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ADOPTION RATE OF IMPROVED DAIRY CATTLE TECHNOLOGIES IN NORTHERN NIGERIA

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ABSTRACT

This study evaluated adoption rate of improved dairy cattle technologies among cattle farmers in northern Nigeria. Purposive method of sampling was used to select both the study area and improved dairy cattle farmers. The study covered the entire registered improved dairy farms in the 16 States of northern Nigeria in 2013/14. Data were obtained by means of questionnaire administered on 61 improved dairy cattle farmers. Descriptive statistics (frequencies, percentages), multinomial logit regression and correlation analysis were used to analyse the data. Results show that majority (74%) of the respondents had information on the technologies from extension workers and 20% obtained their information from their co-farmers. Adoption rate for the three related technologies studied was 55% with animal healthcare being the highest (62%). The trend of adoption rate shows that 1986vto to 2013 had the highest rate, being 67%. The results of multinomial logit regression shows that household, herd size, experience, access, level of living and age were significant at 1% level of probability but age was negative, in influencing adoption behaviour of farmers. One of the problems identified was low price of dairy products in the area. Thus, it was concluded improved dairy farming is capital intensive as all the farmers were millionaires and highly educated. Animal healthcare technology had the highest rate of adoption at 62%. Based these results, it was recommended that adequate animal healthcare, basic veterinary education and extension services should be given priority for more adoption of the technologies. Also, attractive prices for dairy products should be encouraged by dairy farmers' cooperatives.

Keywords: *Animal healthcare, dairy cattle, genetic upgrading and fodder.*

INTRODUCTION

Efforts to develop agriculture are expected to result in improved agricultural production through adoption of improved technologies. Characteristics of technologies explain their rate of adoption. Five of such characteristics are of important; they include: 1) The relative advantage which reflects how the technology is subjectively perceived superior to the previous one; 2) Compatibility reflects how the technology is perceived consistent with the existing values, past experiences and needs of potential adopters; 3) Complexity reflects the perceived difficulty to understand and use the innovation; 4) Trialability is the degree to which an technology may be experimented with on a limited basis; and 5) Observability reflects how the results of an technologies are visible to others (Rogers, 1995). A technology can further be changed or modified (re-invented) by a user according to his/her needs (Rogers, 1995). Communication channels provide information to a social system with the purpose to influence the knowledge and assessment of the

innovation. Mass media is often more effective in creating awareness of an innovation, whereas personal contacts are more effective in forming an opinion about a new idea among farmers. Such interpersonal communication is facilitated if conveyors of information are optimally similar to the receiver in certain attributes (Rogers, 1995).

Time, innovativeness and an innovation's rate of adoption are the main factors in the decision-making process. In the innovation-decision process, an individual passes through the stages of: 1) knowledge, 2) persuasion, 3) decision, 4) implementation (adoption), and 5) confirmation (post-adoption assessment) (Rogers, 1995). Information is sought at the various stages to reduce uncertainty about the usefulness of the innovation. Thus, the decision stages result in adoption or rejection of the innovation.Innovativeness is an expression for how early an individual or other unit of adoption is adopting a new innovation compared to other members of the social system. Adopters are divided into five categories, each with its own characteristics as: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards (Rogers, 1995). Finally, rate of adoption is the relative speed with which an innovation is adopted by members of a social system. The social system with its interrelated units shares an interest in finding solutions to a common goal to improve their agricultural system to enhance livelihood of famers. Such a system has a social and communication structure that facilitates or impedes the diffusion of innovations in the system. Norms, being part of the social system are the established behavioural patterns for system members, in this study, the improved dairy cattle farmers. Often, opinion leaders play a crucial role in influencing system members. Change agents may have the explicit role to influence members in a desirable direction. Both opinion leaders and change agents are central actors in diffusion of innovations and their speed in social systems.

There exists a relative low studies on rate of adoption of improved dairy cattle innovation in northern Nigeria in particular. This knowledge gap constitutes serious problem in dairy industry which this study offered to close. The questions this study asked: first, what are the rates of adoption of improved dairy cattle technologies in northern Nigeria before and after the independent to date? The second, what are the rates of adoption of improved dairy cattle technologies of each of the technologies in the study area? Third, what are the improved dairy cattle technologies available to improved dairy cattle farmers in the study area? Fourth, what are the factors influencing adoption of these improved dairy cattle technologies in

northern Nigeria? Fifth, what are constraints of adopting improved dairy cattle? This study therefore is aimed to answer these questions by proffering improved dairy cattle technologies: genetic upgrading, improved fodder production and animal healthcare. Thus, the objectives of this study were to examine adoption rate of improved dairy cattle technologies in northern Nigeria, determine factors influencing the adoption, effects of adoption on the outputs of the technologies and constraints of adoption associated with the improved dairy cattle technologies in northern Nigeria.

