Measuring the Adoption of Improved Feeding Practices by Smallhold Dairy Buffalo Farmers in Nueva Ecija, Philippines

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ABSTRACT

A face-to-face individual interview-survey of 311 smallholder-farmers in the province of Nueva Ecija, Philippines was conducted to measure and analyze their adoption of improved feeding practices (IFPs) for dairy buffaloes, as introduced in previous technical trainings by the Philippine Carabao Center (PCC). The IFPs included feeding of improved forage, legumes supplementation, and feeding of concentrates. 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 IFP. The total or combined adoption scores (dependent variable) for all three IFPs were then tested for linear correlation and multiple regression with selected socio-economic traits, farm characteristics, and other independent variables. Of the ten variables that showed significant linear correlation with the total adoption scores, only five were found to be significant predictors, namely “years of formal schooling”, “years of experience in dairying”, “animal inventory”, “access to information, education and communication materials”, and “number of agencies sought for technical assistance”. Among the significant variables, the latter emerged as the most powerful predictor for total adoption scores. This would indicate that farmers adopt IFPs as they increase their social capital or communication network by linking with more agencies or institutions that are sources of information, technologies, and technical assistance on dairy buffalo management. Applying the same approach in measuring adoption level for other technologies in dairy buffalo management, as introduced by the PCC, was recommended.

Keywords: feeding technologies; sigma scores; socio-economics

INTRODUCTION

For many years, the Philippine Carabao Center (PCC) has been actively involved in the generation or improvement of various technologies on dairy buffalo production. Basically, the said technologies are in the form of improved dairy buffalo management practices and were disseminated and promoted through a series of technical and practical (hands-on) trainings of farmer-clients. The latter are expected to eventually adopt the said technologies. However, measuring the extent of technology adoption by these farmers and determining the possible influencing factors to adoption have constantly challenged the PCC.

It is for this reason that two previous studies were made (Palacpac, 2010; Palacpac et al., 2015) to measure the adoption of technologies by the farmers with emphasis in the province of Nueva Ecija, which serves as the National Impact Zone for dairy buffalo development. The first of these studies, however, surveyed only a small number of farmer-informants (n=38) while the second has purposely sampled “progressive or successful” dairy farmers. Both studies employed a practical approach in measuring adoption by eliciting dichotomous responses (i.e., “yes” or “no”) from the informants and getting the frequencies and percentage scores. This same approach was used by Shanin (2004) in measuring adoption of dairy buffalo technologies in Egypt. While the results of such studies served their purpose that time, there is difficulty in establishing a relationship between adoption and interval variables such as socio-economic status, income, education, among others, when using indexes or percentages (Ovwigho, 2013).

The current study addressed the aforementioned gaps by increasing the sample size of farmer-informants, expanding the scope of analysis by considering the various stages in the adoption process, and using a standardized Sigma scoring method as proposed by Ovwigho (2013). In demonstrating so, the study team decided to focus its analysis on “feeding technologies” or improved feeding practices (IFPs) as these are seen as most critical in the productivity of the dairy buffaloes.

In general, this study aimed to analyze the adoption of IFPs for dairy buffalos by farmers in Nueva Ecija. Specifically, it aimed to: (1) describe the socio-economics, farm characteristics, communication, and technology attributions by the dairy buffalo farmers (i.e., “independent variables”); (2) measure the adoption scores of IFPs along different adoption stages; and (3) determine any relationship between the adoption scores and selected independent variables.

MATERIALS AND METHODS

Conceptual Framework

The study was based on the concepts and theory of diffusion of innovation (Rogers, 2003; Figure 1) and on how 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). As Figure 2 shows, the stages are said to be hierarchical or pyramidal.

