Trend Analysis of the Agricultural Industry Based on Text Analytics

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Abstract

This research intends to propose the methodology for analyzing the current trends of agriculture, which directly connects to the survival of the nation, and through this methodology, identify the agricultural trend of Korea. Based on the relationship between three types of data – policy reports, academic articles, and news articles – the research deducts the major issues stored by each data through LDA, the representative topic modeling method. By comparing and analyzing the LDA results deducted from each data source, this study intends to identify the implications regarding the current agricultural trends of Korea. This methodology can be utilized in analyzing industrial trends other than agricultural ones. To go on further, it can also be used as a basic resource for contemplation on potential areas in the future through insight on the current situation.

database of the profitability of a total of 180 crop types by analyzing Rural Development Administration's survey of agricultural products income of 115 crop types, small land profitability index survey of 53 crop types, and Statistics Korea's survey of production costs of 12 crop types. Furthermore, this research presents the result and developmental process of a web-based crop introduction decision support system that provides overseas cases of new crop introduction support programs, as well as databases of outstanding business success cases of each crop type researched by agricultural institutions.

Keywords

agriculture, text analytics, topic modeling, LDA, trend analysis

1. Introduction

For a sustainable industrial development, it is necessary to accurately analyze the current situation and decide upon a strategic direction that the industry should head towards, based on this analyzed information (Boettiger, Denis, & Sanghvi, 2017). Despite the fact that agriculture is one of the primary industries for the economic development of the nation (Johnston & Mellor, 1961), unlike other industries, it has a high unpredictability for the future concerning macroeconomic and microeconomic factors, such as climate change, economic recessions, etc. (Pretty et al., 2010). Furthermore, the purpose of agriculture is not merely to maximize productivity, but also to optimize diverse and complex environments, such as farmland development, agricultural environment, food consumption environments, etc. (Pretty et al., 2010). Therefore, this characteristics of industry make the whole industry even more complex. Due to these industrial changes, numerous researchers and practitioners strive to accurately identify agriculture through diverse studies and policies, while core practitioners strive to arrive at developed policy regarding agriculture through diverse studies and policies. The Korean government is conducting projects such as pest control, infrastructure expansion, and consultation services in order to increase agricultural productivity and improve the living conditions in farming areas. However, in order to develop the industry under the limited time and conditions, accurately analyzing the current trend and drawing its implication must be prioritized. As such, the purpose of this research is to accurately detect the current trends and select the core issues for strategic approach concerning agriculture.

The majority of researches intended to detect the current situation of the nation's industry and decide upon the future direction were proposed through a qualitative approach, such as literature studies, Delphi technique, and questionnaires (Hyunjeong, Namok, & Gyeongsik, 2015). However, qualitative approaches have the limitation in that they require much time and costs in

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order to collect and process more than a fixed amount of data to procure reliable results (Netzer, Feldman, Goldenberg, & Fresko, 2012). Furthermore, the Delphi technique, which deals with small samples, also requires alternatives since it has the possibility of the expert's subjective values being reflected on the results deducted. As such, in order to supplement the limitations of the existing qualitative approach, analyses regarding text data are actively conducted, nowadays. Specifically, various techniques are being introduced to analyze the trends within text data (Blei, 2012). In order to analyze the current trends in the agricultural field, this research used topic modeling, which extracts general themes stored in text data in several groups. Using the representative topic modeling technique, LDA, this research deducted methodologies that identifies the industry's core issues and trends deducted from text data, and connected them with Korean agriculture to explore its usefulness.

The responses regarding agricultural policies are expressed through the article, and it includes current trends and problems. These trends and problems academically propose the research direction, and the academic research becomes a medium that proposes issues that policies must be aware of once again. To achieve the research purpose, this research conducts its analysis regarding Korea's academic articles, policy reports, and news articles related to agriculture. By applying LDA equally for each data source, this research compares and analyzes the LDA results deducted from each source to detect similarities and differences. It can be predicted that our research, by deducting the recent trends of agriculture, will be able to detect the current situation even more accurately and provide useful information for deciding upon the future direction. Furthermore, one may expect an efficient resource distribution effect through conducting sustainable and realistic projects.

