ADOPTION SCORES FOR BUFFALO-BASED TECHNOLOGIES IN THE PHILIPPINES AS INFLUENCED BY SOCIO-ECONOMIC, TECHNOLOGICAL, COMMUNICATION, AND INSTITUTIONAL FACTORS

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ABSTRACT

The study aimed to analyze the adoption of 22 technologies on dairy buffalo production in selected sites in the Philippines. A total of 666 farmer-informants who were previously exposed to training and other extension support services on dairy buffalo production were interviewed using semi-structured questionnaire. Dichotomous (yes or no) frequency and percentage responses along five stages, i.e., "awareness", "interest", "evaluation", "trial", and "adoption" were transformed to sigma (Z) scores for adoption. Frequency responses for "number of years of adoption" were likewise transformed to sigma scores. The two sigma scores were added to get the total adoption scores for each technology. The total or combined adoption scores (dependent variable) for all technologies were then tested for linear correlation and multiple regression with selected socio-economic traits, farm characteristics, and other independent variables. Most of the farmer-informants had at least 75% adoption rate in animal health care, improved forage feeding, estrus detection, and feeding of calves with colostrum. Multiple regression analysis indicates that attribution scores, years of experience in dairying, technical assistance, animal inventory, distance of the farm from a buffalo R and D institution, access to information materials and income from dairying positively and significantly influenced adoption scores. To increase adoption, improving the attribution by farmers to technologies as regards their relative advantage, compatibility with existing farm operations, trialability, and simplicity should be given priority consideration in designing and implementing extension delivery systems since it is the most powerful predictor variable to adoption.

Keywords: *Bubalus bubalis*, buffaloes, technology adoption, dairy buffalo, sigma score, impact zone

INTRODUCTION

The Department of Agriculture-Philippine Carabao Center (DA-PCC), a buffalo research and development (R and D) institution oversees the effective and efficient planning, implementation, monitoring, and evaluation of Carabao

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Development Program (CDP) in various sectors of communities. The sustainability of the CDP depends on the genuine communication and lasting relationships among program coordinators, local government units, and various stakeholders. An important aspect of such relationship involves the transfer of various technologies on dairy buffaloes from the DA-PCC to its farmer-clients. The said technologies, which take the form of improved dairy buffalo management practices, were disseminated and promoted through a series of trainings (lecture-discussions) and demonstrations. To allow more focused directions and resource allocation for such technology transfer and other extension support activities, the DA-PCC has implemented the "impact zone" approach.

An "impact zone" is a compact area wherein all ingredients necessary for sustainable buffalo-based enterprise development are put together to create significant effect in the said area (Palacpac *et al*., 2010b). The DA-PCC has identified the province of Nueva Ecija as the National Impact Zone (NIZ) while its 12 regional stations across the country maintain a smaller model (i.e., at the municipality level) via their respective "regional impact zones" (RIZ).

To measure the adoption of technologies by the farmers in the NIZ, two studies were conducted in year 2007 (Palacpac *et al*., 2010a) and year 2013 (Palacpac *et al*., 2015). The former, however, surveyed only 38 farmer-informants while the latter employed purposive sampling to survey only the "progressive" dairy buffalo farmers (n=47), i.e., those who have become quite successful in their buffalo dairying.

The current study was more inclusive in its approach, i.e., it increased the sample size of farmer-informants and surveyed farmers not only in the NIZ but also in some of the RIZs. Likewise, it expanded the scope of analysis by considering the various stages in the adoption process. Results that were generated in this study could be used as empirical basis of DA-PCC for gauging the effectiveness of its extension modalities, technology transfer, and promotion activities.

In general, this study aimed to analyze the adoption of DA-PCC-recommended technologies on buffalo dairying by farmer-clients in the NIZ and the RIZs. Specifically, it aimed to: (1) describe the farmer-informants in terms of their socio-economic and farm characteristics; (2) map the adoption pathways of DA-PCC-recommended technologies; (3) measure the adoption scores of such technologies; (4) determine any relationship between the adoption scores and various socio-economic and farm characteristics, communication, institutional, and technological factors; (5) determine which of these independent variables could influence technology adoption; and (6) recommend ways to improve technology adoption.

MATERIALS AND METHODS

Conceptual framework

The research was based on the concepts and theory of diffusion of innovation (Rogers, 2003) (Figure 1) and on how a farmer's decision in relation to dairy buffalo technologies is measured along the five adoption stages, namely, awareness, interest, evaluation, trial, and adoption (Ovwigho, 2013) (Figure 2).

Study area and sampling procedure

Farmers with existing purebred dairy buffaloes either owned by them or loaned from DA-PCC, were chosen as informants. They have previously undergone technical trainings on dairy buffalo production conducted by DA-PCC from 2009 to 2012. A total of 666 informants were identified for the purpose, i.e., 311 respondents from the NIZ and 355 from the RIZ (Region I=71; Region II=76; Region III=50; Region IV=33; Visayas Region or VR=125). From them, both adopters and non-adopters of the specific technologies were identified.

