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Analysis of News Articles on Urban Agriculture using Text Mining from 2012 to 2021

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ABSTRACT

Background and objective: Urbanization and reckless development have caused numerous problems, and urban agriculture with various functions is getting attention as a countermeasure. The purpose of this study is to provide basic data for revitalizing related research and setting effective policy directions by analyzing online articles on urban agriculture from 2012 to 2021.

Methods: A total of 15,336 online news articles on urban agriculture were collected from January 1, 2012 to December 31, 2021. For more detailed analysis, the time period was divided by 5 years. Next, nouns were tokenized through morphological analysis, and the main keywords were confirmed by simple frequency analysis and TF−IDF weighting analysis. Following that, LDA topic modeling was conducted to generate topics and words for each period. Python 3.9.5 was applied to run the above analysis.

Results: As a result of the analysis, there were four topics in the 1st period and six topics in the 2nd period. Summarizing the topics over time, it was found that urban agriculture is expanding not only to social and cultural areas but also to diverse areas such as welfare and the environment. In addition, as the role of urban agriculture and the demand for services expanded, various education courses and programs were activated, including the implementation of a national professional qualification system, expert training courses, and cultivation technology programs.

Conclusion: Based on the findings, urban agriculture is expected to be able to expand into various areas that take multidisciplinary values into account and create various convergence services that follow the trend of the times.

Keywords: big data, multifunctionality, urbanization, urban farming, urban gardening

Introduction

According to the Statistics of Urban Planning in 2021, 92% of the total population resides in urban areas, which account for about 17% of the national territory, and 50.24% of that population lives in metropolitan areas such as Seoul, Gyeonggi, and Incheon (Ministry of Land, Infrastructure, and Transport, 2021). Cities today have many problems due to the indiscriminate urban development and population concentration (Oh et al., 2013), and there are especially more and more concerns about various environmental problems caused by damages to nature. Urban agriculture is emerging as an alternative to handle this situation, with significance in terms of sustainable development by showing various effects on environmental, social, and economic problems in the city (Im et al., 2009).

Studies thus far have discovered that urban agriculture performs multiple functions such as land conservation, food production, disaster prevention, green space provision, landscape formation, biodiversity conservation, food safety, emotional education, cultural education, promotion of mental and physical health, climate change response, and com-

munity maintenance, thereby connoting the function of convergence that can solve various urban problems related to the environment, society, education, and health (Hu et al., 2011; Ackerman et al., 2014; Holland, 2004; Orsini et al., 2013; Kim et al., 2010; Son et al., 2013).

Since the establishment of the Act on Development and Support of Urban Agriculture in 2011, each local government has been expanding social interest and action toward urban agriculture by conducting various policy projects such as securing land and space for urban agriculture and establishing infrastructure (Jang et al., 2014; Hwang, 2015). Accordingly, studies have been conducted in multiple aspects to activate urban agriculture and improve the system, such as studies on policies to activate and promote urban agriculture for energy independence (Na, 2010), comparison and evaluation of the perception on urban agriculture among urban farmers and public officials (Park et al., 2012), improvement plans for urban planning systems to secure spaces for urban agriculture (Choi, 2014), and valuation of the current state of urban agriculture participation and multifunctionality (Heo and Kwon, 2014).

However, studies on urban agriculture have not fully covered the social discourse. Although there have been more studies using text mining to analyze social issues, such as those that examined online articles and comments in different fields (Kang et al., 2019; Chung, 2021; An et al., 2022); studies searching at changes in issues in news discourse (Ko, 2021; Oh and Kang, 2021; Park and Shin, 2022; Jho and Lee, 2021), there is almost no research identifying the perception and trends of urban agriculture in the media. Considering that social interest in urban agriculture has increased since the establishment of the Act on Development and Support of Urban Agriculture, it is necessary to identify the characteristics of urban agriculture inherent in news discourse. Therefore, this study was conducted with the purpose of identifying changes and characteristics of urban agricultural discourse over time through analysis of online articles on urban agriculture from 2012 to 2021 and providing basic data for setting effective policy directions reflecting social awareness in the future.