2. Literature Reviews

2.1 Text Analytics

Text analytics is an analysis method deducting significant and useful data or information by drawing hidden themes or relationships. LDA, the major topic modeling text mining technique, is being used in research in various fields (Nam, Ha, & Lee, 2018). In other words, since the text mining technique uses a great amount of data, it is capturing the attention of researchers by being able to acquire new insights that cannot be gained from small-sized data (Lee & BradLow, 2011; Netzer et al., 2012; Stamolampros, Korfiatis, Kourouthanassis, & Symitsi, 2018). It has been recognized for its usefulness

in detecting the general trends and tendencies.

In order to attain the competitive advantage in agriculture which can contribute to strengthening the country's economic strength and future industrial development, it is critical to accurately detect the current trend and continually develop the industry through related R&D. Recently, trend analysis based on the text analytics is being used in diverse fields such as bio industry (Joosik, Muung, Sangdae, & Byeonghwan, 2012), aviation industry (Hyeongjeong et al., 2015), construction and transportation industry (Euiseob, Wundong, Daeyeon, & Ilwon, 2007), etc. according to the development of text analytics technique. Text mining and big data processing techniques Is also frequently used in agriculture in various ways. Lina Yu & Sucheol Hwang (2017) analyzed domestic academic resources and policy research resources through the LDA analysis technique to analyze Korea's agricultural product and distribution trends. Sanggyu Eun & Seungjong Bae (2017) also used the text mining technique to study the changes in the agricultural manufacturing maintenance industry and proposed the usefulness of the text mining technique in analyzing the general trend of the industry. Although various existing studies have applied the text mining technique in numerous fields and showed its usefulness in analyzing the trends and tendencies, they still have some limitations that cannot simultaneously reflect the media's opinion since most of the data are based on government project material and research material. In order to supplement this limitation, this research conducted individual text mining concerning academic articles, government policy researches and reports, and social news articles. By comparing and analyzing these, this research simultaneously examined the responses of government policies, research, and media, as well as the major trends.

2.2 Naming process

LDA is a representative grouping technique which deducts meaning in group forms, which lie in data, which is the assembly of enormous amounts of documents. The grouping of the topics deducted from LDA results are conducted based on the word's degree of similarity. Since the degree of similarity is calculated based on the simultaneous appearance frequency in the documents, words included in the same topic have similar characteristics with each other (Blei & Lafferty, 2007; Blei, Ng, & Jordan, 2003; Nam et al., 2018). As such, one of the most important task in LDA is the naming process that determines the characteristics based on the corresponding characteristics of the deducted topic.

Table 1. FAO Strategic Objective and Definition

Issue Group	Definition
Plant protection (PP)	This refers to technological assistance and adjustments between member countries such as maintaining pest lists and tracking pest occurrences, as efforts to prevent global expansion of pests and plant diseases to cultivated and wild plants.
Hunger & Malnutrition (HM)	This refers to activities in order to support and execute activities for resolving hunger and malnutrition.
Plant breeding capacity building (PBC)	This refers to crop development efforts for food security and continual development.
Investment in agriculture (IA)	This refers to a common name for investments for agriculture and farmland development.
Agricultural heritage system (AHS)	This refers to activities intended to certify, support, and protect plant diversity, landscape, intellectual system and culture related to the world's important agricultural heritage systems, its living, and agriculture.
Animal genetic resources (AGR)	This refers to animal species and animal genetic resources (population, breed, genealogy, etc.) which are used or can be used for food and agricultural production.

Generally, naming regarding the topic is conducted by using professional group interviews or surveys.

