A nationwide study was undertaken in China to understand why public interest has shifted away from agriculture and to discuss approaches that may help restore interest and support for agriculture. The study collected 2586 questionnaires from 242 cities in 31 provinces in mainland China. The results suggest that agriculture is still of public interest, but interest has shifted from traditional farming to the consumer perspective in food safety, nutrition and health, food security and agricultural history. Two groups in this study, the younger generation and those with college degrees, show less interest in production agriculture. The accelerating shift in population from rural China to urban areas explains why these two groups are less connected with agricultural issues. The authors contend that it is critically important to keep the urban population knowledgeable of the importance of agriculture and suggest ways to improve communication and support from this educated, city-dweller point of view in order to ensure a stable and secure future. The approach of science appreciation (ways to effectively communicate science to general publics) is proposed to effectively gain renewed interest and engagement with the public in the science of agriculture in order to optimize the needs and benefits from agriculture to society.

The study focused on surveying a large cross-section of people from China on 24 agriculture-related topics. The study included 2586 participants, covering 242 cities in 31 provinces in mainland China. The overall demographic characteristics of the surveyed participants, including their location, their age, educational background, and gender are summarized in Table 1 according to overall percent in each category. The data were analyzed by SPSS software. The Cronbach’s $\alpha$ was 0.912 which illustrated the survey was highly reliable in content consistency.

### RESULTS

The male and female ratio of the respondents was about 53% and 47%, respectively, which indicates a balanced gender distribution. The respondents were dominated by the age group of 26–50 years old, accounting for 61.6%. The education level of respondents was mainly university and above, while the university graduates accounted for 59.1% and postgraduates accounted for 27.8%.

### Differences in public interests

Among the 25 questions asked to the participants, one two-part question served as a control for this study to calibrate the level of interest. It is related to the hot topic of the COVID pandemic and the COVID-19 vaccine. Participants were asked, “How effective is a COVID-19 vaccine?” and “When will life return to normal as it was in the pre-pandemic era?”. Their interests to these two questions were recorded regardless the attitude or judgment they might hold. The 25 questions randomly asked in the questionnaire are listed in Table 2 according to the percentage of people showing interests, from high to low. The responses were used as a measure of the public’s level of interest to agricultural topics (Q1–Q24, Table 2). Not surprisingly, the level of interest to the COVID-19

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related control questions was the highest at 55.6%. There were five agricultural topics attracting interests of over 40% of the participants. Among the 24 agricultural questions, the highest percentage was 48.6%, while the lowest one was 21.0%.

In general, the five questions with more than 40% interest rate emphasized life, history, and cultural perspectives, while the six questions with interest rates <30% were mainly in the field of agricultural science. The interest rates of the other 13 questions were between 30% and 40%, mainly covering food security, food safety, nutrition and health, emerging food, agricultural development, etc. These findings support changes in the participants’ dietary habits and structure, from “filling” to “eat well” to “healthy eating” over the past 40 years, with new thoughts in agriculture.

There are several sets of data worthy of interest when promoting science appreciation. For example, the interest percentages of Q2 (Why do fruits and vegetables taste not as good as they used to?) and Q4 (Which crops are genetically modified? Is genetically modified food safe?) were 47.5% and 43.2%, respectively. To fully understand the responses to these questions, it is necessary to understand Q22 (What are the planting processes of crops?) and Q24 (What are the farming practices for livestock and poultry?). However, the interest percentages of Q22 and Q24 was only 24.3% and 21.0%, respectively. The ranking of these two questions in different groups were mostly 22nd/23rd and 24th. This result supports the view that the public tends to “care about the result, but not how it was achieved”.

Table 1. Demographic characteristics of the surveys.

| Class            | Sub-class            | Percentage | Class          | Sub-class            | Percentage |
|------------------|----------------------|------------|----------------|----------------------|------------|
| Region           | 4 Municipalities     | 24.2       | Age            | Under 25            | 25.0       |
|                  | 9 provinces in Eastern China | 33.1       | 26-50          | 61.6                 |
|                  | 9 provinces in Central China | 34.0       | Over 50        | 13.4                 |
|                  | 9 provinces in Western China | 8.6        | Education      | High school and lower | 13.0      |
| Gender           | Male                 | 52.9       |                | University/College   | 59.1       |
|                  | Female               | 47.1       |                | Postgraduate         | 27.8       |

Table 2. Questions ranked according to public interest.

