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Communication network analysis among Bt corn growers in Isabela, Philippines: A basis for improved agricultural delivery system

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Abstract The communication network was analyzed by evaluating the usefulness of information, frequency of consultations, and strength of information exchange among the actors in the Bt corn production in the province of Isabela, Philippines. Majority of the respondents were male which aged 48 years old, mostly high school graduates and had been experienced in corn farming for an average of 21 years. Most of them owned an average of 1.60 ha farmland. Corn yield ranged from 50 to 100 cavans producing a net income of Php 38, 130.41. Among the technical information on seed variety, land preparation, weather forecast, and harvesting techniques were rated to be very useful while in the economic information only current market prices and future market prices had been rated to be very useful. These results were common from the three information sources. Frequency of consultation with personal information sources recorded the highest mean value of 5.10 indicating a two to three times a month information exchange. Public information sources obtained an average mean of 2.84 which means four or five times a year contact. It signified a gap between the corn growers and public information sources. Among the mass media only radio is widely used (4.56) at two to three times a month. Personal information sources obtained the highest mean information score of 256.33 exhibiting a strong information exchange with the Bt corn growers. It indicated that the personal information sources mainly composed the communication network of the Bt corn growers in Isabela. Total information scores of public and mass media information sources were low which means information exchange was weak. Only total information score of friends and cellphone revealed significantly related with corn yield. It indicated that information exchange with friends and using cellphone made a great impact on the yield of corn.

Keywords: Communication network, Bt Corn growers, Information exchange, Agricultural delivery system

Introduction

The Philippines is Asia's first country to commercialize Bt corn. Its adoption is due to its resistance against the destructive Asian corn borer. Bt

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corn adoption provides statistically significant increases on farm yields and profits; it was foreseen to practically improve corn productivity and reduce corn imports (Mutuc *et al*., 2012). Corn production was largely produced from Isabela province for the second quarter of 2019, supported by its share of 51.8 percent or more than half of Cagayan Valley Region's corn production. Although its cultivation is devoted to millions of hectares annually, the current production is insufficient to meet the local needs (Philippines Statistics Authority, 2019). The Department of Agriculture's National Corn Program reported that on the national average, the overall is still low and inefficient. Given the great demand in corn, production needs to be increased that is why corn growers' productivity must also increase.

Agricultural development entails accelerating productivity and increasing linkages between farm production, agricultural services, industrial and technological inputs, and agro-processing (Mopera, 2016). Moreover, agricultural productivity can possibly be enhanced along the value chain through appropriate, accurate, useful and timely information and knowledge. Continuous exchange of agricultural information and knowledge would strengthen the relationship and create communication networks among the actors. This will allow opportunities for sharing insights, experiences, best practices, marketing and delivery practices, that will greatly help improve farm productivity.

Currently, details on the sources, access and usefulness of information in corn production are not available. This research focused identification of the most common information sources, usefulness of information and frequency of consultations that will determine the total information score of the sources of information. The total information score provided the strength of information exchange among the corn growers and the sources of information. It would establish communication network of the Bt corn growers. Significant relationships between the respondents' socio-demographic profile and total information score of the respondents were also analyzed.

Materials and methods

A total of 447 corn growers with Bt corn farms from the eight towns in the province of Isabela served as respondents. The study employed the snowball or chain referral sampling technique to generate the informants in the study.

Proper coordination with the local government offices was made prior to the conduct of the study. A consent form was clarified to the respondents for ethical reasons that their involvement was completely voluntary and that any details arising from the research would be treated with strict confidentiality.

Research analysis

The communication network of BtCG was analyzed using indices such as frequency of contact with information sources, usefulness of information generated, and total information scores of information sources. Frequency of contact was analysed using the scale and weights were given to each component according to the frequency of contact, were as follows:

Scale	Weights	Frequency of Contact/s
0	0	no contact
1	1	once a year
2	2	two or three times a year
3	4	four or five times a year
4	12	once a month
5	30	two or three times a month
6	52	once a week
7	130	two or three times a week and
8	365	contacts once a day

The degree of usefulness of information generated was weighted as follows:

Scale	Weights	Degree of Usefulness
0	0	not useful at all
0.25	0.01- 0.25	little useful
0.50	0.26– 0.50	moderately useful
0.75	0.51 – 75.00	Useful
1.0	0.75 – 1.00	very useful

The information system was analyzed using the total information score (TIS). The formula is adopted from Demiryurek *et al.*, 2008 as presented below:

TIS = FC x IU

where: FC = the number of times farmers come in contact with information sources;

IU = the usefulness of information

Descriptive statistical tool was used to analyze quantitative data. The Pearson Moment of Correlation was used to analysed relationships among variables.