METHODOLOGY

This study is carried out to examine the adoption rate among improved dairy cattle farmers in northern Nigeria. By this study, improved dairy cattle farmers were those famers who have at least 5 exotic dairy cattle, with one or more veterinary doctors in the farm and had all the modern facilities for artificial insemination and milking hall. The farm also produces fodder crops for the purpose of feeding the animals during the dry season or has facility for storage of hay and other feeds. Data collection took place between October, 2013 and April, 2014.

The Study Area

Northern part of the Nigeria is the main zone for cattle herding and this study was carried out in 16 States of the north, namely: Adamawa, Bauchi, Borno, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kwara, Nassarawa, Niger, Plateau, Sokoto, Taraba and Yobe. Geographically, northern Nigeria lies between Latitudes 7°5′ and 14°5′ north and Longitudes 3°0′ and 14°0′ east (Oguntoyinbo*et al.,* 1983). Northern Nigeria lies within the tropics of savanna zones. Annual rainfall decreases from south to north even within the north. To the extreme north, the rainfall records lower per year, averaging between 508mm, while the extreme southern part of the north, the rainfall could be as high as 1524mm in some years. Second, the rainfall is highly seasonal in nature, starting between the months of May and June. Third, relative humidity is lower during dry season and could be higher than 80% during rainy season in the study area (Oguntoyinbo*et al.,* 1983).

Vegetation is an important physical feature of the zone, making it conducive for dairy cattle and other livestock husbandry (Olofin, 1991). The main characteristic of the zone is that trees are much more widely spaced, shorter. These conditions give comparative advantage for improved dairy cattle farming (Olofin, 1991). The zone is also *tse-tse*flies free making it favourable for dairy cattle to survive (Olofin, 1991).Northern region has a network of rivers such as Niger, Benue, Hadejia, Kumadugu-Yobe, Gongola and Yedzaram (Olofin, 1991). Also,

the region is drained by two major rivers, the Sokoto-Rima, Kaduna and Gurara. Other rivers include Katsina-ala, Ngadda, Taraba, Donga, Bundu and Zamfara to mention a few. A number of these rivers have been harnessed into reservoirs and dams to provide considerable all year round water for domestic, livestock and industrial purposes. Crops grown include sorghum, millet, maize, rice, cowpea, groundnut, wheat, cotton which are rich sources of animal feeds. The region has advantage of the services of the research institutes such National Animal Production Research Institute, Zaria; National Veterinary Research Institute, Jos; Institute for Agricultural Research, Zaria; and many colleges of Agriculture which provide improved technologies and other services to dairy farmers.

Sampling Procedure and Sample Size

One-stage sampling technique was adopted for the study. Purposive sampling procedure was adopted to select the 19 States of northern Nigeria was due the presence of improved dairy cattle farmers. However, as of time that of this study was carried out, Benue, Kogi and Zamfara states and Federal Capital territory, Abuja did not have improved dairy cattle farms. Thus, 16 States of Northern Nigeria were selected as follows:

Table1: Sampling Procedure and Sample Size

State	Population of Improved Dairy Farms in 16 States of Northern Nigeria (100%)	Sample of Improved Dairy Farms Studied (88%)
Adamawa	9	8
Bauchi	2	2
Borno	3	1
Gombe	3	1
Jigawa	4	3
Kaduna	10	7
Kano	9	7
Katsina	1	1
Kebbi	3	2
Kwara	3	3
Nassarawa	1	1
Niger	4	3
Plateau	3	2
Sokoto	10	8
Taraba	1	1
Yobe	3	2
Total	**69**	**61**

Source: Livestock Division of the Ministries of Agriculture in 16 northern States

All (100%) of the population was selected for the administration of the questionnaire with 88% response rate. However, 8 i.e. 12% of the farms included were not studied due to none cooperation and consistent absence and out right refusal of some of the household heads to cooperate with the researcher or the trained enumerators.

Data Collection

Data collection began with reconnaissance visits to the Headquarters of the Livestock Division of the Ministry of Agriculture of each of the 19 States Northern Nigeria and the FCT (Abuja) in order to collect the lists of all registered and unregistered improved dairy cattle farms. At the end data were collected from 61 farmers. Data were collected by the use questionnaire instrument administered by the researcher and a few trained enumerators, who were mostly secondary school teachers and holders of University bachelor degrees or holders of Higher National Diploma (HND) and Nigerian Certificate of Education (NCE).