| Sequence number | Questions                                                                 | Interest (%) |
|-----------------|---------------------------------------------------------------------------|--------------|
| Control         | How effective is the COVID-19 vaccine? When will the life return to normal as it was in the pre-pandemic era? | 55.6         |
| Q01             | Why is bread favored in the West, while steamed buns in China?             | 48.6         |
| Q02             | Why do fruits and vegetables taste not as good as they used to?            | 47.5         |
| Q03             | Why are grains, instead of fruits or meat, our staple food?                 | 46.4         |
| Q04             | Which crops are genetically modified? Is genetically modified food safe?    | 43.2         |
| Q05             | What are the major famines in human history and their main causes?         | 40.6         |
| Q06             | What is the difference between craft beer and regular beer? What's cultivated or plant-based meat? | 38.3         |
| Q07             | What are the influences of fertilizers, pesticides, additives, and hormones on the environment and food safety? | 38.1         |
| Q08             | What is the difference between ancient and modern food?                    | 38.1         |
| Q09             | Which food could assist weight loss? Does a vegetarian diet affect health?  | 37.7         |
| Q10             | Does China have food security challenges? How to solve the problem of food waste? | 37.4         |
| Q11             | With the growth in agricultural production, why do farmers still have a difficult time? | 36.4         |
| Q12             | Why can the United States become the leading country in agriculture? Why does China import massive number of soybeans from the States? | 35.7         |
| Q13             | How did China become an agricultural power? What will Smart Agriculture be like? | 35.3         |
| Q14             | China's population is aging. Will the lack of labor affect agricultural production in the future? | 35.0         |
| Q15             | Farmers used to keep their own seeds. However, diversity and yield of commercial seeds will be reduced if they are kept under private control. Why? | 34.8         |
| Q16             | What are the influences of global warming on agriculture?                  | 34.4         |
| Q17             | How were weeds domesticated into grains in ancient times?                  | 32.4         |
| Q18             | How to keep agricultural culture heritage sites and traditional rural practices? | 31.9         |
| Q19             | Where did the world’s first farmer emerge?                                 | 29.1         |
| Q20             | Does rice originate in China or India?                                     | 28.0         |
| Q21             | What are impacts on agriculture if biodiversity is compromised?           | 27.5         |
| Q22             | What are the planting processes of crops (grain, vegetables, fruits)?      | 24.3         |
| Q23             | How to produce biofuel (i.e. ethanol from corn)? Does it mean that cars are competing with people for food? | 23.0         |
| Q24             | What are the farming practices for livestock and poultry (cattle, horses, pigs, chickens)? | 21.0         |

The above 25 questions include control questions and 24 agricultural-related questions. They are referred in the main text by their sequence number as labeled above.
The respondents were interested in emerging foods, such as craft beer and cultivated/plant-based meat (Q6), agricultural product safety (Q7), food security (Q10), and increasing farmers’ income (Q11). In contrast, interest to global warming (Q16), biodiversity (Q21) and inheritance and conservation of rural civilization (Q18) was not high. These are major issues for society and the low level of interest implies that there is a need to improve and strengthen the related science appreciation efforts to increase public awareness and understanding.

Demographic analysis of interest level
Public attitudes and opinions tend to be diversified in the era of the internet2 and our survey findings demonstrate that this is the case with agricultural topics. The interest level (percentage) was analyzed and presented in groups according to age, education, and gender of the participants (Table3).

Many people over the age of 50 have lived in rural areas while the younger generation who grew up in cities lack the experience of rural life. According to the data in Table 3, the older the participant is, the higher their interest is to the questions. On average, it was 30.6% for the group of 25 years old and younger, 34.9% for the group of 26–50 years old and 44.9% for people in their 50s and older. Among the 24 questions, 23 were deemed more important to those over 50 years old than those 25 years old and younger. The exception was Q17 (How were weeds domesticated into grains in ancient times?). In this case, young participants were more interested. There were 7 questions (Table 3, shown in bold font) whose difference of its interest percentage among different age groups was >20%.

In terms of educational qualifications, it was observed that respondents with higher qualifications had less interest in questions on agriculture. The average percentage found for each group was 40.8% (high school and lower), 34.7% (university/college), and 33.5% (postgraduate), separately. Nineteen of the questions were of higher interest to the group with high school and a lower level of education, while the other five questions were of more interest to those who had postgraduate training. There were 4 questions (Q11, Q19, Q20, Q22) whose interest percentage difference between these two groups was around 20% or greater (Table 3, shown in bold font).

