ANALYSIS OF THE EXTENT OF ADOPTION OF IMPROVED COWPEA (*Vigna unguiculata)* PRODUCTION TECHNOLOGIES BY FARMERS IN GOMBE STATE, NIGERIA

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ABSTRACT

The study assesses the extent of adoption of improved cowpea technologies by farmers in Gombe State, Nigeria. Multi-stage sampling procedure were used to select 606 respondents in the study. Data were collected through questionnaire and analysed using descriptive statistics. The revealed that majority of the respondents were male (81.2%) and 65.3% were married, with an average age of 36 years. Majority (66.3%) of the respondents had a household size of 8, majority of the respondents had formal education, 63.9% of the respondents' main occupation was farming with an average farming experience of 13 years. Less than half (42.9%) of the respondents had farm size of 3ha, 53% of the respondents were not members of any cooperative society and 54.5% had access to informal sources of credit. Majority (87.3%) of the respondents had contact with extension agents. The results on level of farmers' awareness on improved cowpea technologies reveal that, majority, (74.1%) of the respondents were aware of improved varieties, appropriate storage methods (64.4%), recommended planting date for improved cowpea variety (61.7%), while 59.70% of the respondents were not aware of appropriate seeds rate. Result of the extent of adoption revealed that almost half (45.5%) of the respondents adopted 7-9 technologies which were rated as high, 34.4% of the respondents adopted 4-6 technologies rated as medium, and 20.1% adopted 1-3 technologies rated as low. The study concluded that almost half of the respondents adopted 7 to 9 improved cowpea production technologies; improved seeds, herbicide, pesticide, recommended seed treatment, planting date, and spacing, storage, and fertilizer application. The study recommended that Gombe State Agricultural Development Program (GSADP) should monitor the adoption of improved cowpea production technologies by collecting data on the adoption rates, yields, income changes, and other relevant indicators to assess their extension efforts. This feedback will help fine-tune extension strategies and address any challenges faced by farmers.

Keyword: Extent, adoption, improved cowpea and technologies

INTRODUCTION

In many emerging nations, agriculture is vital to the development of their economies. Leguminous crops, such as cereal grains, yams, and tubers, are important to farmers and society. But the cowpea stands out due to its value to farmers as a source of income and food, to society as a source of protein, and to farmers' capacity to harvest the crop before other crops (Julius, Adane, Tahirou, Alpha, Olusoji, Ousmane, and Victor.2020). One of the most significant staple food crops in sub-Saharan Africa, particularly in Nigeria, is the cowpea (Vigna unguiculata). In addition to having a high mineral and vitamin content, cowpea is still one of the least expensive sources of protein for many Nigerians, with a protein level of 25%. (International Institute of Tropical Agriculture, 2020). \technologies, such as improved agricultural technologies, continue to be an essential part of efforts to increase food availability, crop production, and improve soil quality in order to reduce food and nutrition insecurity, which is currently jeopardizing people's right to food accessibility in developing countries (Sennuga and Fadiji, 2020). The term "improved agricultural technologies" (IATs) refers to a set of guidelines for on-farm production and post-production procedures that are intended to produce safe and wholesome agricultural products, including non-food items, while also taking economic, social, and environmental sustainability into account (Sennuga, Baines, Conway and Angba, 2020). One resource for agricultural production is technology. The acceptance of a group or an individual to use a new product or innovation is referred to as technology adoption. The act of adopting an idea or innovation does not occur in a single act, but rather is a mental process that involves at least five stages: awareness, interest, evaluation, trial, and adoption (Sennuga and Oyewole, 2020). Adoption, the final mental stage, is defined by widespread usage of the idea and, most significantly, its continuous use (Sennuga and Fadiji, 2020). Adoption of improved agricultural technologies has been associated with higher earnings and lower poverty, improved nutritional status, lower staple food prices, increased employment opportunities as well as earnings for landless labourers (Sennuga *et al*., 2020).