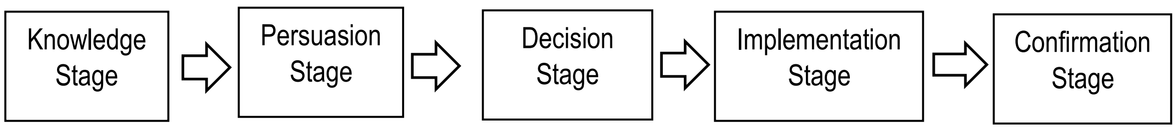

Figure 1. Innovation-Diffusion Process (Rogers, 2003)

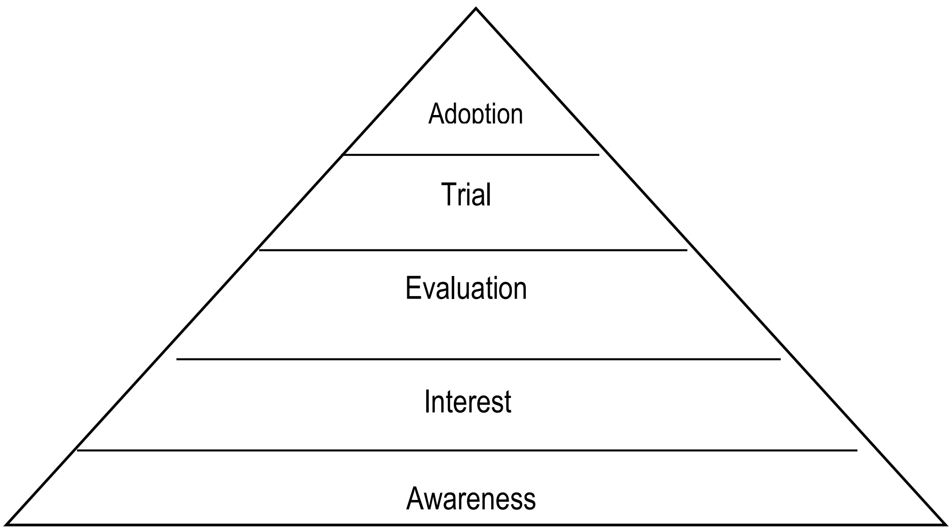

Figure 2. Adoption Stages (Williams et al., 1984 as cited by Ovwigho, 2013)

Farmer-Informants

The study team has purposely sampled **311** smallhold (owning or tending less than 5 hectares of land) farmer-cooperators in Nueva Ecija as informants. They have previously undergone (any period from 1999 to 2011) a two-day technical training at the PCC national headquarters in Nueva Ecija on dairy buffalo management and were raising dairy buffaloes at the time of the interview.

Survey Instrument, Technologies Documented, Dependent and Independent Variables

The study team conducted face-to-face individual interviews with the farmer-informants using a semi-structured survey questionnaire. Three IFPs were considered for establishing the adoption scores namely feeding of improved forage (e.g., napier grass), legumes (e.g., leucaena, gliricidia, peanut hay) supplementation, and feeding of (commercial feed) concentrates. The individual scores for each feeding technology plus the scores for years of adoption were added up to get the “total adoption scores for IFMPs”, which then served as the “dependent variable.”

Possible influencing factors to adoption and their corresponding (independent) variables were selected from the survey questionnaires. These were (1) age (years), (2) education (years of formal schooling), (3) income from dairying (peso value), (4) household income (peso value), (5) experience in dairying (years), (6) household size (no. of household members), (7) animal inventory (no. of buffaloes maintained), (8) size of forage area (no. of square meters), (9) distance of farm from the PCC (no. of kilometers), (10) access to information, education and communication (IEC) materials (number of IEC materials accessed), (11) technical assistance (number of agencies sought for technical assistance), and (12) attribution score for IFPs (scale of 1 to 5; 1=lowest and 5=highest).

Entry, Processing, and Analysis of Data

The 12 socio-economic characteristics of farmers and other influencing factors were analyzed descriptively using means or averages.

Adoption scores for each of the three IFMPs were derived from z-transformations of frequency and percentage data on each adoption stage using the Sigma scoring method suggested by Ovwigho (2013). Likewise, the frequencies of response to the years of adoption were transformed to standard scores. The two types of scores were added up to get the “total adoption scores”, which were then used for correlation and regression analyses.