In order to examine which agricultural issues are included in the LDA results deducted from each text data, this research used the core objectives mostly dealt with in agriculture by Food and Agriculture Organization (FAO) – an affiliated international organization of the UN – to conduct categorization regarding the characteristics shown by the topics. FAO is an organization which is established for the purpose of to achieve the food security worldwide and to ensure that humanity can have access to quality foods for a healthy life, dealing with international contracts and objectives concerning agricultural industries. Currently, a total of 194 countries including South Korea are registered as members in the FAO (FAO, 2019). For agricultural improvement, the FAO is undertaking activities with 9 objectives, including plant protection, hunger, malnutrition, pest management, plant disease, plant breeding, investment in agriculture, agricultural heritage system, and animal genetic resources. The strategic objectives and major activities that is repeated in 9 categories of FAO are plant protection, pest management, and plant disease, which can be integrated as plant protection. So, we determined 6 categories by integrating these three objectives as one category. By using a total of six issue groups including plant protection, this research intends to analyze the core issues mostly dealt with by each data source. The deducted words are categorized. Table 1 in the following outline the naming standard

3. Methodology

This research analyzes three data sources; academic articles, political reports, and news articles. Through the LDA, the data source is reduced and deducted into a K number of topics. By comparing and analyzing the LDA results of each source, this research intends to deeply understand the trends of Korean agriculture. The academic articles regarding agriculture include interests, issues, etc. of the current agriculture of researchers, and contain trends regarding the industry, so they represent academic trends. Such academic articles are written regarding the issues which occur within the country's policies and practical situations. In other words, since numerous scholars are conducting diverse studies and proposing the policy direction regarding topics that must be recognized by the industry (e.g., Hyeoncheol Kim, Changuk Choi, & Gyeongseok Min, 2010; Haecheon Kim, 2013; Ilju Na, Chanyeong Im, & Sohwa Park, 2008; Dayeong Song, 2004; Samsik Lee, 2006; Yeongbok Cho, Yonghee Yang, & Haewon Kim, 2008), its value is high as data analyzed and researched in diverse perspectives through academic perspectives. Policy research reports are the data source of the plans, expectations, etc. of the policies intended to be executed by the country, containing the core fields that the government is currently interested in and wishes to develop. It can be said that policies are influenced by academic article and on-site response. The practical responses concerning policies can be examined in news articles. News articles are media which most speedily and directly relays these circumstances. News articles present the government's policies, future plans, and opinions in diverse ways. Through the opinions of various industry stakeholders, the recognized issues and directions for improvement may be included through the perspective of practitioners. As such, it can be plausible that the

academic articles and policy reports based on these responses can reflect practical circumstances and exert mutual influence with each other. By conducting LDA for each academic article, policy research reports, and news article, the research deducts major topics regarding the agriculture. The deducted topics will be corresponded with the objectives selected by the FAO through the naming process. By mutually comparing the contrasting LDA results of data sources and the corresponding keywords with each other, the implications regarding the current trends can be deducted. Furthermore, by analyzing the data for each year from 2014 to 2017, this research also examines the changes in trends through chronological analyses by the time flow.

3.1 Data

The research used academic articles from Korea's 2 major academic portal sites, specifically articles written on agricultural topics. From these, the text data of related academic articles were extracted, 40-100 articles each from DBpia and KISS, by each year. For news articles, we used the N portal site, which shows the highest market share and use rate in South Korea. In order to maintain the data quality, we excluded data such as promotional material and photo articles. Furthermore, in order to collect data closely related to agriculture, we collected approximately 3700 articles for each year (total of 227,929 articles) in the order of relevance from the articles searched by agricultural keywords. For policy reports, we collected 10-40 policy research reports published on All Nation Policy Research System (PRISM), the report archive related to Korean policies, by each year, and extracted text data from these. Each data in policy reports were collected by considering its relevance to the 'agricultural' keywords as the priority and thus extracted. Since we randomly selected the data within a certain period, the collected data excludes a possibility that might prioritize specific topics. Table 2 outlines the information regarding the data used in this study.