Nigeria is the world's greatest consumer and producer, accounting for 48% of production in Africa and 46% worldwide (IITA, 2020). The semi-arid region of Nigeria is where the majority of Nigeria's cowpea production takes place (IITA, 2011). Nigeria harvests 3.7 million hectares annually. In Gombe State, improved varieties of crops such cowpea, maize, rice, and soybean were introduced. In addition to these improved varieties, management procedures (technologies) were also introduced, such as planting time, pesticides application, application of fertilizer, planting time, seed rate, harvesting, and storage. ITA60, TVx3236 (SAMPEA 11), "IT89KD=288" (SAMPEA 14), IT 90K-82-2 (SAMPLE 15), IT93- 452-1, and (SAMPLE 16) are improved varieties that have been introduced in Gombe State (GSADP, 2019). Although these varieties become difficult to identify by their code varietal names when they reach markets, however, they have been grouped according to their well-known local names, such as kwankwasiya, Kanannado fari, silver, Jan wake, and yaro da kokari (GSADP,2019). Improved cowpea technology can produce 700–1200 kg/ha of cowpea in a single cropping system (Musa, Tanko and Usman, 2016). However, 100 - 400 kg/ha yield is obtained by small-scale farmers who are the primary producers (GSADP, 2020). This

research addressed this gap by assessing the extent of adoption of cowpea technologies by farmers in the study area. This knowledge can assist extension agents to know the level of adoption stages that the farmers are, understanding how agricultural extension services can improve cowpea production, can help to increase productivity and income of cowpea farmers in the study area. Thus, the study analysed the extent of cowpea farmers' adoption of improved production technologies in Gombe State Nigeria, with the following objectives:

I. describe the socio-economic characteristics of the respondents in the study area;
I. assess farmers level of awareness of improve cowpea technologies in the study area; and
ii. assess the extent of cowpea technologies adoption by the farmers;

METHODOLOGY

The Gombe State is located between the Greenwich meridian's Longitudes $10^{0}15^{1}$ - $10^{0}50^{1}$ N and its Latitudes $11^{0}00$ - $11^{0}45^{1}$ E of the Greenwich meridian. It is situated in the geographic center of Nigeria's northeastern region. The State is bordered to the east and north by the States of Borno and Yobe, to the south by the States of Adamawa and Taraba, and to the west by the State of Bauchi. Guinea Savannah and Sudan Savannah are the two agro-ecological zones in this state (Figure 1). Akko, Balanga, Billiri, Dukku, Funakaye, Gombe, Kaltungo, Kwami, Nafada, Shongom, and Yamltu/Deba are the state's 11 local government areas. The typical annual rainfall ranges from 800mm to over 900mm, and it begins in late April and finishes in October. The average daily lowest temperature is 13.6^{0}C – 31.9^{0}C in January and 9.0^{0}C to 28.5^{0}C in August (Gombe State Ministry of land survey 2019).

With a projected population of 3, 822, 081 million people from the 2006 population census number (2,365,000) and a 3.3% annual growth rate of population, Gombe State has an area coverage of around 20,265 km^{2} (NBS,2022). Tangale, Tera, Waja, Bolewa, Hausa, Fulfulde, Jukun, Tula, Cham, Dadiya, Pero, Lunguda, Kamo, and Awak are among the numerous ethnic groups present in the state. The primary occupation is agriculture, which includes farming, processing, gathering, and raising. Production and selling of cowpea, which have developed regional markets for grains in the State, are the primary economic activity of cowpea farmers (GSADP, 2020).

