under the current laws, in case successors want to continue the business, they need to report the cessation of business and the start of the business again to the competent authorities. With such inefficient regulations on the succession of business, successors need to take much time and money to report to the authorities with all human resources and material conditions prepared, which imposes unnecessary burden on business operators. Therefore, there should be clear regulations on the succession of business for those engaged in the insect industry, thereby simplifying the administrative procedures and providing convenience.

○ As the preference of consumers towards pets has been diversified, an increasing number of people keep spiders or scorpions as pets. The deathstalker, a kind of scorpion that has deadly poison, is forbidden to be imported as it may harm national health, in accordance with Subparagraph 3 of Article 237 of the Customs Act, but it is now being smuggled into Korea and distributed around the country, and consumers can easily buy it on the internet. In order to control this situation, it is crucial to implement the legislative bill, specifying: “Among the insects recognized as being harmful according to the risk assessment, deadly poisonous scorpions and spiders are defined as the insects designated under the presidential decree, and rearing, trade and distribution of these harmful insects are prohibited except for the purposes of use approved by the presidential decree, and fines and penalty are imposed to violators (Subparagraph 2 of Paragraph 1 of Article 2, Paragraph 2 of Article 10, Paragraph 1 of Article 16 are newly added to the bill).”

4.3. Roles of Each Stakeholder

○ The roles of each stakeholder are significant in increasing the income of farm households based on the insect industry and reinforcing the function for pursuing public interest. It will be reasonable to divide the roles among relevant institutions, including the Ministry of Agriculture, Food and Rural Affairs (MAFRA), the Rural Development Administration (RDA), local governments, the Korea Forest Service (KFS), insect-related associations and organizations, universities and government-funded research institutes, and insect resources industrialization support centers. The roles of each stakeholder can be allocated as follows.

□ **The government and relevant institutions should supervise the implementation of policies, coordinate works between government departments, continue to explore useful insects, and disseminate mass production techniques.**

○ MAFRA should supervise the implementation of policies related to the insect industry, establish policies for increasing the demand for insects, conduct projects for supporting insect producing companies (farms), provide feedback on the demand for technologies and policies, coordinate and develop policies between government departments, and support the modernization of production facilities for each purpose of use of insects.

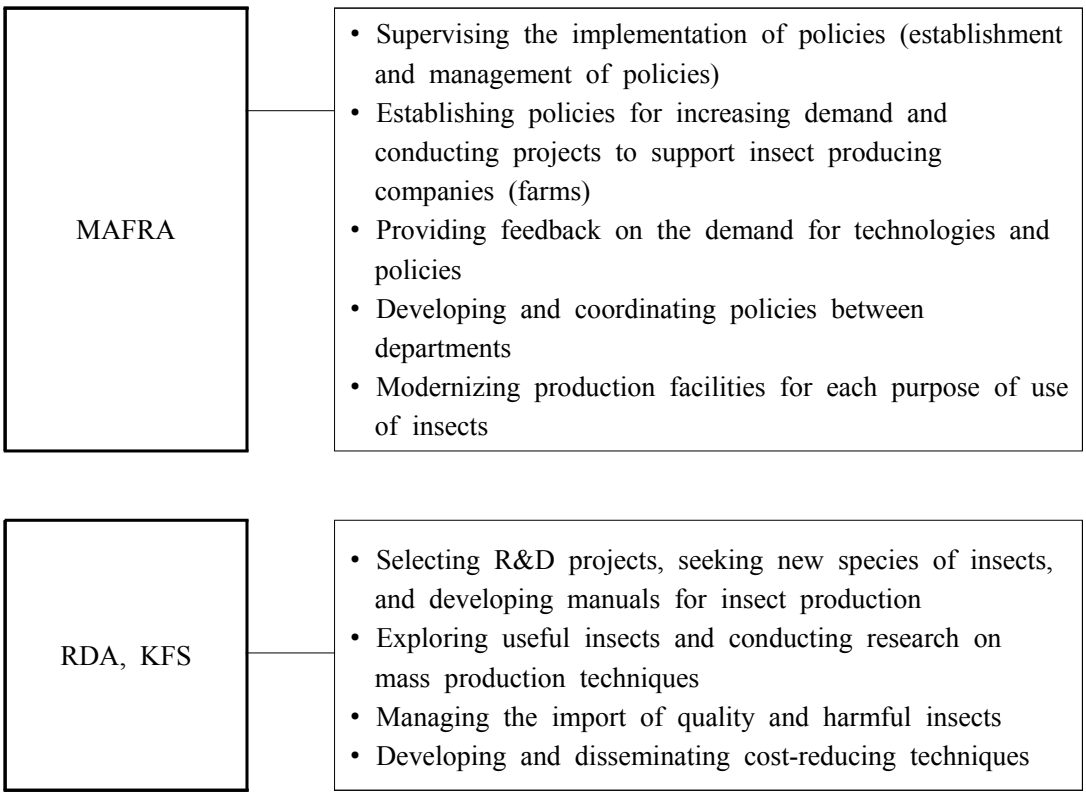
○ RDA should select R&D projects, seek new species of insects, and develop manuals for efficient production of insects. The Administration needs to continuously explore useful insects and develop mass production techniques, while managing the import of quality or harmful insects and comprehensively handling with civil complaints related to

insects, thereby drawing basic data and materials for establishing policies.