Research Methods

Data collection and cleaning

Text mining is a technique for extracting information from unstructured data in the form of text using natural language processing (NLP) (Kim and Lee, 2013). It is used to obtain results beyond just information search, such as extracting meaningful information from a vast text bundle, identifying connections with other information, and finding categories of text (Kim, 2012).

This study used BIGKinds (www.bigkinds.or.kr), a news big data service operated by the Korea Press Foundation, as the text data collection platform to identify overall trends and characteristics of online articles related to urban agriculture through text mining. First, with urban agriculture as the keyword, 15,408 online news articles from 54 media companies published in the last 10 years from January 1, 2012 to December 31, 2021 were collected. For detailed analysis, the time period was divided into 2 periods of 5 years. From 2012, when the Urban Agriculture Act took effect, it was set to be 1st period for 5 years, from 2017, when the Urban Agriculture Act was partially revised due to the expansion of the scope of urban agriculture and the introduction of the urban agricultural manager qualification system, it was set to be 2nd period. And redundant articles were eliminated, ultimately selecting 15,336 articles as the subject of final analysis.

To tokenize the data of the ultimately selected articles into nouns, a morphological analysis was conducted using Okt (Open Korea Text) of KoNLPy, which is the Python 3.9.5 (Pycon, USA) Korean language information processing package. The Okt morphological analyzer normalizes even words that are not registered on the Standard Korean Language Dictionary and requires less time for loading and analysis (Hur et al., 2022; Kim and Kim, 2022).

Next, compound nouns like 'apartment' and 'complex' are defined as 'apartment complex', and mixed words in Korean and English such as 'healing' or words with redundant meaning such as 'Seoul' and 'Seoul-si' were defined as just one word and added to a user dictionary. Moreover, numbers, Chinese characters, and single-letter words with unidentifiable meaning were all processed as stop words.

Analysis methods

In text analysis, the importance of a word in a document is determined by measuring how often a particular word is repeated within a document and how many times the same word occurs within a group of documents (Han et al., 2017). To identify keywords related to urban agriculture based on the previously cleaned data, TF-IDF (term frequency-inverse document frequency) was measured using the TfidfVectorizer module provided by Python library Scikit-learn and simple frequency analysis. TF-IDF is one of the most typical methods used to extract important words in text mining (Choi and Kim, 2015), and it represents the importance of specific words in the entire text in numbers.

Next, this study conducted the Latent Dirichlet Allocation (LDA), a statistical text processing method (Blei and Lafferty, 2009b) that infers topics by clustering text keywords in a document set according to their occurrence probability and distribution in topic modeling, which is an algorithmic model using text mining techniques. Since the LDA algorithm considers prior probabilities, it has a high success rate for consistent clustering of meaningful topics, and interpretation is easier than other techniques (Chung and Lee, 2018; Bae et al., 2013). Fig. 1 is a schematic of LDA, where θ is the topic distribution of a document, z is the topic for a specific word in a specific document, w is the word that can be directly observed, N is the length of the literature, M is the number of documents, α is the parameter for estimating θ which is a topic distribution in the document, and β is a parameter indicating the probability distribution in which a specific word is generated for each topic that the researcher must enter directly (Hyun, 2022; Blei et al., 2003a).

This study conducted LDA topic modeling with Python's Gensim library by setting hyperparameters such as α as 0.1, β as 0.01, and iterations as 1,000 (Rashid et al., 2019; Moon and Song, 2019). Moreover, the coherence scores of the topics were measured to set the K-value, the optimized number of topics. Too many topics may derive meaningless topics since there are no special keywords, and too few topics make it difficult to distinguish topics because many keywords are clustered in one topic (Park and Oh, 2017). The coherence score is calculated through the cosine
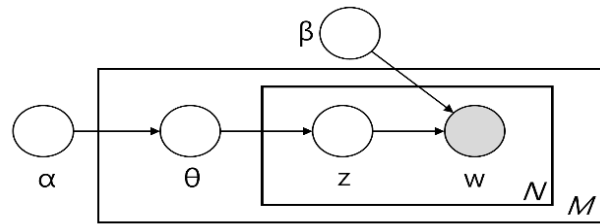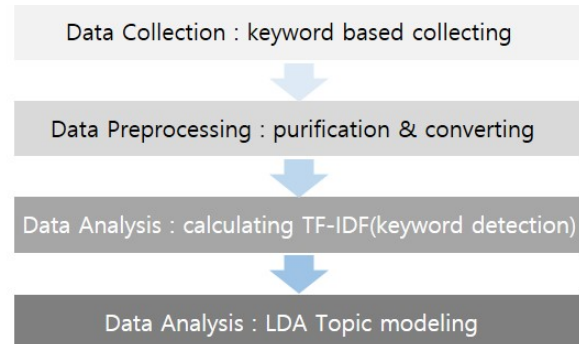