Results

Socio-demographic characteristics of the respondents

Results revealed that most of the respondents are male (73.15%) majority (71.84%) fall within the age range of 31- 60 years, although many of them were between 41-50 years of age and mean age obtained was 47.93 years old (Table 1). Most (27.29%) of them were high school graduates indicating that they were literate. Only few (8.05%) were members of organizations and most (83.33%) of them had been members for an average of seven years. Few (2.78%) of them were officers.

Table 1. Socio-demographic characteristics of corn grower respondents

Profile	**Frequency**	**Percent**
Sex		
Male	327	73.15
Female	120	26.85
Age		
21-30 years old	47	10.51
31-40 years old	93	20.81
41-50 years old	121	27.07
51-60 years old	107	23.94
61-70 years old	60	13.42
71-80 years old	14	3.13
81-90 years old	5	1.12
Mean= 47.93 years old		
Highest Educational Attainment		
Elementary Level	55	12.30
Elementary Graduate	110	24.61
High School Level	79	17.67
High School Graduate	122	27.29
College Level	43	9.62
College Graduate	37	8.28
With Doctoral Units	1	0.22
Membership to Organization		
Member	36	8.05
Non-member	411	91.95
Years of Membership	30	83.33
0-10 years	6	16.67
11 years & above		
Mean= 7.05 years		
Nature of Membership		
Member	35	97.22
Officer	1	2.78

A little more than half (55.48%) of the corn growers have been cultivated in the corn growing industry for over 21 years. A large majority (72.48%) of the corn growers, were landowners and area devoted to corn farming is on average 1.60 ha. More than half (54.79%) obtained a yield ranging from 51 to 100 cavans or 4.61 tons per ha with the average net income of Php 38, 130.41 per ha (Table 2).

Table 2. Farm characteristics of Bt corn growers

Farm profile	Frequency	Percentage
Nature of Ownership of Farmland		
Land is own	300	67.04
Tenant	87	1.44
Land is sharecropped	26	5.92
Land is rent	34	7.61
Years in Growing Corn		
Less than 5 years	57	12.75
6-10 years	49	10.96
11-15 years	54	12.08
16-20 years	39	8.72
More than 21 years	248	55.48
Position in the farm		
Owner	324	72.48
Shared Owner	47	10.51
Paid Manager	29	6.49
Paid Farm Worker	34	7.61
Member of Farming Family	13	2.91
Farm area		
Less than 1 ha	120	26.85
1.00 – 1.99 ha	181	40.49
2.00 – 2.99 ha	76	17.00
3.00 -3.99 ha	39	8.72
4.00 -4.99ha	11	2.46
5 ha and above	20	4.47
Average Area Planted, ha = 1.60		
Yield per ha		
50 cavans and below	102	22.75
51-100 cavans	245	54.79
101- 150 cavans	74	16.47
More than 150 cavans	27	5.99
Average tons per ha = 92.18 cavans (4.61 tons)		
Net Income per ha		
Php20,000 & below	171	38.33
Php21,000-40,000	121	27.18
Php41,000-60,000	90	20.21
Php61,000-80,000	30	6.62
Php81,000-100,000	14	3.14
More than Php 100,000	20	4.53
Average Net Income per ha = Php38,130.41		

Table 3. Perceived degree of usefulness of information from personal, public and mass media sources