Table 2. Data summary

data source	Data		
	no. data		sum
academic Articles	DBpia	252	669
	KISS	417	
news Articles	N portal		227929
policy reports	PRISM		118
total sum	228716		

3.2 Research Model

The purpose of this research is to analyze industrial trends related to agriculture by using 3 types of data sources and to compare and understand the core issues dealt with each data. In order to accomplish research purpose, the analyses of this research will be conducted in three primary stages. Firstly, in order to collect appropriate data which can represent the trend of Korean agriculture, we scrapped data from each data source with agriculture keywords In addition, tokenize process and removing stop-words process were performed to convert the collected data into an analyzable form. In the second step, the transformed data is dimensionally reduced as k number of topics to make analysis possible through LDA. In this study, we use a perplexity function, which quantitatively expresses the model fit of a cluster, to derive an optimal cluster number k which can be interpreted in a meaningful way. The perplexity function appears dependently according to the change of k. The more k, which indicates the number of groups, increases, there is a tendency for the value of perplexity to decrease. In this situation, the number of k can be defined as the level in which the similarity within the topic and the difference between topics is maximized. In this research, the adequate number of groups have been chosen by considering the zones where the derivative of the function responds relatively inelastically according to the change of k. In the final step, we named the characteristics of the topic by using six groups which were reconstructed based on nine goals of FAO. The named task defined the features of the topic through top 20 words among the total words included in the topic, based on the previous research. Table 3 outlines the words used based on the naming processes of the topics. The related words are those that can well represent the group. When the word that expresses the relevant group is contained in the topic, it can be said that the topic includes the relevant group's personality. The personality of the topics has been defined through in-depth interviews between researchers through two-steps procedure.

Table 3. Relevant Words for Each Naming Process

issues	relevant word
Plant protection (PP)	Pesticide, blood clot, water quality, control, strain, manure, odor, pest, virus, infection, etc.
Hunger & Malnutrition (HM)	Aging, climate change, population, food, hunger, nutrition, food insecurity, drought, famine, food shortage, etc.
Plant breeding capacity building (PBC)	Livelihood, poverty, farming, debit, community, increase of food, import and export, grain production, livestock cooperation, training farmers, growth and development, etc.

issues	relevant word
Investment in agriculture (IA)	Industrialization, sales volume, governance, brand, merchandising, profit strategy, amenity, distribution, market management, marketing, profit creation, management strategy, etc.
Agricultural heritage system (AHS)	Ecosystem, eco-friendly, win-win, conservation, national park, shrub, heritage, win-win, circulation, arboretum, etc.
Animal genetic resources (AGR)	Biodiversity, wild, breeding, community, restoration, culture, genetics, system, Saemangeum, Jirisan Mountain, etc.

According to previous research, we defined the importance of the groups as a proportion of named topics on the same basis (Nam et al., 2018). Therefore, if there are more topic which have similar characteristics with topic, the group can be interpreted as an important issue in the data.

4. Results

4.1 Issue Trends of each data by year

Figure 1, 2, and 3 outline the significance of each issue group by each data - namely, academic articles, policies, and news articles which have been dimensionally reduced so that meaningful interpretation may be possible. These show which are the core issue groups that are brought to attention by the relevant data according to the flow of time.
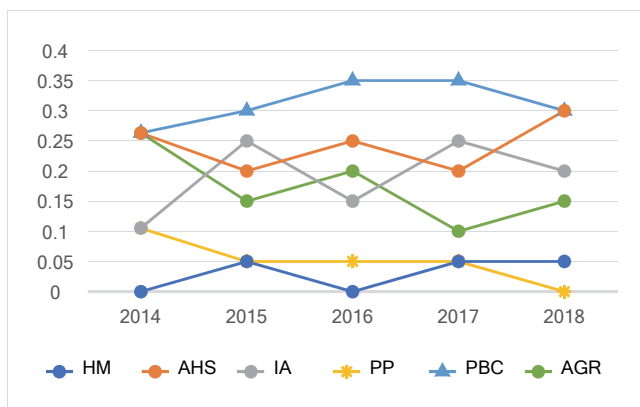