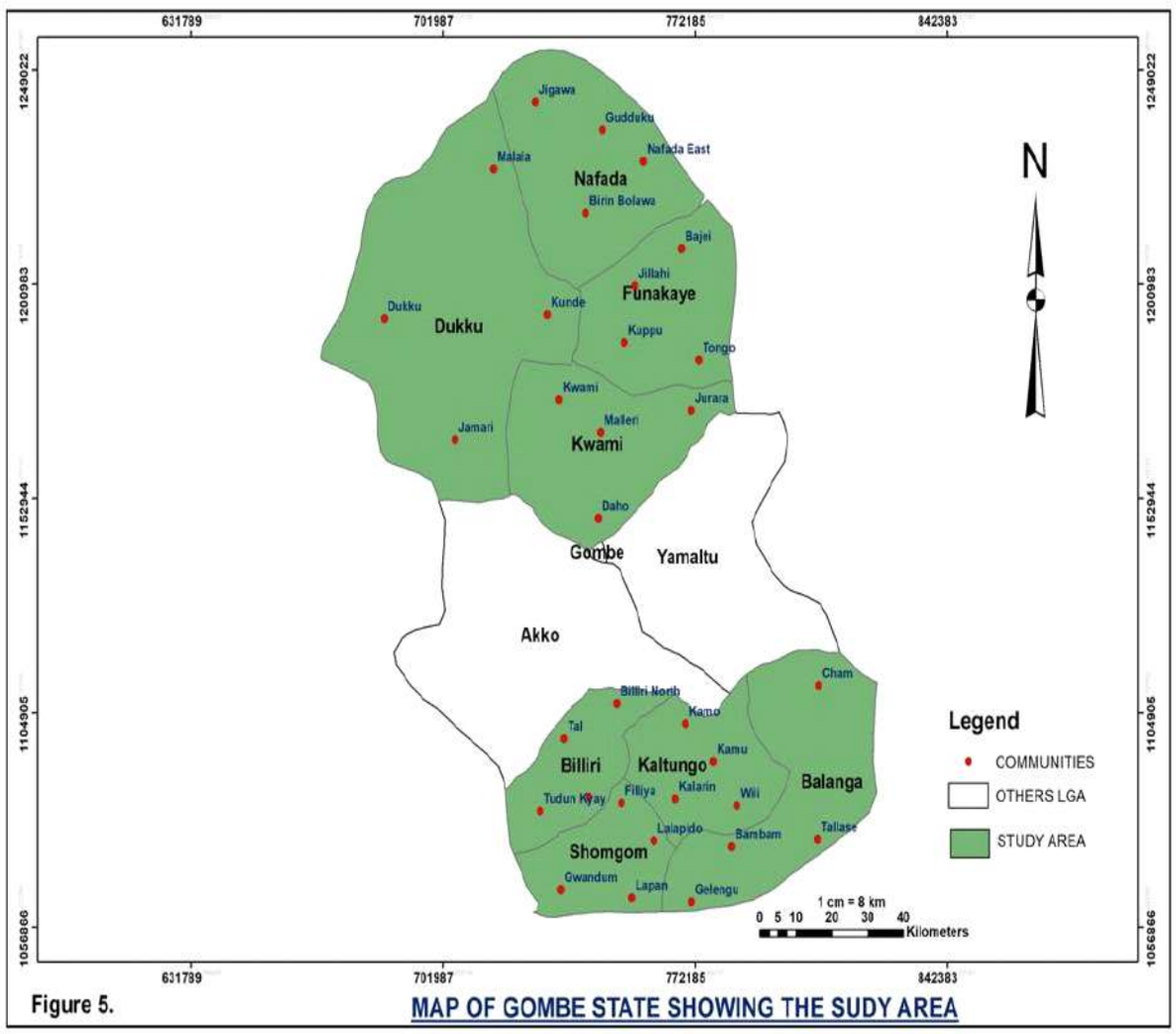

Figure 1: *Map of Gombe State showing the study area*

Multi-stage sampling procedure was used in selecting the respondents for this study. In the first stage, eight of the eleven (11) Local Government Areas (LGAs), were purposively selected and used due to the high concentration of cowpea farmers and high production of cowpea. In the second stage, four farming communities were purposively selected from eight Local Government Areas to give a total of 32 communities as presented in Table 1. In the third stage, a list of 12,282 (sample frame) cowpea farmers was obtained from the extension officers in each of the selected LGAs. Some studies (Yohanna, Madu, Madugu, and Garba, (2021) and Madugu, 2023) used different percentages based on convenience to arrive at sample size. This study, therefore, used 5% to arrive at a sample size of 606 cowpea farmers. This is because the sample frame size is large, thus a selection of a percentage below or above 5% will not give the required sample size.