Survey instrument and technologies documented

Face-to-face individual interviews with the farmer-informants were made using a semi-structured survey questionnaire. Twenty-two (22) technologies or improved practices on dairy buffalo production and management were considered in the survey questionnaire. These included the following: (1) animal housing system; (2) recording system; (3) early weaning of calves; (4) feeding calves with colostrum; (5) feeding calves with milk replacer; (6) complete confinement; (7) improved forage feeding; (8) legume supplementation; (9) mineral supplementation; (10) feeding with urea-treated rice straw; (11) feeding with total mixed ration; (12) feeding with silage; (13) concentrates feeding; (14) cleaning the udder before milking; (15) foremilk stripping; (16) dipping teats in iodine solution after milking; (17) milk cooling; (18) artificial insemination or AI; (19) estrus detection; (20) vaccination; (21) deworming; and (22) vitamin administration.

Possible influencing factors to technology adoption and their corresponding (independent) variables were gathered from the survey questionnaires. These included the following:

Socio-demographic-economic factors

- Age (years)
- Education (no. of years of formal school)
- Civil status (1 = married and 0 = otherwise)
- Sex (1 = male and 0 = female)
- Household income (peso per year)
- Household size (no. of family members)
- Capitalization (pesos)

Farm characteristics

- Location (distance from a buffalo R&D institution, i.e., DA-PCC office in km.)
- Animal inventory (no. of animals)
- Production type (1 = dairy and 0 = otherwise)
- Source of pasture (1 = communal and 0 = otherwise)
- Experience in dairy buffalo raising (no. of years)
- Dairy income (pesos)
- Inputs used (pesos)
- Size of forage area (sq m)

Technological factor

- Average attribute scores

Communication factors

- Number of information, education, and communication (IEC) materials used in information seeking
- Number of individuals communicated with regarding buffalo dairying

Institutional factors

- Attendance to training (no. of days of training attended)
- Extension modalities (no. of extension services exposed to)
- Membership to dairy buffalo raisers' association (1 = member and 0 = otherwise)
- Presence of other government programs

on dairy buffalo in the locality (1 = present and 0 = otherwise)

- Participation in dairy buffalo activity (1 = with participation and 0 = otherwise)

Entry, processing, and analysis of data

The socio-economic characteristics of farmers and other influencing factors were analyzed descriptively using frequencies, means, and percentages and were presented using tables and/or charts. Adoption score (and scale) for each of the 22 technologies identified were derived from z-transformations of frequency and percentage data on each adoption stage using the Sigma scoring method suggested by Ovwigho (2013). Correlation and multiple regression analyses were made to determine any linear relationship between the adoption scores (dependent variable) and the selected socio-economic, farm characteristics, communication, institutional, and technological factors (independent variables). The adoption pathways (Gabunada and Montes, 2013) were mapped by obtaining reports (secondary data) from the DA-PCC's NIZ team and by deriving information from the surveyed questionnaire.

RESULTS AND DISCUSSIONS

Socio-demographic-economic profile

Majority of the farmer-informants were male, married, and their usual household size is 5, which is also the average family size among Filipinos (Table 1). The computed mean age is 48 years old, which implies that they are on the productive stage of their lives and capable of farming activities including buffalo raising. Most of them reached high school level with an average of 9.4 years in formal school. Other socio-demographic profiles are also presented in the Table.

Farm information

About 94% of the farmer-informants were classified as smallhold farmers who are raising 1 to 5 head caracows (Table 2). The average size of forage area (1,497 sq m) may not be enough to provide the requirements of more than one dairy buffalo. As recommended by DA-PCC, at least 1,000 sq m per adult buffalo is needed. Nonetheless, the farmer-informants claimed that they resort to alternative feedstuff such as hay, *sakate* (mixed weeds that are cut-and-carried), legumes, and concentrates to provide for the requirements of their animals.

Raising buffalo provides multiple benefits such as milk, meat, hide, and draft power. Hence, many farmer-informants were engaged in this venture as another source of livelihood. Seventy-five percent of them are involved in dairying and they recognized that proper animal care leads to production of high quality milk.

Animal inventory

The total initial inventory (which dates back to more than 20 years ago) of purebred buffaloes was 650 heads while crossbred and native carabaos were 108 and 337, respectively. Female purebred and crossbred buffaloes are usually used for breeding and dairying while the males are either sold for meat or draft. On the other hand, the native carabaos are utilized mainly for draft. Nonetheless, some native cows are also milked for home consumption.

With the continuous assistance from DA-PCC, animal population under the care of the farmer-informants significantly increased. Additional buffaloes were entrusted to qualified farmers thereby increasing the population of purebred to 1,983 heads. Likewise, bull loan and AI services were continuously being provided to the farmers to improve their stocks. Consequently, current inventory of crossbred buffaloes increased while that of native carabaos decreased. According to the farmer-informants, they disposed most of their native carabaos, as their numbers of crossbred buffaloes increased. They see the latter as offering more potential benefits.