Fig. 1. Graphical model representation of LDA.

Fig. 2. Data analysis flowchart.

similarity of each vocabulary considering the normalized pointwise mutual information, and higher scores indicate that each topic has more topic coherence (Jho and Lee, 2021; Kim and Kim, 2019). This analysis was conducted through Python (Fig. 2).

Results and Discussion

Keyword analysis related to urban agriculture

Major keywords were derived by analyzing 15,366 online articles (Fig. 3) in the last 10 years, which were ultimately selected by collecting urban agriculture as the keyword. First, as a result of simple frequency analysis of keywords, garden (35,665) was mentioned the most, followed by project (31,539), education (23,620), region (20,766), center (20,540), citizen (18,173), support (17,666), experience (17,043), operation (15,702), and residents (14,097) (Fig. 4). Garden was mentioned multiple times throughout all periods and thus identified as a word highly correlated to urban agriculture. Project was mentioned consistently after garden along with words like support and operation, and it was mentioned 1.2 times more than garden in 2020 and

2021, implying that projects related to urban agriculture were further expanded and conducted during this period.

By region, Seou l (4,151) was mentioned the most, followed by Busan (3,368), Daegu (3,368), Gangdong-gu (2,908), Incheon (2,831), Gyeonggi-do (2,821), Gwangju (2,433), Gwanak-gu (2,239), Sejong (2,227), and Daejeon (2,204) (Fig. 5). The top 5 regions including Gangdong-gu in Seoul that was the first in Korea to establish the ordinance on environment-friendly urban agriculture activation and support in November 2010 (Choe and Oh, 2019) were identi-

fied as upper-level local governments that enacted ordinances related to urban agriculture between 2010 and 2012 (Park and Ahn, 2013). These regions were developing a support system to activate urban agriculture by quickly preparing legal grounds and actively promoting related activities.

Next, the TF-IDF weighting analysis presenting the importance of specific words in the text in statistics was conducted by dividing the time period into 5 years each into the 1st period (January 1, 2012 - December 31, 2016) and 2nd period (January 1, 2017 - December 31, 2021) to derive major keywords. The top 30 keywords based on the TF-IDF values of each period are as shown in Table 1.

In the 1st period, creation (1823.33) was the highest, followed by development (1302.14), expansion (1224.23), supply (1038.93), plan (973.89), participation (944.26), community (697.04), securing (633.08), facility (621.64), and green space (612.44). These words were reflecting the social mood about the need for each local government to establish the institutional grounds to develop urban agriculture and create the space and develop the services for urban agriculture through garden supply and green space
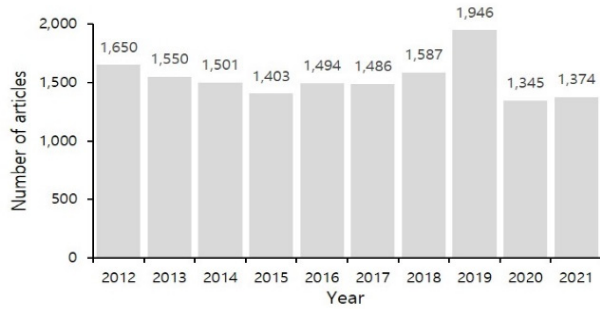