Table 1: Sampleframeandsamplesize

LGA	Community	Sample frame	Sample size 5%
Billiri	Billiri North	270	14
	Tal	350	18
	Baganje North	300	15
	Tudu Kwaya	250	13
Balanga	Bambam	400	20
	Tallase	650	33
	Cham	300	15
	Gelengu	500	25
Shongom	Gwandum	240	12
	Filiya	300	15
	Lalaipido	217	11
	Lapan	210	11
Kaltungo	Kamo	230	12
	Kamu	200	10
	Kalarin	300	15
	Wili	250	13
Kwami	Doho	1100	55
	Jurara	1000	50
	Kwami	1200	60
	Malleri	900	45
Dukku	Malala	300	15
	Kunde	550	28
	Dukku	500	25
	Jamari	200	10
Funakaye	Kuppu	219	11
	Tongo	245	13
	Bajei	150	8
	Jillahi	200	10
	Jigawa	200	10
Nafada	Gudduku	175	9
	Nafada East	175	9
	Birin Bolawa	196	10
TOTAL		12, 282	606

Source: Field survey (2021)

The data for this study was obtained mainly from primary sources with the used of structured questionnaire. The analytical tools used to achieve the objectives of the study were descriptive statistical tools.

Table 2: Distribution of socio-economic characteristics of cowpea farmers (n=606)

Sex			
Female	114	18.8	
Male	492	81.2	
Age			
18-25	101	16.7	36
26-33	163	26.9	
34-41	152	25.1	
42-49	107	17.7	
50-57	57	9.4	
58-80	26	4.3	
Educational level			
Non-formal	76	12.5	
Primary	252	41.6	
Secondary	46	7.6	
Tertiary	232	38.3	
Experience			
1-8	254	41.9	13
9-16	174	28.7	
17-24	95	15.7	
25-32	60	9.9	
>40	3	.5	
Extension contacts			
No	77	12.7	
Yes	529	87.3	
Total	**606**	**100**	

Source: Field Survey, 2022.

Socio-economic Characteristics of Cowpea Farmers

Sex of respondents

The results in Table 2 revealed that majority (81.2%) of respondents were males, while female respondents made up 18.8 %. This indicates that men dominated the State's cowpea farming, this could be as a result of cultural characteristic which permits the male counterpart to participate in the majority of activities, while the female is mostly responsible for maintaining the family. Males have greater mobility and the freedom to attend various seminars, meetings, and training sessions thanks to social and cultural values and conventions. This result was consistent with the findings of Harrison and Oguntunde (2021) in a study impact of agricultural extension service delivery on cassava production in Kwami local government area in Gombe State Nigeria, observed that there were more male farmers than female farmers in their study area. These similarities could be attributed to the cultural attributes and land tenure system practiced in the area.

Age of the respondents

The results in the table 2 show that 26.9% of the respondents fell within the age bracket of 26-33

years, while 25.1%, 17.7%, 16.7%, 9.4% and 4.3% fell within the age brackets of 34 - 41, 42-49, 18- 25, 50- 57 and greater than 58 years respectively. The average age of the sampled population was 36 years old, which is an important consideration when it comes to the adoption of new technology. This was supported by the fact that the majority (53%) of respondents were between the ages of 26 and 41. Younger farmers contribute to the change of agriculture by being open to implementing new technology, such as improved cowpea varieties and agrochemicals, in order to boost production and, therefore, raise living standards. This is due to the fact that research on the adoption of technologies like improved seeds, pesticides, and agronomic methods emphasizes that young people are more risk-oriented than their older counterparts and frequently adopt more. These results suggest that the majority of respondents are still young adults who are receptive to learning about new ideas and agricultural innovations. Similar to this, Bashir, Ndaghu, Nakwe, Abdulazeez and Samuel. (2018) found that over majority of respondents were between the ages of 20 and 49, which is considered to be a youthful age group that is agile and more open to accept new and improved technology. This conclusion, however, was in contrast to Nwaiwu (2015) finding that the average age of farmers in southeast Nigeria was 57 years old. This discrepancy may be the result of regional differences in the study areas, which may be explained by the fact that youths are more likely to enter farming in the north than in the southeast, where many farmlands have been destroyed by gully erosion and floods, making farming very unappealing to young people.

Educational level of the respondents

The results showed that 41.6% of respondents had completed primary school, and 38.3 % had completed higher education, indicating that the respondents were well-educated and at least capable of reading and understanding. When it comes to farmers adopting new technology and making decisions, education is crucial. This suggests that the respondents are able to grasp, inquire about, and use improved cowpea technology with ease. Since the vast majority of the respondents had formal education, it stands to reason that they would find it simpler to accept any new technology, they are aware of the advantages of modern technology, so they won't be surprised by their appearance. This is consistent with the finding of Bashir *et al*. (2018) that the majority of respondents (50%) had attained some sort of schooling. The degree of education of farmers and their adoption of technology were both significantly correlated, according to Kamara, Omoigui, Kamai, Ewansiha and Ajeigbe. (2018).