Regardless of the size of their farm, they also invest time and resources to ensure that their animals are provided the best health care, housing condition, and proper nutrition. Simply put, "what is good for their animals is good for their business". In general, there was a significant increase in animal inventory across the region with a total of 3,098 buffaloes, 64% of which are purebred.

Communication behavior and access to information

The main sources of information related to buffalo raising by the farmer-informants were from "institutions", such as DA-PCC and local government units (LGUs) (Figure 3). Most of the information accessed relates to addressing particular concerns in their buffaloes. Other sources of information (thru interpersonal communication) include organization's leader, co-farmers, and AI technicians. Printed materials such as newspapers, pamphlets, newsletters, brochures, and the like are also important to them.

The farmer-informants also shared the information they sought to their family members, co-raisers, and friends. Proper management and proper milking of their dairy animals are mostly the information being shared by the farmer-informants through informal communication. According to them, sharing of information became their bonding time and a habit in their community that, in return, strengthened their relationship.

Attribution scores for technology adoption

Attributes of the innovation is an important part in explaining adoption of innovation. Rogers (1995) explained such influencing attributes of an innovation, which include *relative advantage, compatibility, complexity* and *trialability*. *Relative advantage* is the degree to which an innovation is perceived as being better than the idea it supersedes (easily adopted and implemented); *compatibility* is the degree to which an innovation fits with the existing values, past experiences, and needs of potential adopters (the more compatible, the greater the chance of adoption); *complexity* is the degree to which an innovation is perceived as difficult to understand and use (simple to use will be more easily adopted); and *trialability* is the degree to which an innovation may be experimented with in a limited basis (it requires investing time, energy and resources before being fully implemented).

Attributes of the innovations were assessed per region using a constructive statement per category and measured along a scale of 1 to 5, with 5 as "strongly agree" and 1 as "strongly disagree" (Table 4). Results showed that all respondents were more receptive and aggressive in implementing new ideas in farming activities. Since they have more experience and familiarity in dairying, a particular technology they learned has a clear advantage over the traditional practice, which enabled them to adopt and implement in their farm immediately.

Farmer-informants preferred technologies that are economical, effective, socially acceptable, and easy to use. Likewise, they readily accept new ideas, which are more compatible, familiar and fits closely with their farm situation. Moreover, technologies that were clearly and fully disseminated by technical experts have higher rate of trial and adoption among the farmer-informants. They claimed that they have higher acceptance of technologies that were demonstrated because such practice somehow dispelled their uncertainty about the technology.

In general, attributes of innovation particularly relative advantage, compatibility, complexity, and trialability could influence farmer-informants in their decision whether to adopt or not new ideas or technologies.

Measuring technology adoption using sigma scoring method

In this section, only the data from one technology (i.e., animal housing system) are presented for purpose of illustrating how the sigma scores for adoption, sigma scores for years of adoption, and adoption scales for the various technologies were generated. The same procedures were applied to the other technologies under study to generate data for subsequent analysis.

Adoption (Sigma) scores

Table 5 presents the frequency and percentage of responses (yes or no) for "animal housing system" technology for each adoption stage. The percentages were transformed to proportion, z-scores, and standard z-scores using Sigma scoring method (Ovwigho, 2013). The standard z-scores were then rounded off, as shown in the last column.

Sigma scores for years of adoption

Table 6 shows the frequency responses to the "number of years of adoption" of "animal housing system", their cumulative frequencies, cumulative frequency to the midpoint, and cumulative proportion to the midpoint, which were then transformed to standard Z scores and rounded off.

Adoption scales

The rounded off Z scores for stages of adoption (Table 5) were incorporated to the rounded off Z scores for the number of years of adoption (Table 6) to generate the adoption scale for "animal housing system" (Table 7).

To illustrate, for "animal housing system", the scale consisted of aware (4), not aware (0); interested (4), not interested (0); evaluated (4), did not evaluate (0); tried (3), did not try (2); adopted (4), did not adopt (1); 18 years adoption (9), 13 to 17 years adoption (8), 9 to 12 years adoption (7), 7 years adoption (5), 6 years adoption (3), 4 to 5 years adoption (2), 3 years adoption (1) and 1 to 2 years adoption (0).

Note that farmer-informants who "did not try" and who "did not adopt" animal housing system technology still got scores of 2 and 1, respectively. This means that the constructed adoption scale allows for the approximation of interval scale because there is no absolute zero value (Ovwigho, 2013). In other words, a farmer-informant who "did not" try or "did not adopt" a particular technology is not bereft of at least an "awareness" of the said technology, as clearly shown in the adoption scale.

Frequency distribution of adoption scores

The scores on the scale for each of the 22 technologies were added up to get the "total adoption score" for each farmer-informant. Doing so also allowed the generation of a frequency distribution table (Table 8).