Data Analysis

The data collected for this study were analyzed using descriptive statistics, mainly frequencies, mean and percentages; correlation analysis adoption index and Multinomial Logistic model. The Multinomial Logistic Regression Model was used to investigate the factors that influence adoption behaviour of improved dairy cattle farmers in the area. This model was chosen because of it's to contend with a dependent variable which has more than two components (Salasya, *et al.,* 2007; Adekunle and Henson, 2007). The retrieved data were subjected to the SPSS Statistical Package for analysis.The model involves a dependent variable (Y), the technology adoption decision variables and a set of explanatory independent variables that might influence the final probability, Pi, of adoption of the technologies. These explanatory variables can be thought of as being in a k vector Xi and the model then takes the form of:

$$Logit\ (P_i) = E\left[\left(\frac{Y_i}{n_i}\right)/X_i\right]$$

The Logits of the unknown binomial probabilities (that is, the logarithms of the odds) are modeled as a linear function of the Xi

$$Logit\ (P_i) = ln\left[\left(\frac{p_i}{1-p_i}\right)\right] = \beta_0 + \beta_1 X_1 + \text{--------} + \beta_{10} X_{10}$$

The unknown parameters βj (j = 1, 2, 3…10) were estimated by Maximum Likelihood method. Six categorical dependent variables representing the individual technologies considered in the study were artificial insemination, crossbreeding roughages, concentrates, preventive and curative animal health care.

Specifically, the following empirical model is specified:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \text{--------} + \beta_{10} X_{10} + e$$

Where,

Y = the categorical dependent variable of adoption decision of the improved dairy cattle farmers;
X_1 = Age (yr)
X_2 = household size (No. of persons)
X_3 = Education level (No. of years in school)
X_4 = Income (Naira from sale of products/year)
X_5 = Herding experience (No. of years in herding)
X_6 = Herd size (No. of cattle in the herd)
X_7 = Lactating cow (No. of milking cow in the herd)
X_8 = Credit (Amount received in Naira)
X_9 = Extension contact (No. of visit by extension worker/year)
X_{10} = Level of living (No. of Material things possessed by the respondent quantify in Naira)
β_1 ------ β_{10}= the parameters to be estimated;
e = error term.
The independent variables were tested at 5% critical levels.

RESULTS AND DISCUSSION

Socio-economics Characteristic the Respondents

The results of the socio-economic characteristics of the respondents presented in Table 2 reveals that majority of the respondents fell within 40 – 50 years of age with a mean age of 48 years, and 57% of them were retired civil servants and were primarily dairy cattle farmers. In addition, 60% of them had University degrees in various disciplines with majority having family sizes of 16 members or more. The result of annual income of the respondents revealed that majority of them had annual income of less than ₦2, 000, 000. The finding also revealed that majority of the respondents had less than ten years of experience in the dairy cattle industry, indicating that their dairy cattle farming experience was low. The result of institutional factors revealed that a greater number of the respondents (53%) did not have access to extension services; 57% had no access to credit facilities. The sampled farms were located between 0.25km and 3.00km from all year sources of water supply. Also, 61% of the respondents reported high market demand for dairy products.

Table 2: Distribution of the Respondents by Socio-economics Characteristics

Age (years)	Frequency	Percent
No response	10	16
<26	9	15
26-35	3	5
36-45	6	10
46-55	14	23
56-65	11	18
66-75	3	5
>76	5	8
Total	61	100
Educational status		
No education/Arabic	5	7
Adult education	1	2
Primary education	2	4
Secondary education	2	4
Tertiary education (Diploma/Nigerian Certificate in Education)	14	22
University degree	37	61
Total	61	100
Household size		
No response	10	16
< 5	5	8
6-10	12	20
11-15	5	8
16-20	7	12
21-25	13	21
26 and above	9	15
Total	61	100
Income (N = million)		
No response	11	18
<1.0	11	18
1.0 – 1.9	10	16
2.0 – 2.9	4	6
3.0 – 3.9	2	4
4.0 – 4.9	4	6
5.0 – 5.9	2	4
6.0 – 6.9	9	14
7.0 – 7.9	5	8
8.0 – 8.9 and above	3	6
Total	61	100
Herding of experience		
No response	10	16
5 and below	18	29
6-10	13	21
11-15	6	10
16-20	7	11

21-25	2	4
26-30	1	2
31 and above	4	7
Total	61	100
Extension contact		
Cannot remember	9	15
3 – 4 contacts	36	59
No contact	16	26
Total	**61**	**100**

Adoption Rates of the Improved Dairy Cattle Technology

The base year for the calculation of adoption rate for this study is 1986. This is because the period ushered in the Structural Adjustment Programme (SAP) in Nigeria with the objectives to reform foreign exchange system, trade policies, and business and agricultural regulations. Livestock sub-sector was one of the many sub-sectors of agriculture that was affected by the reform. Thus, it is pertinent to have knowledge of the rate of adoption of improved dairy cattle technologies in northern Nigeria. Figure 1 shows that the adoption rates for the genetic upgrading was57%, fodder cultivation was62% and animal and healthcare was 46%; while the whole package was 55%.