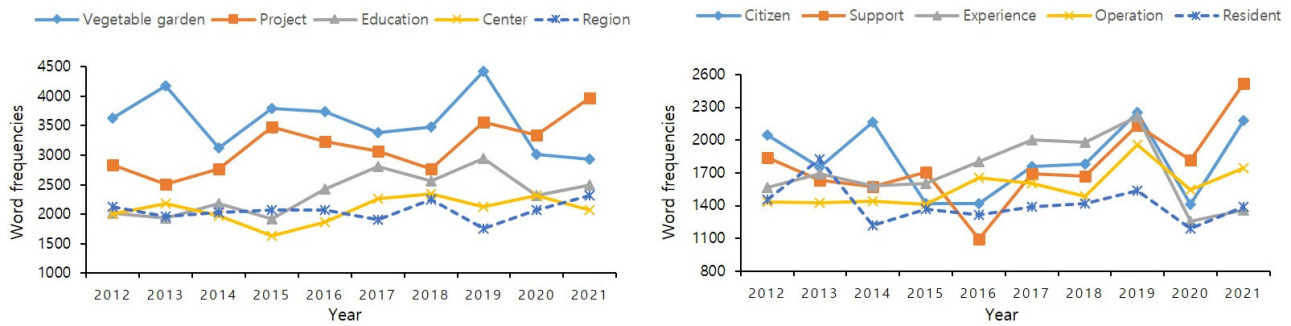**Fig. 3.** Number of articles mentioning urban agriculture by year.

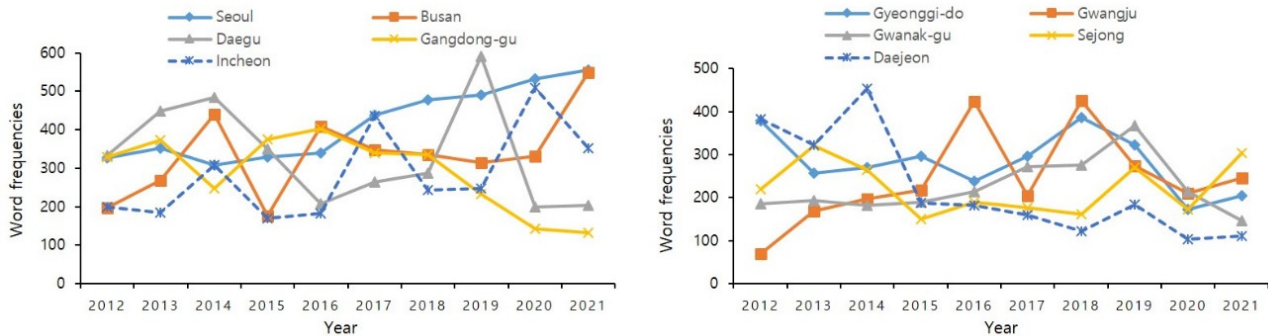**Fig. 4.** Top 10 most frequently mentioned keywords.

Fig. 5. Top 10 most frequently mentioned regions.

expansion with the enforcement of the Act on Development and Support of Urban Agriculture in 2012. Moreover, they proved the expectations for the multifunctionality of urban agriculture such as local community recovery through participation in urban agriculture activities.

In the 2nd period, spreading (2110.33) was the highest, followed by enforcement (1604.97), fostering (1454.69), proceeding (1362.96), hosting (1360.19), promoting (1332.21), welfare (1319.21), healing (1314.30), expert (1301.05), and program (1300.58). These words identified that urban agriculture is receiving attention as an important means to contribute to promoting public welfare by setting the conditions to expand urban agriculture such as fostering experts and implementing related programs as well as by providing healing through urban agriculture activities.

LDA topic modeling analysis

LDA topic modeling, which is the algorithm to find the topics hidden in the text, was conducted to identify the topics of online news articles related to urban agriculture as well as their meanings. First, the coherence scores of topics were measured to calculate the optimum number of topics, and the results showed that the coherence score in the 1st period was highest at 0.535 when there were 4 topics, and that in the 2nd period was highest at 0.409 when there were 6 topics. Based on these results, 10 keywords from each of the 4 topics of the 1st period and 6 topics of the 2nd period were derived, and the topics were named according to the meanings (Table 2).