Correlation and multiple regression analyses were made to determine any linear relationship between the standardized total adoption scores (dependent variable) and the selected independent variables.

Data were consolidated and analyzed using MS Excel and SPSS Version 17.

RESULTS

Socio-Economics and Other Independent Variables

Majority of the farmer-informants were males, middle-aged, attended secondary education, and have around five years of experience in buffalo dairying (Table 1). Likewise, average annual income from dairying accounted for almost 15% of the total annual household income. Most farms are located quite far from the PCC, which implies the need for regular extension support from the agency. Average size of the forage area was inadequate to support the requirement of some four dairy buffaloes, which indicates that most farmers also gathered forages or feedstuff from outside their farms.

Table 1. Selected socio-economic and farm profile of farmer-informants (n=311).

Particulars	Mean
Age (years)	49
Household size (number of household members)	5
Years in formal school	9.5
Years of experience in dairying	5.2
Annual household income in 2014 (Php)	180,514
Annual income from dairying in 2014 (Php)	26,530
Distance of farm from PCC (km)	29.2
Size of forage area (sq m)	1,538
Animal inventory (number of dairy buffaloes maintained)	4

On a scale of 1 to 5 (1 as strongly disagree and 5 as strongly agree), the farmer-informants generally “agreed” as to the relative advantage, compatibility, trialability, and complexity of the IFPs (Table 2).

Table 2. Attribution scores given by farmer-informants for the improved feeding practices (n=311).

Attributes of IFPs	Mean Score	Description
Relative advantage (*IFPs can be done year round)*	3.64	Agree
Compatibility (*IFPs are compatible within the farm context)*	3.75	Agree
Trialability (*IFPs can be tried and adopted in the farm)*	3.82	Agree
Complexity *(IFPs require simple task)*	3.78	Agree

Scale:1.0 – 1.7 = Strongly disagree
1.8 – 2.5 = Disagree
2.6 – 3.3 = Undecided
3.4 – 4.1 = Agree
4.2 – 5.0 = Strongly agree

Adoption (Sigma) Scores

Table 3 presents the frequency and percentage of responses (yes or no) for individual IFP 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.

Table 3. Sigma scores for stages of adoption for specific improved feeding practices (n=311).

Technology	**Adoption Stages**	**Response Categories**	**F**	**%** (F/n)*100	**Proportion** (%/2)	**Z**	**Standard Score** (Z+2)*2	**Z Rounded**
	Awareness	Yes	311	100	0.5	0	4	4
		No	0	0				0
	Interest	Yes	311	100	0.5	0	4	4
		No	0	0				0
	Evaluation	Yes	311	100	0.5	0	4	4
		No	0	0				0
Feeding of Improved forage	Trial	Yes	308	99.04	0.4952	-0.01	3.98	4
		No	3	0.96	0.0048	-2.59	-1.18	0
	Adoption	Yes	289	93.83	0.4692	-0.08	3.84	4
		No	19	6.17	0.0308	-1.87	0.26	0
Legumes supplementa-tion	Trial	Yes	209	67.20	0.3360	-0.42	3.16	3
		No	102	32.80	0.1640	-0.98	2.04	2
	Adoption	Yes	187	89.47	0.4474	-0.13	3.74	4
		No	22	10.53	0.0526	-1.62	0.76	1
Feeding of concentrates	Trial	Yes	151	48.55	0.2428	-0.7	2.6	3
		No	160	51.45	0.2572	-0.65	2.7	3
	Adoption	Yes	110	72.85	0.3642	-0.35	3.3	3
		No	41	27.15	0.1358	-1.1	1.8	2

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

Table 4 shows the frequency responses to the "number of years of adoption" of each IFP, 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.

Table 4. Sigma scores for years of adoption for specific improved feeding practices (n=311).