Media	Personal		Public		Mass	
Technical Information	Mean	QD	Mean	QD	Mean	QD
1. Seed variety	0.84	VU	0.81	VU	0.81	VU
2. Land preparation	0.84	VU	0.77	VU	0.77	VU
3. Weather forecast	0.84	VU	0.77	VU	0.70	VU
4. Soil management	0.70	U	0.70	U	0.70	U
5. Fertilizer application	0.72	U	0.72	U	0.72	U
6. Disease and pest control	0.63	U	0.63	U	0.63	U
7. Use of machinery	0.64	U	0.64	U	0.64	U
8. Harvesting techniques	0.76	VU	0.76	VU	0.86	VU
9. Storage methods and techniques	0.54	U	0.54	U	0.24	LU
Mean	*0.72*	*U*	*0.70*	*U*	*0.67*	*U*
Economic Information						
1. Current market prices	0.88	VU	0.88	VU	0.88	VU
2. Future market Prices	0.71	U	0.71	U	0.61	U
3. Market locations	0.76	VU	0.76	VU	0.66	U
4. Budgeting methods	0.53	U	0.62	U	0.62	U
5. Credit sources	0.53	U	0.53	U	0.23	LU
6. Procedure for credit procurement	0.53	U	0.58	U	0.58	U
7. Stock/record keeping	0.20	LU	0.16	LU	0.16	LU
8. Cooperative association	0.20	LU	0.20	LU	0.20	LU
9. Labor availability	0.74	U	0.74	U	0.84	VU
10. Risk management in agriculture	0.74	U	0.74	U	0.44	**U**
11. Government policies	0.63	U	0.63	U	0.63	U
12. Government grants	0.64	U	0.64	U	0.64	U
Mean	*0.59*	*U*	*0.60*	*U*	*0.54*	*U*

Legend:
0.75 – 1.00 very useful (VU)
0.51 – 0.74 useful (U)
0.26 – 0.50 moderately useful (MU)
0.25 – 0.01 little useful (LU)
0 not useful at all

Communication network analysis

Usefulness of information, it described the condition to which the farmers find the information generated from the three sources of great benefit or impact while farming corn (Table 3). The technical information from the three sources obtained mean scores of 0.72, 0.70 and 0.67, indicating that the information generated to be useful. Noteworthy in the result showed that seed variety, land preparation, weather forecast, and harvesting techniques were rated to be very useful. Soil management, fertilizer application, disease and pest control, use of machinery, and storage methods and techniques were rated to be useful, except for the mass media source where storage methods and techniques were considered to be little useful. Usefulness of economic information from the three sources generated mean scores of 0.59, 0.60 and 0.54 all described as useful. Only current market prices and future market prices had been rated as very useful, while stock/record keeping and cooperative association were rated little useful possibly because most of the Bt corn growers do not store their produce.

Frequency of consultation with information sources

The overall mean obtained from personal sources is 5.10, of which consultation happens two or three times a month (Table 4). However, family members (5.83) were still the main source of information for they talked about corn farming to be once a week. Remarkably, public information sources only obtained an average mean of 2.84 with a description of four or five times a year of consultation. Similarly, media channels (3.01) are used four or five times a year for generating information. However, more frequently used one were radio (4.56), used two or three times a month and TV (3.85) used once a month. Other mass media channels are used only four or five times a year. This implies that conventional print materials and mobile phones are only used from time to time.

Total information score

It referred to the strength of information exchange between the corn growers and their sources of information categorized into weak (IS>74), moderate (75<IS<149) and strong (>150). Based on the result as shown in Table 5, personal information sources obtained a mean of 256.33 IS with the family members having the highest of 316.6 IS. The rest of the sources obtained similar IS of 182.4. The values imply a strong information exchange

among the components of the personal information sources. There is established good seeking and sharing of information within the personal information subsystem. Total information score obtained from the public information sources was very low mean (13.58 IS). This expresses a low communication strength with the farmers. In terms of the mass media sources, the obtained mean IS score was 29.29 denoting a low strength of information exchange. However, radio (182.4 IS) showed a strong information score. The result suggested that farmers also generated information by listening over the radio.