The keywords related to urban agriculture in each topic of the 1st period are as follows. The top keywords of Topic 1 were service, participation, green space, opportunity, program, school, job, and activity. These words showed that urban agriculture activity and service were receiving attention, such as operation of urban agriculture education and programs including school gardening activity and related job creation. Accordingly, Topic 1 was named urban agriculture activity and service.

Table 1. Top 30 Keywords by TF-IDF score according to time period

The 1st period (2012.01.01. - 2016.12.31.)						The 2nd period (2017.01.01.- 2021.12.31.)					
Rank	Keywords	TF-IDF	Rank	Keywords	TF-IDF	Rank	Keywords	TF-IDF	Rank	Keywords	TF-IDF
1	Creation	1832.33	16	Economy	561.80	1	Spreading	2110.33	16	Cultivation	1229.56
2	Development	1302.14	17	Network	555.74	2	Enforcement	1604.97	17	Role	1205.87
3	Expansion	1224.23	18	Food	555.42	3	Fostering	1454.69	18	Co-prosperity	1203.50
4	Supply	1038.93	19	Village	525.15	4	Proceeding	1362.96	19	Service	1190.10
5	Plan	973.89	20	Public-private partnership	523.21	5	Hosting	1360.19	20	Policy	1178.02
6	Participation	944.26	21	Industry	519.44	6	Promoting	1332.21	21	Culture	1170.86
7	Community	697.04	22	Society	507.89	7	Welfare	1319.21	22	Plant	1156.42
8	Securing	633.08	23	School	505.20	8	Healing	1314.30	23	Smart	1150.24
9	Facility	621.64	24	Job	503.23	9	Expert	1301.05	24	Urban regeneration	1132.57
10	Green space	612.44	25	Rural Area	502.80	10	Program	1300.58	25	Activation	1090.11
11	Opportunity	610.39	26	Activity	497.30	11	U.A. manager[z]	1276.12	26	Contribution	1086.83
12	Returning to farming	596.36	27	Urban-rural exchange	487.30	12	Downtown	1269.52	27	Balcony	1086.81
13	Rooftop	592.42	28	Seoul	477.31	13	Environment	1251.67	28	Improvement	1065.08
14	Promoting	591.54	29	Action	457.24	14	Activity	1248.16	29	MAFRA[z]	1064.78
15	Program	585.30	30	Change	441.24	15	Space	1239.21	30	Exposition	1061.92

[z]Abbreviations: U.A. manager, Urban Agricultural manager; MAFRA, Ministry of Agriculture, Food and Rural Affairs.

The top keywords of Topic 2 were expansion, facility, promoting, economy, industry, development, and securing. This proved that the discourses formed were about the basis expansion, facility establishment, and network development to develop and revitalize urban agriculture, and the social expectations for economic effects in various industries. Accordingly, Topic 2 was named urban agriculture development and revitalization.

The top keywords of Topic 3 were creation, rooftop, food, supply, plan, village, farm, returning to farming, Seoul, and apartment. Food was produced by creating spaces for urban agriculture in daily life on apartment rooftops in the form of box gardens. Moreover, there was interest in spaces where urban agriculture can be accessed in the living sphere such as experience farms or village gardens. Accordingly, Topic 3 was named urban agriculture composition space and daily life.

The top keywords of Topic 4 were community, network, society, urban-rural exchange, change, action, establishment, and exhibition. These words showed that the territory of urban agriculture was expanding toward society and culture, such as operating urban agriculture programs, providing technologies, and hosting exhibitions to form an understanding and a bond among urban residents about agriculture and rural areas. Accordingly, Topic 4 was named urban agriculture and social culture.

The keywords related to urban agriculture in each topic of the 2nd period are as follows. The top keywords of Topic 1 were proceeding, hosting, healing, welfare, service, Ministry of Agriculture, Food and Rural Affairs (MAFRA), strategy, emotion, meaning, and leisure. These words were reflecting the social mood about the proper functions such as healing, emotional purification, and leisure activation obtained from urban agriculture activity and the develop-