Technology	**Years of adoption**	**F**	**CF**	**CFM**	**CPM** (CFM/n)	**Z**	**Standard Score** (Z+2) x 2	**Z Rounded**
Feeding of Improved forage (n=289)	17	1	289	288.5	0.9983	2.93	9.86	10
	16	5	288	285.5	0.9879	2.25	8.5	9
	14	1	283	282.5	0.9775	2.01	8.02	8
	11	3	282	280.5	0.9706	1.89	7.78	8
	10	2	279	278	0.9619	1.77	7.54	8
	9	1	277	276.5	0.9567	1.71	7.42	7
	8	3	276	274.5	0.9498	1.64	7.28	7
	7	28	273	259	0.8962	1.26	6.52	7
	6	121	245	184.5	0.6384	0.35	4.7	5
	5	98	124	75	0.2595	-0.64	2.72	3
	4	10	26	21	0.0727	-1.46	1.08	1
	3	7	16	12.5	0.0433	-1.71	0.58	1
	2	6	9	6	0.0208	-2.04	-0.08	0
	1	3	3	1.5	0.0052	-2.56	-1.12	0
Legumes supplementation (n=187)	16	1	187	186.5	0.9973	2.78	9.56	10
	14	3	186	184.5	0.9866	2.22	8.44	8
	13	1	183	182.5	0.9759	1.98	7.96	8
	12	1	182	181.5	0.9706	1.89	7.78	8
	9	2	181	180	0.9626	1.78	7.56	8
	5	10	179	174	0.9305	1.48	6.96	7
	4	64	169	137	0.7326	0.62	5.24	5
	3	88	105	61	0.3262	-0.45	3.1	3
	2	10	17	12	0.0642	-1.52	0.96	1
	1	7	7	3.5	0.0187	-2.08	-0.16	0
Feeding of concentrates (n=187)	15	1	110	109.5	0.9955	2.61	9.22	9
	14	2	109	108	0.9818	2.09	8.18	8
	13	1	107	106.5	0.9682	1.86	7.72	8
	9	2	106	105	0.9545	1.69	7.38	7
	6	6	104	101	0.9182	1.39	6.78	7
	5	38	98	79	0.7182	0.58	5.16	5
	4	47	60	36.5	0.3318	-0.43	3.14	3
	3	6	13	10	0.0909	-1.34	1.32	1
	2	4	7	5	0.0455	-1.69	0.62	1
	1	3	3	1.5	0.0136	-2.21	-0.42	0

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

Adoption Scale

The rounded off Z scores for stages of adoption (Table 3) were incorporated to the rounded off Z scores for the number of years of adoption (Table 4) to generate the adoption scale for specific IFPs (Table 5).

Table 5. Adoption scales for specific improved feeding practices (n=311).

Level of Adoption	Improved Feeding Practices					
	Feeding of Improved forage		Legumes supplementation		Feeding of concentrates	
	Response categories	Score	Response categories	Score	Response categories	Score
Awareness	Yes	4	Yes	4	Yes	4
	No	0	No	0	No	0
Interest	Yes	4	Yes	4	Yes	4
	No	0	No	0	No	0
Evaluation	Yes	4	Yes	4	Yes	4
	No	0	No	0	No	0
Trial	Yes	4	Yes	3	Yes	3
	No	0	No	2	No	3
Adoption	Yes	4	Yes	4	Yes	3
	No	0	No	1	No	2
Years of adoption	17	10	16	10	15	9
	16	9	15	9	10-14	8
	10-14	8	9-14	8	6-9	7
	7-9	7	5-8	7	5	5
	6	5	4	5	4	3
	5	3	3	3	2-3	1
	3-4	1	2	1	1	0
	2	0	1	0	-	-
	1	0	-	-	-	-
Minimum		12		14		15
Maximum		30		29		27

To illustrate, for improved forage, the scale consisted of aware (4), not aware (0); interested (4), not interested (0); evaluated (4), not evaluated (0); tried (4), did not try (0); adopted (4), did not adopt (0); 17 years adoption (10), 16 years adoption (9), 10-15 years adoption (8), 7-9 years adoption (7), 6 years adoption (5), 5 years adoption (3), 3-4 years adoption (1), 2 years adoption (0), and 1 year adoption (0). The same process of describing the scales applies to the legumes supplementation and feeding of concentrates.