Figure 1. Academic article group importance

The analysis results regarding academic articles in figure 1 generally do not show dramatic changes with time. The importance of Plant Protection (PP) and Hunger & Malnutrition (HM) continually show low importance for 5 years. In the case of plant breeding capacity building (PBC), continually shows high importance. While PP and HM require measures from that perspective, PBC and AHC require a high level of technology since they

are related to issues whose occurrence can be predicted from the future perspective. Since academic articles have the proceeding trait that requires them to propose novel and original ideas or new insight on top of the existing academic and practical background, it is determined that these tendencies are related to written objective and academic trait of academic articles. In the case of investment in agriculture (IA), it showed fluid characteristics, but also showed a little decreased result from 2014 to 2018. Animal genetic resources (AGR) showed contrasting results. This result can be interpreted that the measures regarding agricultural poverty should be considered as a fundamental diversity of species over the short-term resource supplement.
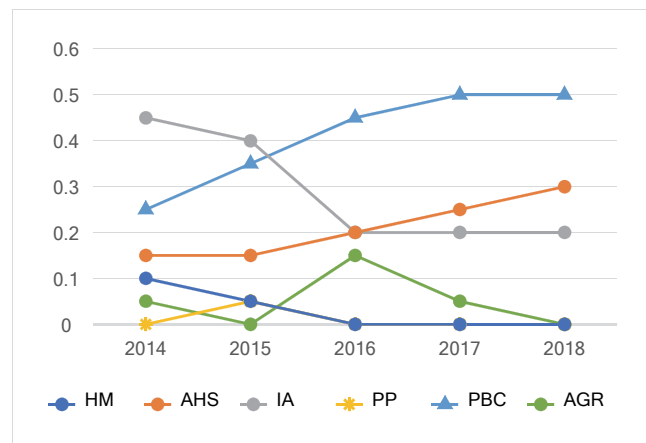

Figure 2. Policy group importance

In the case of policy reports, the result showed the tendency to focus on a specific group in a specific perspective to anticipate maximum efficiency from the limited resources outlined by the policy. First of all, it can be seen that, as with academic articles, the importance of PP and HM are comparatively low. Furthermore, it shows that the importance of AGR is also continually at low levels. Although PP and AGR are policy groups that must be noted for the growth engine of long-term and strategic agriculture, the results from analyzing Korean policies suggest that the two are not dealt with significantly in policy reports. As such, for an improving and positive growth of Korean agriculture, a policy proposal for the relevant group seems necessary. While HM similarly shows low importance levels, unlike the previous two groups, it is due to the fact that starvation and malnutrition issues are generally resolved in the current situation of Korea, thus showing these tendencies.

In the case of PBC and AHS, the level of importance increases with time. It can be anticipated that for the changes in the two groups, the Korean government is

proposal policies for strengthening future-oriented development conditions in agriculture. In contrast, IA shows the highest importance in 2014, but reduces almost by half within time. It is determined that the importance of the current conditions reduced according to the strengthening of future-oriented development conditions.
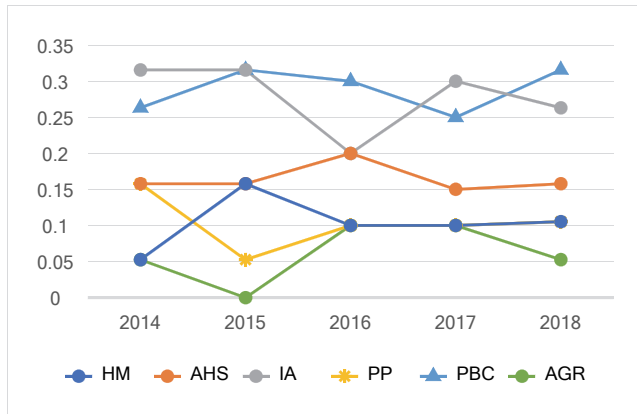

Figure 3. News article group importance

Similar to academic research, news articles related to agriculture do not show dramatic changes. However, PP, HM, and AGR show low importance levels, as with policy reports. Furthermore, it can be seen that these are similar to data related to policy reports in other agriculture groups. This is because the topics generally dealt with by news articles are policies, and thus news articles are written about the groups that policies focus on. In other words, it can be expected that the groups marked by policies will also be significantly dealt with in news articles.