Those farmers who got total adoption scores of at least 18 in all technology categories (except AI, whose farmers' scores should be at least 19) were characterized as "adopters" (see shaded score ranges).

Majority of the farmer-informants' scores were 21 to 25 for herd management, calf management, feeding, breeding and reproduction, and animal health. Those scores indicate that they started adopting the technology in year 2010 to 2012 and that after they heard of the technology, they immediately tried and finally adopted it. Their herds are in good condition and many were getting pregnant.

In addition, most of the farmer-informants' scores were 21 to 25 for milking and milk handling practices, which indicates that they started milking in 2011 to 2013. It appears that they started practicing such techniques a year after they heard of them.

Relationship of adoption scores and selected independent variables

Because the total adoption scores for the technologies were measured at the interval level, it allowed analysis of relationship with other interval variables (or independent variables) such as those indicated earlier.

For ease of analysis, the adoption scores of a farmer-informant for all 22 technologies were totaled then subjected to tests of linear correlation and regression.

Out of the 25 explanatory variables, 12 significantly correlated with total adoption score. These were the age of the farmer, education, income from dairying, off-farm income, distance of farm from the DA-PCC, animal inventory, years of experience in dairying, size of farm devoted to dairying, attribution score, access to IEC materials, technical assistance, and other government program related to dairying (Table 9).

Multiple regression analysis was performed to determine more the relationship of the 12 independent variables that have correlated significantly with the adoption scores (dependent variable) of the farmer-informants. Using backward stepwise regression method, seven variables were found to be significant predictors (Table 10). The coefficient of determination (R^2) was 0.527, indicating that approximately 53% of the variation of the total adoption scores could be explained by the seven variables included in the model. The F-value was 102.362 with a P-value of 0.000, indicating that the model was statistically significant. In determining model adequacy, we look at some broad features of the results, such as the R^2 value and *F*-value, which were both statistically significant in this study.

Attribution score was statistically significant (P=0.000) and has the highest B value among the explanatory variables. The coefficient of 19.374 means that an increase by one unit in the attribution score would increase adoption score by 19.37, holding other predictors constant. This means that the technology that offers better idea, more compatible, effective, sounds familiar and fits well to the farm situation would have a more positive impact on adoption.

Experience in dairying was statistically significant (P=0.000) and also had a positive value. It implies that accumulated experiences in dairying helped the farmers to have better information on how to handle and understand the benefits of adopting technologies. This is consistent with the studies of Effendy, Setiawan *et al.* (2013); Dehinenet *at al.* (2014); Palacpac *et al.* (2016), which positively correlated years of farming experience with adoption. In short, more experienced farmers tend to have higher adoption scores. The coefficients for *technical assistance* and *access to IEC materials* were also positive and statistically significant with B values of 9.790

and 9.665, respectively. Farmers who receive adequate technical assistance from more agencies and who are able to access more IEC materials can avail themselves of modern buffalo management information and technologies on nutrition, breeding, animal health care, hygienic milking and milk cooling, among others. This finding is consistent with the study of Dehinenet *et al*. (2014), which showed that availability of technical assistance particularly veterinary services intensely increases adoption of dairy technology. Chelkeba *et al*. (2016) also stated that provision of AI service, training on crossbreed dairy management and access to extension service significantly increase adoption.

Animal inventory was statistically significant (P=0.000) and had a positive B value. With large farm size, farmers are more aggressive to adopt technology, which could lead to more productive buffalo raising. Similar results were seen in the studies of Ward *el al.* (2008); Rezvanfar and Arabi (2009); Chelkeba *et al*. (2016), which held that the number of dairy cows has increased the extent of adoption of improved livestock technologies.

Distance of the farm from the DA-PCC was statistically significant (P=0.000) and had a negative B value. The farther the farmers are from DA-PCC, which is the main source of technologies for dairy buffalo production, the lesser the frequency of interaction, hence, reduced tendency to adopt dairy technologies. This is in agreement with Musaba (2010); Kariyasa and Dewi (2011); Chelkeba *et al*. (2016), which reported that an increase in distance of farms from technology sources decreases livestock technology adoption.

Income from dairying was also significant (P=0.041) and had a positive B value. Farmers who earn more income from dairying have more motivation and more means to support the costs of adopting dairy technologies. The role of income in improving dairy production is widely known for allowing farmers to provide all necessary requirements in dairy farming activities (see for example Dehinenet *et al*., 2014).

CONCLUSIONS AND DISCUSIONS

Improving the attribution scores by farmers to particular technologies on buffalo dairying should be given more attention by DA-PCC since this is the most powerful predictor variable (having the highest B value). As discussed earlier, farmers give high attribution to technologies that (1) give relative advantage to his/her buffalo operations, (2) compatible with existing farm operations and practices; (3) can be tried easily; and (4) require simple tasks. Thus, these attributes should always be given due consideration by DA-PCC when engaging with the farmers in the course of technology transfer or dissemination.