Table 4. Frequency of consultation with information sources

Personal Information Sources	**Mean**	**Description**
1. Family members	5.83	Once a Week
2. Relatives	4.83	Two or Three Times a Month
3. Friends	4.82	Two or Three Times a Month
4. Co-corn growers	4.93	Two or Three Times a Month
Mean	*5.10*	*Two or Three Times a Month*
Public Information Sources		
1. Municipal Agricultural Technician	3.47	Four or Five Times a Year
2. University Agricultural Extensionist	2.89	Four or Five Times a Year
3. Researchers	2.50	Two or Three Times a Year
4. Experts	2.45	Two or Three Times a Year
5. Agriculture Graduates	2.70	Four or Five Times a Year
Mean	*2.84*	*Four or Five Times a Year*
Multi-Media Channels		
1. Radio	4.56	Two or Three Times a Month
2. Television	3.85	Once a Month
3. Newspaper	2.74	Four or Five Times a Year
4. Farm journals/magazines (ex. Agriculture Magazine)	2.43	Two or Three Times a Year
5. Farm Primer	2.93	Four or Five Times a Year
6. Brochure	2.91	Four or Five Times a Year
7. Package of Technology	2.72	Four or Five Times a Year
8. Leaflet	2.45	Two or Three Times a Year
9. Chart/poster	2.40	Two or Three Times a Year
10. Internet	1.98	Two or Three Times a Year
11. Cellphone	3.43	Four or Five Times a Year
Mean	*3.01*	*Four or Five Times a Year*

Legend:
7.13 – 8.00 Contacts Once a Day
6.24 – 7.12 Two or Three Times a Week
5.35 – 6.23 Once a Week
4.46 – 5.34 Two or Three Times a Month
3.57 – 4.45 Once a Month
2.68 – 3.56 Four or Five Times a Year
1.79 – 2.67 Two or Three Times a Year
0.90 – 1.78 Once a Year
0.00 – 0.89 No Contact

Table 5. Information system and communication network in corn production

Sources of Information	Total Information Score	Strength of Information Exchange
Personal Information Sources		
Family member	316.6	Strong
Relatives	182.4	Strong
Friends	182.4	Strong
Co-corn growers	184.4	Strong
Mean	*256.33*	*Strong*
Public Information Sources		
Agric. Technician	24.32	Weak
Univ. Extensionist	12.16	Weak
Researcher	12.16	Weak
Experts	12.16	Weak
Mean	*13.58*	*Weak*
Mass Media Information Sources		
Radio	182.4	Strong
TV	24.32	Weak
Newspaper	12.16	Weak
Farm Journal	12.16	Weak
Farm Primer	12.16	Weak
Brochure	12.16	Weak
Package of Technology	12.16	Weak
Leaflet	12.16	Weak
Poster	12.16	Weak
Internet	6.08	Weak
Cellphone	24.32	Weak
Mean	*29.29*	*Weak*

Legend: IS<74 – weak degree of information contact
75<IS<149 – moderate degree of contact
IS>150 - strong degree of contact

Relationship between variables

The relationship between yield and total information score of the respondents are shown in Table 6. Only friends and cellphone were found to have significant contribution on the increase of corn yield. This implies that the more direct or cellphone information contact with their friends, the better the corn yield.

Table 6. Correlation between yield and total information score of the respondents

Information Sources	Production/Yield		Decision
Personal	r-value	p-value	
Family members	.026	.612	Fail to reject Ho
Relatives	.082	.106	Fail to reject Ho
Friends	.107	.035	Reject Ho
Co-corn growers	-.004	.941	Fail to reject Ho
Public Information Sources			
Municipal agricultural technician	.054	.285	Fail to reject Ho
University agricultural extensionists	.013	.795	Fail to reject Ho
Researchers/Experts	.029	.572	Fail to reject Ho
Chemical company technicians	.019	.705	Fail to reject Ho
Chemical company sales representatives	.040	.427	Fail to reject Ho
Multi-media Channels			
Radio	.065	.203	Fail to reject Ho
Television	.035	.497	Fail to reject Ho
Newspaper	-.037	.470	Fail to reject Ho
Farm journals/Magazines	.037	.471	Fail to reject Ho
Farm primer	-.010	.839	Fail to reject Ho
Brochure	-.041	.421	Fail to reject Ho
Package of technology	.021	.675	Fail to reject Ho
Leaflet	.025	.617	Fail to reject Ho
Charts/poster	.047	.355	Fail to reject Ho
Internet	.022	.666	Fail to reject Ho
Cellphone	.103	.043	Reject Ho

p-value of .05 and below are significant and above .05 are not significant

Discussion

Socio-economic profile of Bt corn growers

From the results, the mean age among the corn growers was 47.93 years old which individual mean was still in prime age and can withstand the rigors of corn farming. Majority of them had completed secondary school and somehow finished high level of literacy.