4.2 Progress of Core Issue Group by Each Year

While the importance level of each issue group change with the duration of time, the tendencies of change can be broadly divided into three categories. The first includes groups whose importance level increases with time, such as PBC and AHS.
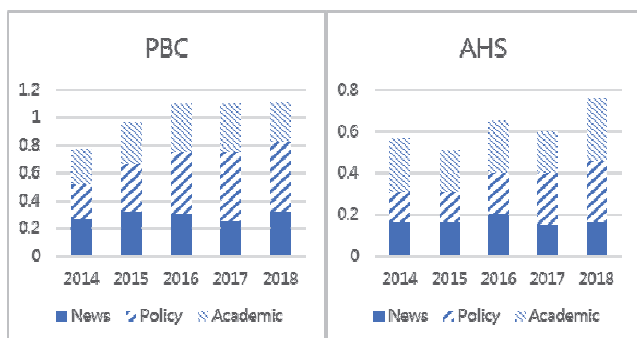

Figure 4. Progress of Importance by Each Year for Category 1

Each of the bars in figure 4 represent the sum of significance held by the group corresponding to the data of academic articles, policy, and news articles. In other words, the size of the bar graph indicates the importance of the relevant group in the corresponding year. It can be seen that both groups are significant agricultural issues whose importance is gradually being noticed. It can also be noted that the importance included by the issue group corresponding to policy and news articles is increasing. Furthermore, the government likewise is aware of their importance and reflecting them in their policies, proposing blueprints regarding agriculture.
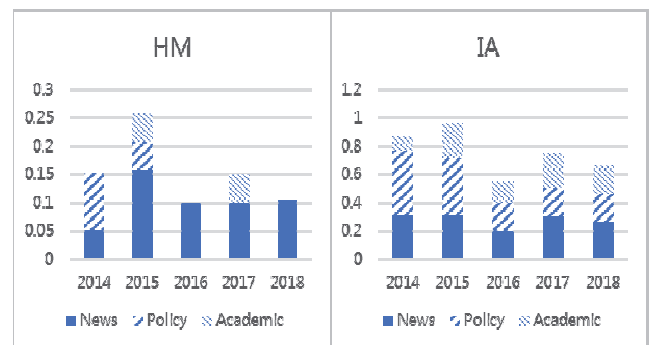

Figure 5. Progress of Importance by Each Year for Category 2

The second issue group is one whose importance decreases with the duration of time. IA and HM are included in this category. These two issue groups are directly related to problems such as poverty escape, starvation, and nutrition imbalance. As such, these relevant groups are issues that are generally resolved in the current situation of Korea. In the case of IA, the level decreases but is consistently reflected in policies. In comparison, HM is unable to receive much attention in the related policy and data after 2016 as an issue group.

As proposed in the previous section, the first category are all items that should serve as the foundation for strategic response for long-term discernment rather than response for the current situation. In contrast, the second category is the issue group that focuses on the current issue and shows response. As such, it can be seen that Korea is gradually focusing less on the basic support cases regarding farmlands and food. In return, the attention for future measures is continually increasing.
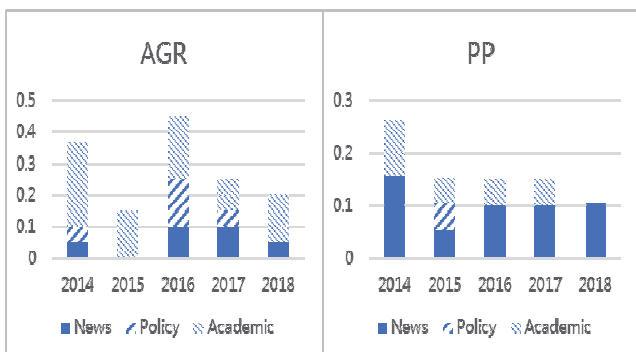
Figure 6. Progress of Importance by Each Year for Category 3

Figure 7. Progress of Importance of Each Group

The third category includes AGR and PP. In the case of PP, it decreases with the passage of time, while that tendency changes fluidly for AGR. However, both groups are related to the diversity of animal and plant types and breeds, and through this and thus to ecosystem preservation, but have low importance in terms of policy. As such, category 3 has a future-oriented personality like category 1 but receive low focus in policy. However, in the case of AGR, diverse academic approaches are being conducted. Nonetheless, for category 3 to have sustainable development, it requires more importance concerning the relevant group in terms of factors to be considered.