There were no significant differences found between genders. The average interest percentages in both men and women were 35.2%. Among the 24 questions, 22 questions attracted similar level of interest from both groups. However, men showed much less interest than their female counterparts in two questions: Q02 (Why do fruits and vegetables taste not as good as they used to?) and Q09 (Which food could assist weight loss? Does a vegetarian diet affect health?).

Demographic analysis of interest ranking
In addition to the above analyses, some additional data are worth noting. For example, the interest percentage of different age groups was generally very close to each other for Q06 (What is the difference between craft beer and regular beer? What’s cultivated or plant-based meat?). It was 38.1% (under 25), 38.1% (26–50),

| Seq. no. | Age     | Gender   | Education          | Mean    |
|---------|---------|----------|--------------------|---------|
|         | Under 25 | 26-50    | Above 50           |         |
|         | Male     | Female   | High school and lower |       |
|         | University/College | Post-graduate | Male     | Female   |
| Q01     | 45.0     | 48.9     | 53.7               | 49.6    |
| Q02     | 38.2     | 49.0     | 58.0               | 50.4    |
| Q03     | 43.5     | 45.1     | 57.8               | 49.6    |
| Q04     | 26.2     | 46.9     | 57.8               | 44.5    |
| Q05     | 35.8     | 40.6     | 50.0               | 48.4    |
| Q06     | 38.1     | 38.1     | 39.7               | 36.5    |
| Q07     | 23.8     | 39.4     | 58.3               | 48.1    |
| Q08     | 38.7     | 36.9     | 42.2               | 41.2    |
| Q09     | 37.8     | 37.4     | 39.1               | 36.8    |
| Q10     | 26.2     | 37.5     | 58.0               | 41.2    |
| Q11     | 30.3     | 36.4     | 47.7               | 49.6    |
| Q12     | 28.3     | 35.8     | 49.1               | 34.4    |
| Q13     | 26.2     | 35.1     | 50.9               | 40.4    |
| Q14     | 27.7     | 36.0     | 46.6               | 37.4    |
| Q15     | 27.4     | 34.7     | 49.1               | 46.3    |
| Q16     | 29.4     | 33.7     | 46.6               | 43.0    |
| Q17     | 38.7     | 29.6     | 33.6               | 32.0    |
| Q18     | 30.8     | 30.8     | 38.5               | 35.0    |
| Q19     | 31.6     | 27.0     | 34.2               | 43.6    |
| Q20     | 24.6     | 26.8     | 40.2               | 41.5    |
| Q21     | 23.5     | 26.2     | 40.5               | 31.8    |
| Q22     | 22.9     | 23.9     | 28.7               | 36.2    |
| Q23     | 20.7     | 22.6     | 29.0               | 32.0    |
| Q24     | 19.8     | 20.2     | 27.3               | 30.6    |
| Mean    | 30.6     | 34.9     | 44.9               | 40.8    |

The data are labeled in bold font if the percentage difference among groups is >20%.
39.7% (over 50). However, the ranking of this question in each of the age groups according to their interest percentages was rather different, which was 6th, 7th, and 17th, respectively. To address these differences, the interest ranking of the 24 questions was further analyzed (Table 4).

The results showed that 19 questions shared a consistent level of interest (percentage versus ranking), particularly the top three questions and the last three questions. In terms of age groups, there were three questions whose differences in ranking were more than 12 (half of the 24 questions). In terms of educational qualifications and gender, there was only one question whose ranking difference among different groups was >12.

In terms of age, Q04 (Which crops are genetically modified? Is genetically modified food safe?) ranked 18th among participants under 25 years old, 3rd for those age 26–50 and 5th for those over 50 years old. In other words, “post-95” young people do not seem to be concerned about the debate on genetically modified crops and foods. This is consistent with previous reports. Another example is Q10 (Does China have food security challenges? How to solve the problem of food waste?). The response was 20th for the “high school and lower”, 16th for university/college graduates, and the 7th for those who hold post-graduate level degrees. This difference can be correlated to the aspiration and vision of people with more education. In terms of gender, the health-related question Q09 (Which food could assist weight loss? Does a vegetarian diet affect health?) ranked much lower (20th) among men compared to women (4th).