It is then possible to indicate the minimum and maximum scores on the adoption scale for each IFP, i.e., 12 (min) and 30 (max) for improved forage; 14 (min) and 29 (max) for legumes supplementation; and 15 (min) and 27 (max) for feeding concentrates.

Note that farmer-informants who did not try legumes supplementation and feeding of concentrates would still get scores of 2 and 3, respectively (as shown in the shaded rows of Table 5). Likewise, those who did not adopt legumes supplementation and feeding of concentrates would still get scores of 1 and 2, 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 IFP (in this case legumes and feed concentrates) is not bereft of at least an "awareness" of the said IFP, as clearly shown in the adoption scale.

Frequency Distribution of Adoption Scores

The scores on the scale for each IFP 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 6).

Table 6. Frequency distribution of total adoption scores for specific improved feeding practices (n=311).

Improved Feeding Practices								
Feeding of Improved forage			Legumes supplementation			Feeding of concentrates		
Adoption score	Frequency	%	Adoption score	Frequency	%	Adoption score	Frequency	%
30	1	0	29	1	0	27	1	0
29	5	2	27	7	2	26	3	1
28	6	2	26	10	3	25	8	3
27	32	10	24	64	21	23	38	12
25	121	39	22	88	28	21	47	15
23	98	32	20	10	3	19	10	3
21	17	5	19	7	2	18	3	1
20	9	3	16	26	8	17	41	13
16	19	6	14	98	32	15	160	51
12	3	1	-	-	-	-	-	-
Mean Score=23.1			Mean Score=23.4			Mean Score=21.2		

Majority of the farmer-informants scores were 23 and 25 (mean of 23.1) for improved forage; 14 and 22 (mean of 23.4) for legumes supplementation; and 15 (mean of 21.2) for feeding of concentrates (see shaded rows).

Relationship of Adoption Scores and Selected Independent Variables

Because the total adoption scores for the IFPs 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 score of a farmer-informant for all three IFPs were totaled then subjected to tests of linear correlation and regression.

Linear correlation tests yielded significant results for 10 out of 12 variables considered when measured against the total adoption scores (Table 7).

Table 7. Summary of correlation analysis

Independent Variables	Pearson correlation, r	Sig. (1-tailed), p
Age	-0.098*	0.042
Household size	-0.106*	0.031
Household Income	0.103*	0.040
Years of formal schooling	0.178**	0.001
Years of experience in dairying	0.188**	0.000
Distance of the farm from the PCC	-0.207**	0.000
Animal inventory	0.314**	0.000
Income from dairying	0.287**	0.000
Access of IEC materials	0.193**	0.000
Technical assistance	0.226**	0.000

**Significant at the 0.01 level (1-tailed)
*Significant at the 0.05 level (1-tailed)

Of the 10 variables, three have negative linear correlation with the total adoption scores for the IFP. These included the following:

a. *Age* - Younger farmers are seen to be more open to new ideas and more capable than older farmers in adopting feeding technologies that demand physical activities such as maintaining or gathering improved forages and legumes, i.e., *older farmers, lower adoption scores.*
b. *Household size* - The more household members, the more time and money spent for supporting them; the less time and money available for adopting feeding technologies, i.e., *higher household size, lower adoption scores.*
c. *Distance of the farm from the PCC* - The farther the farmers are from PCC, which is the main source of technologies for dairy buffalo production, the lesser the frequency of interaction hence reduced tendency to adopt feeding technologies; *longer distance of farmer from PCC, lower adoption scores*.