Adoption could also be influenced positively by providing technical assistance on buffalo dairying and relevant IEC materials to these farmers (as these are powerful predictor variables as well). In short, the DA-PCC should expand or strengthen further its extension or technology transfer activities or modalities. One such promising learning modality is the Farmer Livestock School (FLS) on dairy buffalo production (Department of Agriculture-Philippine Carabao Center, 2019), which was recently piloted in Nueva Ecija and Ilocos Norte. Compared to the short-term technical training with visit approach, which was the traditional extension practice of DA-PCC, the FLS is a season-long, adult learning modality that is anchored on learning-by-doing principle. So far,

Table 1. Mean data for selected socio-demographic-economic profile of farmer-informants.

Socio-demographic economic characteristics	NIZ (311)	R I (71)	R II (76)	R III (50)	R IV (33)	VR (125)	All (666)
Age (years)	49	53	45	46	46	49	48
Household size	5	5	5	5	5	5	5
Years in formal school	9.5	9.7	10.3	9.1	9.7	8.3	9.4
Years of experience in dairying	5.2	6.0	4.3	4.0	3.7	5.7	5.1
Annual household income (Php)	174,008	71,622	95,668	201,454	151,145	115,556	144,368
Annual income from buffalo production (Php)	35,311	17,876	18,615	20,398	78,354	39,476	33,342
Distance of farm from DA-PCC (km)	29.2	90.1	116.6	94.3	64.9	18.3	50.6

Table 2. Mean data for farm characteristics of farmer-informants.

Farm characteristics	NIZ (311)	R I (71)	R II (76)	R III (50)	R IV (33)	VR (125)	All (666)
Size of forage area (sq m)	1,355	1,008	1,902	607	2,667	1,929	1,497
Farm classification (%)							
Small-hold (1-5 cow)	90	97	98	98	91	98	94
Family module (6-10 cow)	9	3	1	2	6	2	5
Semi-commercial (11-20 cow)	1	0	0	0	3	0	1
Commercial (21 and above)	0	0	1	0	0	0	0
Source of pasture (%)							
Communal field	13	14	91	10	3	11	21
Farm	37	34	8	12	12	19	27
Both	50	52	1	78	85	70	52
Production type (%)*							
Breeding	28	54	74	48	27	22	36
Meat	0	0	3	0	0	13	3
Dairying	84	51	30	58	85	98	75
Draft	0	3	63	0	0	57	18

*Multiple responses were allowed

Table 3. Summary of technologies adopted by the farmer-informants in the National and Regional Impact Zones.

Improved management practices (DA-PCC-recommended technologies)		% Adoption						
General	**Specific**	**NIZ (311)**	**R I (71)**	**R II (76)**	**R III (50)**	**R IV (33)**	**VR (125)**	**All (666)**
Herd management	Animal housing system	86	77	16	86	91	21	65
	Recording system	86	72	14	72	100	58	71
Calf management	Early weaning (at birth)	0	0	0	0	0	0	0
	Feeding with colostrum	93	75	51	66	91	100	85
	Feeding with milk replacer	0	0	0	0	0	0	0
Feeding	Complete confinement	3	3	0	0	0	3	2
	Improved forage	93	92	75	78	91	95	90
	Legume supplementation	60	66	57	40	73	80	63
	Mineral supplementation	57	65	4	64	70	85	58
	Urea-Treated Rice Straw	3	0	3	0	6	2	2
	Total Mixed Ration	0	0	0	0	0	0	0
	Silage	2	4	1	0	0	0	2
	Concentrates	35	28	4	10	42	55	33
Milking and milk handling	Cleaning the udder	82	65	21	56	91	89	73
	Foremilk stripping	63	55	21	22	64	80	58
	Dipping teats in iodine solution	60	48	21	0	45	65	50
	Milk cooling	21	46	7	4	64	67	31
Breeding and reproduction	Artificial insemination	61	82	57	76	88	76	68
	Estrus detection	96	90	50	96	100	99	91
Animal health	Vaccination (twice a year)	91	75	84	92	61	99	89
	Deworming (2-4 times a year)	96	93	82	100	100	100	95
	Vitamins (4 times a year)	96	93	84	100	85	98	94

Table 4. Attribution scores given by farmer-informants for selected technologies in dairy buffalo production.