**DISCUSSION**

In recent years, the old-school “science appreciation” books have been of little or no value for many publishing houses, and subscriptions to journals of agricultural science have declined sharply. It has become a common phenomenon for students at agricultural colleges and universities to be “learning agriculture, hating agriculture, and abandoning agriculture”. Despite the complicated reasons behind this trend, it is worth rethinking how agricultural topics are communicated in classrooms and to the public. Changing the presentation style to enhance interest and engagement can be achieved by incorporating stories about popular aspects of agriculture combined with good depth and breadth of comprehensible knowledge. Based on the results of this survey we suggest four approaches to improve communicating topics related to agricultural science.

### Table 4. Demographic analysis of interest ranking.

| Seq. no. | Age     | Education       | Gender       |
|----------|---------|-----------------|--------------|
|          | Under 25 | 26–50 | Above 50 | High school and lower | University/College | Postgraduate | Male | Female |
| Q01      | 1       | 2     | 6       | 2             | 2              | 1            | 1    | 2      |
| Q02      | 5       | 1     | 2       | 1             | 1              | 3            | 4    | 1      |
| Q03      | 2       | 4     | 4       | 3             | 3              | 2            | 2    | 3      |
| Q04      | 18      | 3     | 5       | 8             | 4              | 4            | 5    | 5      |
| Q05      | 8       | 5     | 8       | 6             | 5              | 5            | 3    | 7      |
| Q06      | 6       | 7     | 17      | 17            | 6              | 9            | 8    | 6      |
| Q07      | 4       | 10    | 1       | 12            | 9              | 10           | 7    | 9      |
| Q08      | 20      | 6     | 14      | 5             | 7              | 12           | 6    | 10     |
| Q09      | 7       | 9     | 18      | 16            | 8              | 8            | 20   | 4      |
| Q10      | 16      | 8     | 3       | 13            | 11             | 6            | 10   | 8      |
| Q11      | 11      | 11    | 11      | 4             | 10             | 14           | 9    | 13     |
| Q12      | 13      | 13    | 10      | 20            | 16             | 7            | 13   | 12     |
| Q13      | 14      | 12    | 12      | 15            | 14             | 11           | 11   | 15     |
| Q14      | 17      | 14    | 7       | 14            | 12             | 13           | 14   | 14     |
| Q15      | 15      | 15    | 9       | 7             | 15             | 16           | 16   | 12     |
| Q16      | 12      | 16    | 13      | 10            | 13             | 17           | 12   | 16     |
| Q17      | 3       | 18    | 21      | 21            | 17             | 15           | 15   | 18     |
| Q18      | 10      | 17    | 19      | 19            | 18             | 18           | 19   | 17     |
| Q19      | 9       | 19    | 20      | 9             | 19             | 20           | 17   | 20     |
| Q20      | 19      | 20    | 16      | 11            | 20             | 21           | 18   | 21     |
| Q21      | 21      | 21    | 15      | 23            | 21             | 19           | 21   | 19     |
| Q22      | 22      | 22    | 23      | 18            | 22             | 23           | 22   | 22     |
| Q23      | 23      | 23    | 22      | 22            | 23             | 22           | 23   | 23     |
| Q24      | 24      | 24    | 24      | 24            | 24             | 24           | 24   | 24     |

*1, highest rank; 24, lowest rank. The data are labeled in italics and bold font if the ranking difference among different groups is >12.*
First, general knowledge must be taught at school or via multiple educational platforms. Urban civilization is embodied in history, science and technology, and humanistic care. Such characteristics were reflected in this study. The public has shown more interest in food culture, origins of food, and famine, while less interest to pure scientific topics. In order to understand the above topics of interest, it will require a certain level of general knowledge as a foundation to build further knowledge and create a greater understanding of agriculture and where food comes from.

Agriculture is a broad and deep field with many topics attracting public interest. The implementation of agricultural science communication requires innovation in the body of knowledge and the way of thinking about it. For example, research on the origin of grains not only allows biologists to explore genetic resources of wild species and improve crop varieties, but also helps anthropologists build ethnic history. Food security requires consideration of population, resources, and environment as well as the global trading system. The development of bioenergy has connected corn, sugar cane, soybeans, and petroleum, which at one time seemed irrelevant, to a single supply chain with each piece relating to another. The debate over genetically modified organisms involves many topics including the public’s right to know, bioethics, environmental protection, government supervision, media and communication, commercial profits, international trade, and national sentiments.