5. Discussion and Conclusion

Agriculture, which is one of the major industries of the country, is striving to develop the generally diverse and complex environment instead of merely increasing productivity. In order to achieve this goal, it is vital to accurately analyze the current situation of the industry and to decide upon a desirable direction for the future. To understand the industry's trend within the massive data contained in policy reports, academic articles, and news articles, we deducted issue groups primarily dealt by each data through LDA. The implications were derived by comparing and analyzing the importance of the derived groups by year and category.
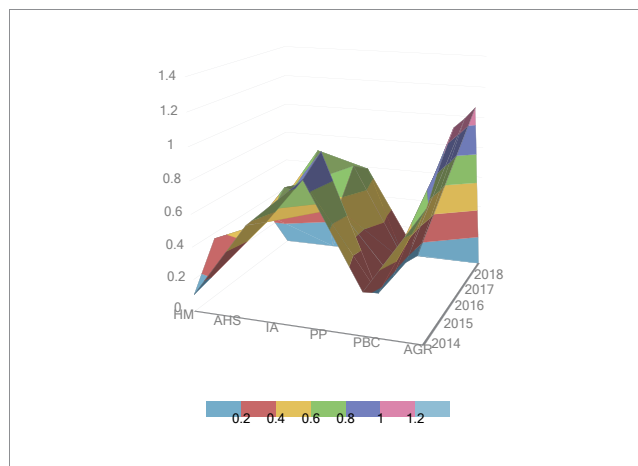
Figure 7 presents the trends of the importance level of the groups proposed by this research by of each year. Results from dynamic analysis with the passage of time show that interest regarding PBC is steadily maintained at high levels regardless of time while PP is unable to receive interest comparatively.

Such results provide the following implications. Firstly, while there were no rapid group importance changes for academic articles and news articles, in the case of policy there are rapid changes comparatively since it must reflect changes in reality. Secondly, after comparing the LDA results deducted from the three different types of data sources, we found that future-oriented groups were comparatively receiving attention. Likewise, policies related to those groups were also being proposed with focus.

On the other hand, the importance of issues focused currently such as HM and IA are decreasing. However, the interest of the two groups(AGR, PP) in relation to species diversity that constitute the ecosystem has been relatively low while the interest of the sustainable development is still growing. Furthermore, unlike the previous research which analyzes trends on a single data source, we deducted primary topics from diverse sources. Through analyzing LDA results, we can draw an current trends of agriculture and even more developed insight for the future. Additionally, by conducting longitudinal analysis by each year, we can discover the implied variations of the major trends. In other words, the methodology proposed in this research can easily understands the trends relatively limited time or cost by having analytics for unstructured data.

Despite these advantages, this research has a few limitations. Firstly, although we use news articles, it is difficult to reflect the feedbacks of the stakeholders at the actual with a single data source only. In this reason,

we need to use more related sources, such as social network services (SNS) which is the online platforms rapidly growing for the future research. The influence of social network services is being proved in various studies. Various studies have demonstrated the usefulness and influence of SNS to derive implications (e.g. Gunawan & Huarng, 2015; Leung & Bai, 2013; Pookulangara & Koesler, 2011; Rossier & Bernardi, 2009).

Secondly, since this research used data limited to a specific country, Korea, it is hard to generalize the results globally. Thirdly, in order to extend our implications, it is necessary to use the public confidential data sources internationally. For instance, since we used academic articles used in Korean academic journals, the topics can be seen more suitable to Korean features. If data from certified international academic journal (e.g. SCI, SSCI, etc.) is used, it is presumed that those results will be more useful for generalization. Lastly, LDA has only analyzed the major trends through core topics, and it is not considering the emotions of the feedbacks. Furthermore, there are limitations that it is difficult to identify the relationship between groups. Thus, more elaborately, specific analyses of current trends in agriculture require, in addition, network analysis to identify the impact between each group, along with emotional analysis.

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