Technologies and attributes	Attribution scores						All
	NIZ	R 1	R 2	R 3	R 4	VR	
Animal housing system							
Relative advantage (prevents diseases and inbreeding)	4.74	4.69	3.88	4.63	4.64	4.65	4.69
Compatibility (acceptable to neighbors)	4.66	4.64	3.85	4.47	4.65	4.71	4.62
Trialability (can be tried and adopted in the farm)	4.68	4.63	3.62	4.50	4.45	4.59	4.61
Complexity (requires simple task)	4.67	4.64	3.54	4.38	4.24	4.41	4.57
Animal recording system							
Relative advantage (provides accurate information)	4.65	4.58	3.70	4.34	4.48	4.66	4.59
Compatibility (compatible within the farm context)	4.60	4.68	3.60	4.20	4.58	4.69	4.57
Trialability (manageable)	4.64	4.51	3.40	4.20	4.48	4.68	4.55
Complexity (requires simple task)	4.75	4.57	3.70	4.20	4.55	4.67	4.57
Calf management							
Relative advantage (prevent parasites and diseases)	4.60	4.75	3.23	4.28	4.44	4.58	4.54
Compatibility (health care can be done easily)	4.57	4.64	3.33	4.40	4.23	4.19	4.49
Trialability (can be tried and adopted in the farm)	4.59	4.63	3.20	4.38	4.39	4.31	4.51
Complexity (require simple task)	4.50	4.60	3.47	4.41	4.33	4.56	4.47
Feeding							
Relative advantage (readily available in the community)	3.64	4.01	3.19	3.84	4.06	4.61	3.81
Compatibility (compatible within the farm context)	3.75	3.98	3.65	3.91	4.06	4.50	3.92
Trialability (can be tried and adopted in the farm)	3.82	4.01	3.50	3.88	4.17	4.56	3.91
Complexity (require simple task)	3.78	3.99	3.67	3.81	4.21	4.68	3.91
Milking and milk handling							
Relative advantage (prevent spoilage)	4.50	4.58	4.00	4.35	4.77	4.72	4.54
Compatibility (compatible within the farm context)	4.42	4.58	3.71	4.46	4.59	4.42	4.43
Trialability (can be tried and adopted in the farm)	4.54	4.55	3.74	4.44	4.62	4.66	4.52
Complexity (require simple task)	4.43	4.50	3.97	4.39	4.68	4.69	4.47

Table 4. Attribution scores given by farmer-informants for selected technologies in dairy buffalo production. (Continue).

Technologies and attributes	**Attribution scores**						**All**
	NIZ	**R 1**	**R 2**	**R 3**	**R 4**	**VR**	
Artificial insemination							
Relative advantage (can improve stocks)	3.68	4.30	4.00	4.20	4.50	4.73	4.05
Compatibility (compatible within the farm context)	3.62	4.01	3.71	3.97	4.14	4.49	3.89
Trialability (can be tried and adopted in the farm)	3.62	4.10	3.65	4.01	4.08	4.56	3.84
Complexity (requires simple task)	3.59	4.07	3.76	4.02	4.20	4.53	3.83
Animal health							
Relative advantage (prevent diseases and avoid mortality)	4.66	4.67	4.20	4.65	4.67	4.73	4.63
Compatibility (compatible within the farm context)	4.60	4.63	4.04	4.60	4.52	4.53	4.53
Trialability (can be tried and adopted in the farm)	4.59	4.63	4.03	4.55	4.56	4.70	4.54
Complexity (require simple task)	4.60	4.58	4.15	4.58	4.62	4.68	4.56

Scale: 1.00-1.79 = Strongly disagree
1.80-2.59 = Disagree
2.60-3.39 = Undecided
3.40-4.19 = Agree
4.20-5.00 = Strongly agree

Table 5. Sigma scores for stages of adoption for animal housing system (n=666).

Adoption stages	Response categories	F	% (F/n)*100	Proportion (%/2)	Z	Standard score (Z+2) x 2	Z Rounded
Awareness	Yes	660	99	0.4955	0.01	4.02	4
	No	6	1	0.0045	-2.61	-1.22	0
Interest	Yes	660	100	0.5000	0	4	4
	No	0	0	0.0000	-	-	0
Evaluation	Yes	660	100	0.5000	0	4	4
	No	0	0	0.0000	-	-	0
Trial	Yes	505	76.52	0.3826	-0.3	3.4	3
	No	155	23.48	0.1174	-1.19	1.62	2
Adoption	Yes	433	85.74	0.4287	-0.18	3.64	4
	No	72	14.26	0.0713	-1.47	1.06	1

Note: F = Frequency; % = Percentage; Z = Sigma scores (checked from standard normal distribution Table)

Table 6. Sigma scores for years of adoption for "animal housing system" (n=433).

Years of adoption	**F**	**CF**	**CFM**	**CPM (CFM/n)**	**Z**	**Standard score** (Z+2) x 2	**Z Rounded**
18	6	433	430.0	0.9931	2.46	8.92	9
17	9	427	422.5	0.9758	1.97	7.94	8
16	0	418	418.0	0.9654	1.82	7.64	8
15	0	418	418.0	0.9654	1.82	7.64	8
14	1	418	417.5	0.9642	1.80	7.60	8
13	1	417	416.5	0.9619	1.77	7.54	8
12	6	416	413.0	0.9538	1.68	7.36	7
11	0	410	410.0	0.9469	1.62	7.24	7
10	4	410	408.0	0.9423	1.57	7.14	7
9	12	406	400.0	0.9238	1.43	6.86	7
8	40	394	374.0	0.8637	1.10	6.20	6
7	140	354	284.0	0.6559	0.40	4.80	5
6	124	214	152.0	0.3510	-0.38	3.24	3
5	27	90	76.5	0.1767	-0.93	2.14	2
4	23	63	51.5	0.1189	-1.18	1.64	2
3	36	40	22.0	0.0508	-1.64	0.72	1
2	3	4	2.5	0.0058	-2.53	-1.06	0
1	1	1	0.5	0.0012	-3.04	-2.08	0

Note: F = Frequency; CF = Cumulative Frequency (sum of all previous F up to the current point); CFM = Cumulative Frequency to the Mid-point (current CF plus previous CF divided by 2); CPM = Cumulative Proportion to the Mid-point; Z = Sigma scores (checked from standard normal distribution Table).