Table 2. Results of LDA Topic modeling according to time period

Period	The 1st period : 2012.01.01. - 2016.12.31.		
Topic number	Keywords	Title of topics	Proportion (%)
Topic 1	Participation, Green space, Opportunity, Program, School, Job, Activity, Public-private partnership, Homepage, Raised bed	Activity and service	30.8
Topic 2	Expansion, Facility, Promoting, Economy, Industry, Development, Securing, Co-operative, Field, Comprehension	Development and revitalization	22.7
Topic 3	Creation, Rooftop, Food, Supply, Plan, Village, Farm, Returning to farming, Seoul, Apartment	Composition space and daily life	20.2
Topic 4	Community, Network, Society, Urban-rural exchange, Change, Action, Establishment, Exhibition, Returning to rural area, Ecology	Social culture	26.3
Period	The 2nd period : 2017.01.01. - 2021.12.31.		
Topic number	Keywords	Title of topics	Proportion (%)
Topic 1	Proceeding, Hosting, Healing, Service, Welfare, MAFRA[z], Strategy, Emotion, Meaning, Leisure	Service and welfare	20.6
Topic 2	Expert, Exposition, Policy, Agreement, Contest, Change, Startup, Demonstration, Urban agricultural manager, Input	Policy and project	23.5
Topic 3	Enforcement, Promoting, Space, Role, Activation, Improvement, Online Circulation, Outcome, Value	Activation base	12.3
Topic 4	Downtown, Creation, Culture, Balcony, Stability, Home, COVID-19, Gangdong-gu district, Life, Fine dust	Daily life	18.2
Topic 5	Spreading, Fostering, Program, Cultivation, Co-prosperity, Agricultural technology center, Recruitment, Adolescent, Tourism, Suggestion	Program	11.9
Topic 6	Environment, Plants, Smart, Energy, Urban regeneration, Contribution, Action, Sustainability, Mind, Discovery	Environment	13.5

[z]MAFRA: Ministry of Agriculture, Food and Rural Affairs.

ment of the urban agriculture service system in the form of welfare by expanding the scope of urban agriculture policies into welfare. Accordingly, Topic 1 was named urban agriculture service and welfare.

The top keywords of Topic 2 were expert, exposition, policy, agreement, contest, change, startup, demonstration, certified urban and agricultural manager. These words showed that attention is paid to contest projects, demonstration projects, and expositions to expand urban agriculture, along with the certified urban agricultural manager system, which is a national professional qualification related to urban agriculture. Accordingly, Topic 2 was named urban agriculture policy and project.

The top keywords of Topic 3 were enforcement, promoting, activity, role, activation, improvement, and online. These words represent the creation of the foundation for urban agriculture activation as well as the activities, such as enforcing and amending laws and systems related to urban agriculture, promoting professional education, and exchanging information by opening an online website. Accordingly, Topic 3 was named urban agriculture activation base.

The top keywords of Topic 4 were downtown, space, culture, balcony, stability, home, and COVID-19. This implies that interest in urban agriculture activities in indoor space like the balcony has grown since the outbreak of COVID-19. This shows that the space for urban agriculture became more diversified from outdoors like rooftops and farms to indoors, establishing itself as a daily life activity that brings stability. Accordingly, Topic 4 was named urban agriculture and daily life.

The top keywords of Topic 5 were spreading, fostering, program, cultivation, co-prosperity, agricultural technology center, recruitment, and adolescent. These words show that all kinds of education and programs are actively implemented, such as school education on urban agriculture for adolescents or cultivation skill training through an agricultural technology center. Accordingly, Topic 5 was named urban agriculture program.

The top keywords of Topic 6 were environment, plant, smart, urban regeneration, contribution, energy, action, sustainability, mind, and discovery. These words show that the role of urban agriculture is rising in terms of sustainable urban regeneration and energy reduction considering the environmental aspect. Accordingly, Topic 6 was named urban agriculture and environment.

The 1st period is the initial stage in which the Act on Development and Support of Urban Agriculture was enforced, and social interest was focused on the social and cultural aspects such as forming an understanding and a bond about agriculture and rural areas and creating space to promote urban agriculture. On the other hand, the 2nd period is when the social interest was on providing urban agricultural services considering the environment and welfare by laying the foundation for activation of urban agriculture and expanding the scope. This is in line with previous studies reporting that urban agriculture is evolving in various forms, has multiple functions such as preserving the ecological environment in urban space and maintaining the educational/cultural functions as well as the community, promotes health through urban agriculture activities, and has effects on welfare as an activity space for the elderly, outdoor living space for people with mental and physical disabilities, and rehabilitation space for people in need of recuperation(Kim et al., 2010; Son et al., 2013). Accordingly, urban agriculture can expand its scope to various fields considering its multiple values and create various convergence services that follow the trends of the times.