□ The private sector should transfer techniques to farms and build the cooperative system between farmers.

○ Insect-related associations should take charge of on-site demand surveys regarding the pioneering of new markets, insect consumption and support for farm households, and develop mass production techniques focusing on production fields in cooperation with RDA. In addition, associations should take the lead of transferring developed techniques to farms and consolidating mutual cooperative relationships and information sharing systems between farmers. At the same time, they should come up with measures to promote insects by creating check-off funds.

Figure 2. Roles of Stakeholders for Development of Insect Industry



	• Developing functional materials through research on medicinal effects and useful substances • Setting the direction of technological development for each purpose of use of insects by reflecting changes in consumption patterns • Introducing the quality control and certification system for each purpose of use of insects • Developing techniques to prevent disease and pest
Insect-related associations	• Jointly purchasing production materials and equipment • Managing insect-rearing farms by transferring mass production techniques developed by RDA • Pioneering new markets at home and abroad for each purpose of use of insects • Collecting on-site data and materials and opinions of insect-rearing farm households • Controlling the supply and demand for each purpose of use of insects and pioneering new markets • Making efforts to secure demand for insects by promoting insects based on check-off funds
Universities and government-funded research institutes	• Developing new functional materials related to insects • Finding the effect of each type of insect and developing brands • Operating specialized training programs to nurture quality human resources • Providing consultation in establishing government policies
Local governments and insect resources industrialization support centers	• Promoting local festivals and experience centers • Expanding the demand for insects by holding insect expositions and fairs • Providing consulting service to insect-rearing farms

○ Universities and government-run research institutes should take the initiative of developing new materials related to insects, and continue

to verify the effectiveness of new useful insects and secure their functionality. In addition, they should conduct expert training programs that the government consigns to them for nurturing quality human resources, and be committed to providing advice in the process of policy establishment.

□ **The role of the insect resources industrialization support centers led by the government is crucial.**

○ Last but not least, the insect resources industrialization support centers should promote local festivals and experience centers and hold insect expositions and fairs in connection with regional sixth industries, thereby boosting local economy.

○ It is particularly important for these centers not to be engaged in production, distribution and experience activities to avoid affecting the existing insect markets. Accordingly, the roles of the centers should be clearly defined to let them support all insect-related policies and systems.

4.4. Implications and Expected Effects

○ The invigoration of the insect industry is expected to create economic effects and satisfy public interests. Insects as pollinators and natural enemies are sold by large-scale companies equipped with technical capacity and facilities rather than ordinary farm households. Accordingly, the most desirable situation will be created when insect-producing companies make profits, while fruit-growing farms and those using protected farming methods also enjoy improved quality of their products and reduced labor cost. In the aspect of public interest, the use of pollinating insects can stabilize the supply of food, and the

use of insects as natural enemies can provide green and safe agricultural products to consumers.

○ Farms and companies producing insects for feed, including mealworms, crickets and flies, earn profits, while livestock farms use highly nutritious feed and reduce their expenses, which can lead to an increase in the self-sufficiency rate of food of the country.

○ As seven species of insects, including grasshopper, cricket and mealworm, are officially announced as edible ones, the income of both farms and companies producing these insects is expected to grow. In addition, people can become healthier by consuming these insects, affecting the overall national health.

○ Environment-purifying insects refer to those used for disposal of livestock excrement and food waste. Producing ptecticus tenebrifer and other insects of this kind can increase the income of insect companies and can reduce the expenses for disposal of livestock excrement and food waste. All these advantages will lead to the enhancement of national environment.

○ Insects for education and pet insects can increase the income of farm households who produce them, while teenagers, local residents, and urban citizens who use or keep these insects can feel emotional satisfaction. When this market is connected to the sixth industry, it will contribute to the growth of the local economy.

○ This study employed a priori approach to express the direct and indirect effects of the production and use of insect resources. If there is an opportunity to analyze these effects in a quantitative method, the result of such research would contribute to the development of the insect industry.

Table 7. Expansion of Farm Household Income and Reinforcement of Function for Public Interest

Producers (Farms, Companies, etc.)	Consumers (Users)	Direct/Indirect Effects		
		Producers (Farms, Companies)	Consumers (Users)	Value as Public Interest
Pollination	Farms of protected agriculture, fruit-growing farms	Income	Income	Supply of food
Natural Enemies	Eco-friendly farms	Income	Income, quality	Safe agricultural products
Feed	Livestock farms	Income	Income (cost)	Self-suffi-ciency rate of grain
Food	General consumers	Income	Health enhancement	National health
Environment Purification	Livestock farms, disposal sites	Income	Cost reduction	Environment improvement
Education, Pets, Tourism	Consumers	Income	Satisfaction	Local economy

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