Second, the awareness of crisis. Communication of agricultural science should enable the public to truly understand the crises and challenges faced by the nation’s agriculture. To boost the yield of crops, chemical fertilizers and pesticides have been used in excessive quantities, subsequently caused many environmental problems such as soil compaction and water contamination. Seeds are the “core” of agriculture. China’s seed production is generally lacking international competitiveness. According to this survey, only 37.4% of the public are concerned about food security and food waste (Q10), and 34.8% of the public are concerned about seeds (Q16). Both questions shared a rather low interest ranking. China is the world’s most populated country and the number one food importer. The 120 million tons of agricultural products imported annually is equivalent to 53 million hectares of arable land, which is equivalent to 40% of China’s 133 million hectares of arable land. Over reliance on imports to feed the nation is not a satisfactory situation so the development of the agri-food sector should be of concern to every citizen in China.

Starting from 1962, it took South Korea 30 years to complete industrialization. The urban population increased from 28% in 1960 to 74% in 1990, making it one of the “The Four Little Dragons”. However, along with the economic success, the position of agriculture in South Korea has been significantly weakened. People neglected the fact that the poor rate of food self-sufficiency, as reflected in significant food waste, is not difficult to hypothesize that China will have a similar problem to that of Korea. The lesson should be learned as otherwise China will experience weaknesses in their agri-food production systems.

Third, agriculture needs to be close to life. The public has changed from agricultural producers to today’s food consumers, whose interest to agriculture has transformed from “farm” to “taste”. The food chain connects the farm, where raw foods are initially produced, all the way to dining tables, providing food to fulfill the various needs of modern customers. The above results show that topics related to the consumption of food received high attention, while the production of food was falling out of the public’s general interest. If we are to have a sustainable society, we need sustainable food production systems and we need greater public awareness and interest. This may be achieved if we increase our efforts to popularize agricultural science and food production covering the entire food chain from farm to fork.

Forth, humanistic care should be promoted. The progress of industrialization is inevitably accompanied by the fading away of rural practices, old cultures, pastoral songs and poems, etc., which are now hardly remembered by anyone. Farming and advances in agriculture were the foundation for progress and industrial development. However, even tens of thousands of years later, the root of humanity would still rely on the fertile land with its grains and crops. It is the authors’ hope that modern agriculture can reposition farming and food production so that it is recognized as central to the nation’s development. The national spirit accumulated from the thousands of years of China’s farming civilization can be rekindled and will nurture us towards a brighter and sustainable future. This is a China-centric perspective but also could be a global perspective.

METHODS
Survey design
To identify the key topics in agriculture, we summarized more than 5000 questions and comments from the audience and readers from several popular science lectures and Wechat posts from 2016 to 2020 in China. The authors interviewed more than 100 scholars, journalists, officials and business managers who are interested in agriculture, and collectively selected 24 main issues of public concern. These issues were classified to 4 areas:
1. agricultural science;
2. food safety and environmental protection;
3. food security and national policy;
4. history and anthropology.

An initial question on the COVID-19 pandemic was used as the calibration for the subsequent 24 questions relating to agriculture. From December 1 to 10 in 2020, this study selected 100 respondents in Shanghai City and Shandong Province to conduct on-site trial surveys. The respondents came from various disciplines of study and had no direct link to agri-food sector to reduce the chance of bias. They represent the better educated population in cities. Based on the feedback, the expression and wording of the questionnaire was revised and improved, and presented as the formal questionnaire for the further investigation.

Investigation process
This survey was carried out on a mobile platform of questionnaire called Wen-Juan-Xing during December 21–28, 2020, covering age group of 18 years old and above. A total of 2586 valid questionnaires were recovered from residents in 242 cities located in 31 provinces, municipalities, and autonomous regions in Mainland China. The questions were presented in a random order. The participants voluntarily participated in the survey and were asked to pick the questions that interest them. Ethical review and approval was not required for the study, nor was written informed consent from the survey respondents to participate in this study, in accordance with national legislation and institutional requirements. The level of interest was measured by calculating the percentage of respondents who were interested in each question. The data were analyzed by SPSS software.

DATA AVAILABILITY
The authors declare that all data supporting the findings of this study are presented in the article. The raw data are available on request.

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AUTHOR CONTRIBUTIONS

D.L. and K.C. designed and conducted the questionnaires and survey. K.C. and L.K. wrote the manuscript.

COMPETING INTERESTS

L.K. is an Associate Editor for npj Science of Food. L.K. was not involved in the journal’s review of, or decisions related to, this manuscript. The remaining authors declare no competing interests.

ADDITIONAL INFORMATION

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