Conclusion

This study was conducted with the purpose of providing basic data to activate related research and set an efficient policy direction by analyzing online articles related to urban agriculture in the past 10 years. First, for detailed analysis of 15,366 articles collected and cleaned, a simple frequency analysis and TF-IDF weighting analysis were conducted to derive major keywords by dividing the time period into the 1st period (January 1, 2012 - December 31, 2016) and 2nd period (January 1, 2017 - December 31, 2021).

Next, LDA topic modeling was conducted to understand the inherent meaning of the articles. In the 1st period, 4 topics were defined as urban agriculture activity and service, urban agriculture development and revitalization, urban agriculture composition space and daily life, urban agri-

culture and social culture. In the 2nd period, 6 topics were named as urban agricultural services and welfare, urban agriculture policy and project, urban agriculture activation base, urban agriculture and daily life, urban agriculture program, and urban agriculture and environment.

The results of topic analysis modeling over time in the 1st period and 2nd period are summarized as follows. First, in the 1st period when the Act on Development and Support of Urban Agriculture was enforced, attention was paid to expanding the foundation or establishing the facilities to promote urban agriculture or produce economic effects through network development. On the other hand, in the 2nd period, the focus of the discourse was on amending the laws and systems related to urban agriculture and laying the groundwork to spread and advance urban agriculture by establishing the national professional qualification, with the implementation of policies and projects to promote urban agriculture.

Second, there was much interest in urban agriculture activities and programs taking place in apartment rooftop gardens, school gardens, and experience farms in the 1st period, whereas in the 2nd period, there was more interest in urban agriculture activities taking place indoors, such as the balcony, due to the outbreak of COVID-19. In particular, various programs and education were receiving attention, such as expert training and cultivation skill education, as urban agriculture established itself as a daily life activity that brings stability.

Third, the scope of urban agriculture was expanded from the concept of growing and cultivating in the 1st period, such as providing urban agriculture services applying social and cultural aspects such as recovering the local community and forming an understanding and a bond about agriculture and rural areas. In the 2nd period, the scope was expanded even more, increasing the demand for roles and services of urban agriculture in the environment, such as sustainable urban regeneration and environmental education. Moreover, the scope of urban agriculture policies was expanded to welfare with proper functions like healing and emotional support through urban agriculture, thereby spreading actions related to urban agriculture.

Taken together, in order to revitalize urban agriculture it is necessary to operate various experience programs, in-

cluding professional education at each stage, and systematic services for expansion and sustainment, including environment and welfare, such as sustainable development, physical and mental healing, are needed. For this, each local government should prepare and systematically manage support-related systems, and considering the multifunctionality of urban agriculture, specialized research might be necessary to create convergence services combined with various fields.

This study has significance in that it identified the characteristics of online news articles related to urban agriculture over time. However, it also has the following limitations. First, the subjects were only articles from 54 media companies provided by the BIGKinds platform in data collection. For more detailed analysis, it is necessary to conduct an objective research based on more massive data by including articles from more diverse media.

Second, the data collection period was limited only to 10 years from 2012 when the Act on Development and Support of Urban Agriculture was established. Considering that interest in urban agriculture constantly increased since the 2000s (Kim, 2020), it will be possible to more elaborately observe the changes in major keywords related to urban agriculture by dividing the time period into before the enactment of the Act on Development and Support of Urban Agriculture and 10 years after the enactment.

Third, the performance of the Korean morphological analyzer is limited. The Okt analyzer used in this study has normalization functions and quick processing speed (Park and Shin, 2022), but it requires the process of having to add unregistered words on the analyzer library, during which some words with important meanings may be excluded. Therefore, in future research, more accurate results can be derived by validating the most suitable analyzer for the research data based on the measurement of the recall and precision of morphological analysis in various analyzers.

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