Years of farmers' experience

The result shows that majority (41.9%) of the respondents had a farming experience of 1-8 years, 28.7% had a farming experience of 9-16 years, 15.7% had a farming experience of 17-24 years, 9.9% had a farming experience of 25-32 years and 3.1% of the respondents had farming experience of 33 and above years. The mean farming experience in the study area was 13 years. This was as a result of the respondents' youthful age, as experience often increases with age. This implies that cowpea farmers in the study area can easily identify improved technologies that can boost their yield and increase income. Since the majority of the respondents had longer farming experience, it is implied that these farmers are more likely to take actions that will boost their cowpea yield and income. Their degree of expertise can aid in the

adoption of improved cowpea technologies; it may be sufficient for a good and palpable output, and it can distinguish between excellent and bad technologies. Bashir *et al*. (2018) stated in their work that the Majority of the respondents had 6-15 years of farming experience in cowpea production in Taraba State Nigeria. The mean farming experience was 11 years.

Extension contact

As a result of the favorable effects of extension contact on agricultural productivity, 87.3% of respondents reported having interacted with extension personnel at some point. Extension agents act as a bridge between farmers and research institutions to introduce innovation. This order instructs extension agents to give the farmer essential information about using improved technology and to give feedback to the research institute. Any extension worker primary objective is to explain and show to farmers how to use these improved technologies; doing so encourages the adoption of improved cowpea production technologies. This, however, was in contrast to that of Bashir *et al*. (2018), who found that (100%) of respondents had no contact with the extension agents but instead adopted the technologies on their own or with assistance from other farmers. According to Tijjani, Nabinta and Muntaka. (2015), lack of farmer interaction with extension agents undermines the theoretical function that these organizations are meant to play in the diffusion and adoption of technology.

Farmers' Awareness of Improved Cowpea Technologies

Table 3: Distribution of Farmers' Based on Awareness of Improved Cowpea Technologies (n=606)

Cowpea technologies	Aware (%)	Not Aware (%)	Ranking
Use of improved seeds	449 (74.1)	157 (25.9)	1st
Appropriate storage methods	390 (64.4)	216 (35.6)	2nd
Date of planting recommended for the improved cowpea variety (months)	374 (61.7)	234 (38.3)	3rd
Spacing recommended for the crop (cm)	360 (59.4)	246 (40.6)	4th
Seed treatment recommended	357 (58.9)	249 (41.1)	5th
Fertilizer recommended for application per unit of area for improved cowpea production (kg/ha),	325 (53.6)	281 (46.4)	6th
Pesticide application	294 (48.5)	312 (51.5)	7th
Herbicide recommended for application per hectare of area for improved cowpea production (liter/ha),	259 (42.7)	347 (57.3)	8th
Seed rate recommended per hectare (kg/ha)	244 (40.3)	362 (59.7)	9th

Figures in parentheses are percentages

*Multiple responses

Source: Field Survey, 2022.

The results in Table 3 show that (74.1%) of the cowpea farmers in the study area are aware of using improved seeds, which were ranked first and were introduced to the farmers by extension agents, fellow farmers, and other sources. farmers were also aware of the improved seeds and maturation period. IT89KD-288 (SAMPLE 11 rough seed coat, white color with brown helium, large seed size, with a maturity period of 80- 85 days) SAMPLE 14 (rough seed coat, medium seed size, white hue with brown bubbles, 70-75-day maturation time), SAMPLE 15 (rough seed coat, white color with black helium, medium seed size, with maturity period 70-75 days), SAMPLE 16 and (rough seed coat, white color with brown helium, large seed size, with maturity period 65-70 days). This result is consistent with that of Muddassir, Shenaifi, Kassem and Alotaibi. (2020), who also found that respondents had a good understanding of the improved maize seed used in the study area. The results of this study's analysis of improved seed are at odds with those of Bashir *et al* (2018) study, which reported low adoption for improved seed.