Table 7. Adoption scale for animal housing system (N=666).

Level of adoption	**Response categories**	**Score**
Awareness	Yes	4
	No	0
Interest	Yes	4
	No	0
Evaluation	Yes	4
	No	0
Trial	Yes	3
	No	2
Adoption	Yes	4
	No	1
Years of adoption	18	9
	13-17	8
	9-12	7
	8	6
	7	5
	6	3
	4-5	2
	3	1
	1-2	0

Table 8. Frequency distribution of total adoption scores for different technologies on dairy buffalo production (n=666).

Herd management				**Calf management**						**Feeding**			
Housing system		**Recording system**		**Early weaning of calves**		**Feeding calves w/ colostrum**		**Feeding calves w/ milk replacer**		**Improved forage feeding**		**Legume supplementation**	
Score	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**
28	6	30	2	16	618	30	2	16	663	30	2	29	1
27	11	29	3	0	48	29	4	0	3	29	2	28	4
26	22	28	14			28	17			28	23	27	12
25	40	27	31			27	38			27	30	26	27
24	140	25	133			26	71			26	45	25	22
22	124	24	140			25	98			25	177	24	99
21	50	23	53			24	127			24	138	23	114
20	36	22	45			23	94			23	64	22	55
19	4	21	44			22	86			22	49	21	32
16	72	20	6			20	32			21	51	20	41
14	155	17	59			16	17			20	18	19	14
0	6	13	127			13	77			16	36	16	49
		0	9			0	3			12	31	14	191
												0	5
Mean	19.96		20.97		14.85		22.51		15.93		23.14		19.73

Table 8. Frequency distribution of total adoption scores for different technologies on dairy buffalo production (n=666). (Continue)

Feeding										Milking and milk handling			
Mineral supplementation		Feeding with UTRS		Feeding with TMR		Feeding with silage		Feeding with concentrates		Cleaning the udder		Foremilk stripping	
Score	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**
29	1	23	1	16	1	21	1	28	1	30	1	29	2
28	4	22	1	12	526	20	2	27	1	29	6	28	4
27	10	20	4	1	139	18	5	26	5	28	14	27	11
26	25	19	7			17	66	25	16	27	19	26	18
25	15	16	523			16	569	24	52	26	43	25	41
24	77	1	130			15	2	22	60	25	100	24	78
23	103					0	21	21	27	24	109	23	86
22	47							20	25	23	86	22	68
21	47							19	26	22	74	21	51
20	43							18	8	20	35	19	25
19	15							17	109	17	50	16	43
16	92							15	331	13	128	14	234
14	177							0	5	0	1	0	5
0	10												
Mean	19.17		13.15		12.87		15.63		17.53		21.27		19.24

Table 8. Frequency distribution of total adoption scores for different technologies on dairy buffalo production (n=666). (Continue)

Milking and milk handling				Breeding and reproduction				Animal health					
Dipping teats in iodine solution		Milk cooling		Artificial Insemination		Estrus detection		Vaccination		Deworming		Vitamins administration	
Score	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**	**Score**	**Freq.**
29	2	28	1	29	2	30	2	30	2	30	1	30	2
28	1	27	2	28	4	29	6	29	5	29	7	29	6
27	9	26	6	27	11	28	16	28	19	28	18	28	17
26	18	25	16	26	32	27	38	27	34	27	41	27	38
25	30	24	26	25	68	26	80	26	39	26	51	26	41
24	66	23	27	24	85	25	74	25	127	25	153	25	150
23	86	22	35	23	98	24	123	24	145	24	179	24	179
22	62	21	33	22	56	23	122	23	99	23	82	23	87
21	37	20	41	21	52	22	68	22	57	22	46	22	49
19	21	18	22	20	44	21	50	21	41	21	38	21	37
16	48	15	447	19	2	20	26	20	23	20	19	20	23
14	282	0	10	18	148	16	13	16	24	16	17	16	15
0	4			13	64	12	45	12	51	12	14	12	22
						0	3						
Mean	18.57		16.92		21.07		22.84		22.78		23.73		23.55

Table 9. Summary of correlation analysis between total adoption score and selected independent variable.