Membership to organizations can widen the horizon of farmers for information seeking or sharing. Isaac *et al*. (2007) pointed out that promotion of community involvement may facilitate the transfer of information, not simply

to introduce information, but also to promote social exchange and interaction, strengthen pre-existing informal source networks, and increase social proximity among farmers. However, few Bt corn growers are members of organizations. Reasons include insufficient access to organizations and no time to join organizations. Hale and Mupetesi (2005) emphasized that among the challenges in farmers' organization included the fragmented farmers' communities, inadequate linkages at regional level, available skills and knowledge are not shared across the region and the level of commercialization and engagement in agricultural trade is still very low. The average farm yield was 4.61 tons per ha which affirmed the findings of Philippine Statistics Authority that for 2019, yield per hectare improved 2.85 metric tons to 2.95 metric tons or by 3.5 percent thereby making Cagayan Valley Region significant increment in production at 163 thousand metric tons.

Communication network analysis

Personal information sources which are considered as informal sources remain to be the source of information of Bt corn growers. It composed their communication network where information in corn farming revolved. Adio *et al*. (2016) pointed out that majority of the farmers rely on informal sources of information from neighbors, friends and colleagues rather than from the extension workers. This also validates the claim of Food and Agriculture Organization (n.d.) that the farmers' needs were not met by the more formal sources such as the agricultural technicians, nor the programs handed down to the technicians for transfer to farmers who are adequate to their needs. Moreover, the high total information score could affirm that the communication network of the Bt corn growers are the members of the personal information sources. This is the avenue where they share or seek information or experiences related to corn farming. It can also be assumed that among the members of the communication network, there may be prominent or star performers who have shown success in their corn farming which emulated by other Bt corn growers. In a related study conducted by Wood *et al*. (2014) they found out that when making decisions regarding from whom to seek advice or with whom to share inputs, farmers would often reach out to peers who have demonstrated clear signs of successful farming practices. Nyantakyi-Frimpong *et al.* (2019) also found evidence showing that farmers who demonstrated clear signs of successful farming practices, and also tended to be popular advisers within a cooperative to their peers or at the individual network level. In addition, someone may have played the role of a gatekeeper in the Bt corn network, who could have prevented the transfer of an information not suited to

them. Schut *et al.* (2014) presumably pointed out that skillful local farmers can facilitate resource-conserving agricultural innovations, as such this can curb the top-down transfer of farming knowledge which are not applicable to the information needs of the farmers, one major criticism of agricultural extension delivery in most developing countries. Radio and TV were found to be effective mass media information sources among the Bt corn growers. Accordingly, radio is easy to use. It provides local information, and can be used even while working in the farm. As pointed out by Temba *et al.* (2016) majority of farmers used televisions, mobile phones and radio to get extension information. Likewise, in the study of Licht and Martin (2007) stated that soybean producers revealed that among the mass medium channels radio was the most preferred because information was rated to be more timely. The public information sources are driven by professional staff of various institutions. They serve as information sources from outside the farmers' communities. Ideally, they are expected to provide the farmers with scientific and technical support services. However, the Bt corn growers rarely get information from agricultural technicians, university extension workers, researchers and experts due to the limited frequency of consultation. The informants mentioned insufficient funds, personnel, and mobility as factors. Despite this however, information generated from them were found to be useful. The information generated may have contained practices that were used and had made an impact in their corn farming.

Relationship of some socio-economic characteristics and total information score

Friends and cellphone as sources of information were found significantly contributed on the increase of corn yield. The information generated from friends or other co-corn growers through cellphones may have been utilized that made a great impact on the corn yield. Dealing with friends and other corn growers for information forms an interpersonal or communication network. Skaalsveen *et al*. (2020) pointed out that interpersonal networks are important for farmers such can influence farmer learning and decision-making. The cellphone would be used to browse the internet where the generated information have helped to improve corn yield. Also, Zhang *et al.* (2016) emphasized that with easy access to information, knowledge and experts supported through ICT-based information dissemination services, farmers were able to improve their income and economic situation through better practice.

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