The post-harvest stage of agricultural production is crucial, and if it is not effectively managed, it leads in a loss of both the quality and quantity of the crop. The storage technique was another technology that came in second in ranking. As a result, storage technology has garnered a lot of attention. Cowpea farmers in the study area were also knowledgeable about the date of planting, planting spacing, and seed treatment, with 61.7 %, 59.4%, and 58.9% ranking third, fourth, and fifth, respectively, among the farmers. Been aware of these technologies, if used, can lead to great yields of cowpea: correct spacing, planting at the suggested date of planting (timely), and seeds treated before planting. These are advantageous to the farmer as it leads to higher production and profit.

Stages of Adoption of Cowpea Technologies

Table 4: Distribution of farmers stages of adoption of cowpea technologies

Rec. proved Seed	Rec seed treatment	Seed rate	Rec. planting Date	Rec. planting spacing	Rec. Fertilizer application	Pesticide application	Appro Storage	Rec. herbicides per hectare
(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	
2.5	8.7	6.8	2.8	3.6	3.1	30.2	20.0	
7.1	10.1	15.2	14.2	12.5	9.2	10.9	6.4	
5.1	13.2	8.6	8.7	16.5	19.5	8.9	3.3	
4.6	7.9	12.4	10.7	9.9	12.7	5.0	3.5	
10.9	13.0	18.8	17.5	20.5	19.1	16.2	4.8	
69.8	47.0	38.3	46.0	37.0	36.3	28.9	62.0	

With 69.8% of respondents adopting the technology, Improved varieties recorded a positive adoption report; nevertheless, 10.9% of respondents are at the trial stage of the improved varieties technology, and 7.1% were at the awareness stage. Seed treatment which increases seed germination and yield is adopted by 47% of the respondents in the study area, 13% of respondents were at the trial of the technology but have not yet fully adopted it. Recommended seeds rate was found to have been adopted by 38.3 % of the sampled respondents, whereas 18.8 % of the respondents said they were at the trial stage of adoption of the technology. Less than half (37%) of respondents reported using recommended planting spacing, according to Table 4 results, 20.5% of the respondents are at the trial stage and 16.5% of respondents were at interest stage of the technology. For the production of cowpeas, a single superphosphate at a rate of 200 kg/ha-1 should be used. Table 4 showed that 19.5% of the respondents were at the interest stage of the adoption of this technology, and 19.1% are at trial stage, while the majority (36.3%) had adopted the technology. Storage technology was found to have been adopted by 62% of the studied respondents, whereas 20% of the respondents said they were not aware of the technology.

Table 5: Extent of adoption of the recommended technology

Extent of Adoption	Frequency	Percentage
Low (1-3)	122	20.1
Medium (4-6)	208	34.4
High (7-9)	276	45.5
Total	606	100

Source: Field survey, 2022

Three (3) adoption levels of the improved cowpea technologies were identified: low (1-3), medium (4-6), and high (7-9). This suggests that a farmer would fall into one of the groups indicated depending on how many technologies were available at the time and were used by the farmer. According to the data in Table 5, the majority of farmers use a variety of technologies. According to this data, 34.4% of farmers are still at the medium level of technology adoption, while 45.5% of farmers fall into the high group. The finding of this study disagrees with result of Alkali, Sani and Ibrahim. (2021) which reported that majority of respondents fall into the category of medium adoption. Research report by Deshmukh, Kadam and Shinde. (2017) revealed that majority of respondents had low adoption levels, with the remaining respondents having high and medium adoption levels, respectively. This is consistent with Table 5 finding that the majority of respondents are at the adopters' stage. This implies that less than half of the respondents adopted the complete cowpea improved technologies.

Conclusion and Recommendation

The study concluded that majority of the respondents are aware of these improved cowpea production technologies area and less than half of the sampled respondents' adopted 7-9 improved cowpea technologies in the study. The study recommended that the State government and other stakeholders should support extension agents in their efforts to regularly provide training for farmers on a

quarterly on basis on improved cowpea technologies that can help maintain the crop's high production. This will spread the word about the accessibility and value of improved cowpea technologies.

In order to evaluate the success of its extension activities, the Gombe State Agricultural Development Program (GSADP) should track the adoption of improved cowpea production technology by gathering information on adoption rates, yields, income changes, and other relevant indicators. This feedback loop will assist in honing extension tactics and addressing any issues farmers may be having.

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