Independent variables	Pearson correlation, r	Sig. (1-tailed), p
Age	.103**	.008
Education	.092*	.018
Off-farm income	.089*	.022
Income from dairying	.244**	.000
Distance of the farm from the DA-PCC	-.261**	.000
Animal inventory	.228**	.000
Years of experience in dairying	.293**	.000
Size of the farm devoted to dairying	.080*	.040
Attribution score	.596**	.000
Access to IEC materials	.298**	.000
Technical assistance	.221**	.000
Other government program related to dairying	.077*	.047

Table 10. Multiple regression results between total adoption scores and selected independent variables.

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	300.636	5.384	-	55.837	.000
Attribution score	19.374	1.016	.534	19.059	.000
Years of experience in dairying	2.557	.303	.234	8.433	.000
Technical assistance	9.790	1.994	.141	4.911	.000
Animal inventory	.967	.236	.129	4.089	.000
Distance of the farm from the DA-PCC	-.091	.026	-.104	-3.548	.000
Access to IEC materials	9.665	2.811	.101	3.438	.001
Income from dairying	3.944E-5	.000	.065	2.051	.041

$R^2 = 0.527$; F-value = 102.362

Figure 1. Innovation-Diffusion process (Rogers, 2003).

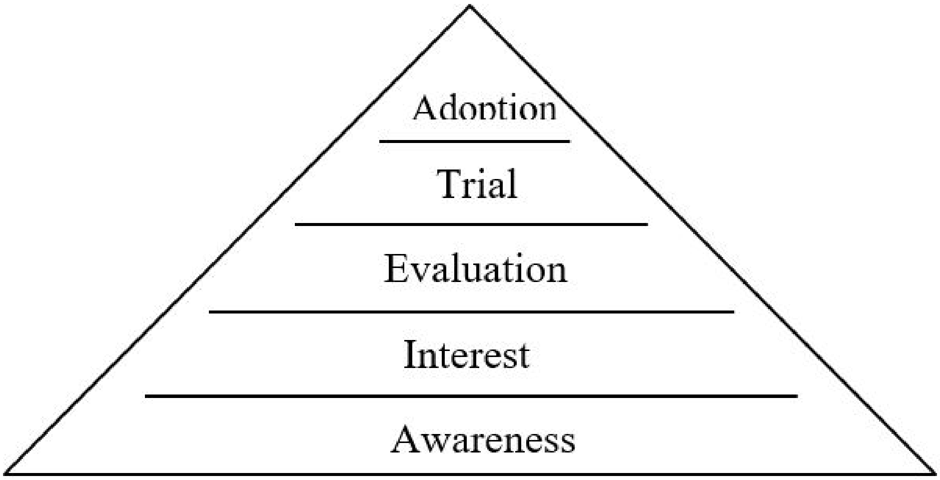

Figure 2. Adoption stages (Williams *et al*., 1984 as cited by Ovwigho, 2013).

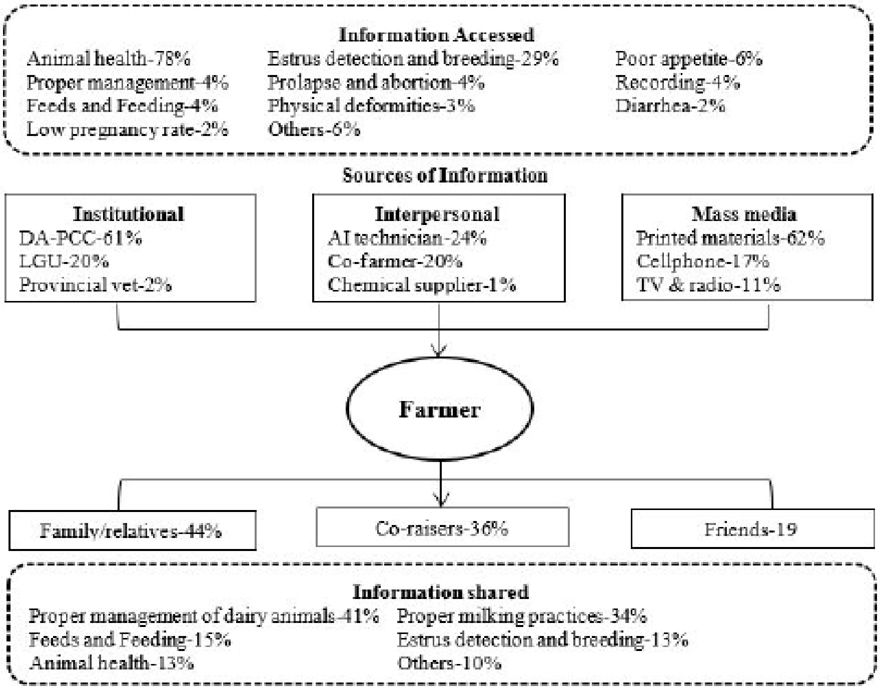

Figure 3. Sources of information and kinds of information accessed and shared by the farmers.

positive feedbacks from FLS farmer-participants and facilitators were generated from the two pilot sites.

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