Seven variables showed significant positive correlation with the total adoption scores. These are described below.

a. *Household income* - The higher the household income, the more means to adopt feeding technologies, i.e., *higher income, higher adoption scores*.
b. *Years of formal schooling* - Farmers who spent more years in formal schooling tend to be more “technically” adept and open to adopting feeding technologies, i.e., *higher formal education, higher adoption scores*.
c. *Years of experience in dairying* - The more years the farmers are experienced in dairying, the increased tendency to adopt feeding technologies, i.e., *more experienced farmers, higher adoption scores.*
d. *Animal inventory* - Farmers with more buffaloes tend to adopt feeding technologies to adequately support the animals’ requirements; *more animals, higher adoption scores.*

e. *Income from dairying* - Farmers who earn more income from dairying have more motivation and more means to support the costs of adopting feeding technologies; *higher income, higher adoption scores.*

f. *Access to IEC materials* - This is a measure of communication attribute. The more IEC materials accessed, the more informed the farmers are hence more tendency to adopt feeding technologies; *more IEC materials accessed, higher adoption scores.*

g. *Technical assistance* - This is also a measure of communication attribute and social capital. The more agencies the farmers sought assistance from, the more informed or technically equipped they are to allow adoption of feeding technologies; *more agencies sought assistance from, higher adoption scores.*

The 10 (independent) variables that showed significant correlation coefficients were further subjected to multiple regression analysis to predict the value of the dependent variable (total adoption scores).

Using backward stepwise regression method, five variables were found to be significant positive predictors to total adoption scores. These are *years of formal schooling* (t=2.352, p=0.019), *years of experience in dairying* (t=2.348, p=0.020), *animal inventory* (t=2.273, p=0.024), *access to IEC materials* (t=2.828, p=0.005), and *technical assistance* (t=4.594, p=0.000) (please see shaded rows in Table 8).

Table 8. Multiple regression analysis

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	50.745	2.859		17.748	0.000
Age	-0.026	0.036	-0.040	-0.706	0.481
Household size	-0.181	0.211	-0.047	-0.857	0.392
Household income	-3.128E-7	0.000	-0.016	-0.277	0.782
Years of formal schooling	0.309	0.131	0.132	2.352	0.019
Years of experience in dairying	0.391	0.167	0.129	2.348	0.020
Distance of the farm from PCC	-0.038	0.023	-0.092	-1.632	0.104
Animal inventory	0.274	0.121	0.174	2.273	0.024
Income from dairying	1.036E-5	0.000	0.093	1.256	0.210
Access to IEC materials	3.018	1.067	0.151	2.828	0.005
Technical assistance	3.336	0.726	0.240	4.594	0.000
		R^2 =	0.247		
		F =	9.134		0.000

Dependent variable: Total adoption score

The above results are consistent with earlier research works, which showed positive relationship of technology adoption with variables such as education (Xu and Wang, 2012; Singha et al., 2012; Abdullah and Samah, 2013), farming experience (Effendy, et al., 2013), animal inventory or herd size (Ward, et al., 2008), access to information materials (Prokopy et al., 2008), and technical assistance (Lowitt et al., 2015).

Among the predictor variables, “technical assistance” (number of agencies sought for technical assistance) had the largest beta value at 0.240, which means it had the largest impact on the “total adoption score” of farmer-informants for IFPs. This means that if we control for other predictors in the model, an increase by one unit of a standard deviation in the “number of agencies sought for technical assistance” would increase the “total adoption scores” by 0.240 of a standard deviation.

The coefficient of determination (R^2) is 0.247, indicating that the regression model accounts for 24.7% of the variation in the “total adoption scores” for IFPs by the farmer-informants.

CONCLUSIONS

Sigma scoring method (Ovwhigho, 2013) for adoption of IFPs by dairy buffalo farmers made possible the analysis of its correlation and regression with interval data such as socio-economics, farm characteristics, and other selected independent variables. This would have been difficult when adoption data are expressed as percentages of dichotomous responses. Apparently, the “number of agencies sought for technical assistance” is the most powerful predictor variable for their adoption scores. This would signify that farmers tend to adopt feeding technologies when their social capital or communication network increases, i.e., as they linked with more agencies that are, foremost, sources of technical information or improved management practices on dairy buffaloes. We recommend applying the same approach in measuring adoption level of other technologies on dairy buffalo management, as introduced by the PCC.

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