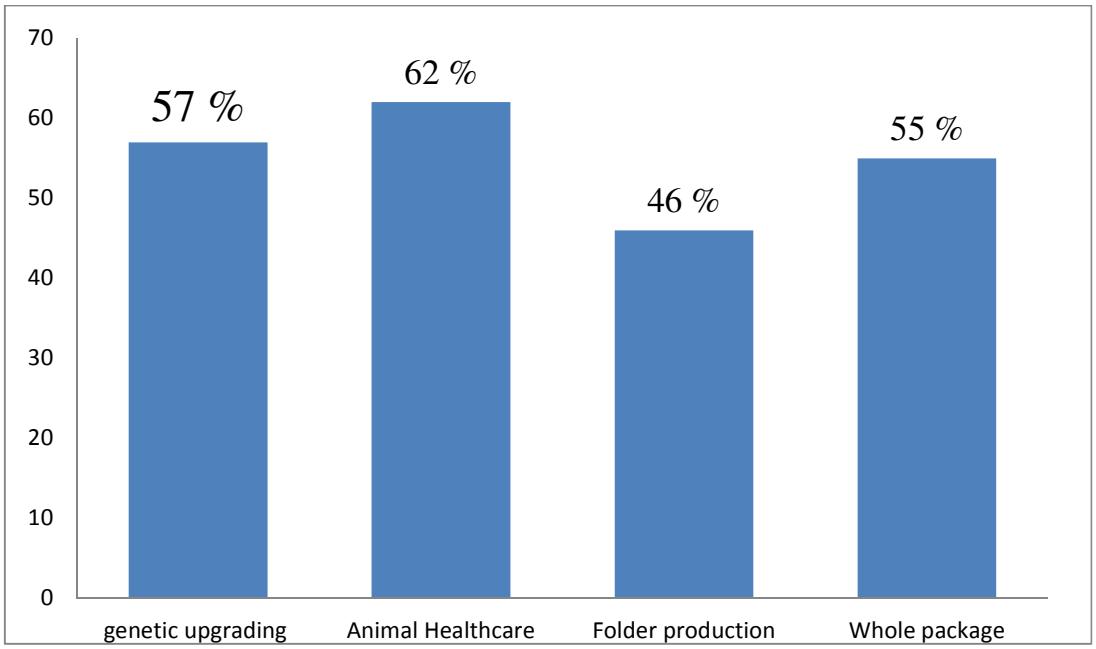

Figure 1: Adoption Rate by Technology (1986 -2015)

Table 3 shows the frequency distribution based on rates of adoption for different dairy cattle production technologies, whole package inclusive, among the dairy farmers. Over 29% of the respondents had genetic upgrading adoption rate ranging from 10% to 49%. Other 11% had adoption rate between 90% and 100%, while the majority, 42% were within the range of 50% to 69%. In the feed production technology, none of the respondents had adoption rate that exceeded 89%. Only a little over 8% and about 5% exceeded 89% adoption rates in animal health care and whole package technologies adoption rate. The study observed that the adoption rate, more especially, the whole package technology is relatively low in the area. This is because some farmers had preference for some technologies to the neglect of others.

Table 3: Adoption rate for the dairy production technologies

% / Scores	Genetic upgrading		Feed production		Animal health care		Package	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
10 - 29	4	7	10	16	6	10 12	19	
30 - 49	13	22	28	46	13	22	26	43
50 - 69	26	43	13	22	25	41	13	22
70 - 89	11	17	10	16	12	19	7	11
90 - 100	7	11	-	-	5	8	3	5
Total	**61**	**100**	**61**	**100**	**61**	**100**	**61**	**100**

Adoption Rate of Improved Dairy Technologies in Northern Nigeria from colonial period – 2010

Analyzing Figure 2, it is clear that from 1986 to date shows that 67% of dairy cattle farms studied in northern Nigeria were using improved technologies in their herds either in full or in parts. This adoption rate is more than triple the 15% level in 1985, and over 60% increase compared to the 10% level in 1975 (fig. 2). Improved dairy cattle technologies increased rapidly to 52% adoption rate.

Second, the number of improved dairy cattle adopters was growing slowly between 1960 and 1985 to 5 adopters; in 1960 and below, 6 adopters; in 1961 – 1975 to 9 adopters; adding roughly to 20 adopters between colonial period and 1985. Meanwhile, the proportion of northern Nigerian dairy cattle farmers using improved technologies has risen somewhat faster, from fifteen per cent (15%) in 1985 to about fifty two per cent (52%) in 2010. This finding agrees closely with Bradford *et al.* (2007) who reported an increase of fifteen per cent (15%) of adoption among Wisconsin farmers in five years.

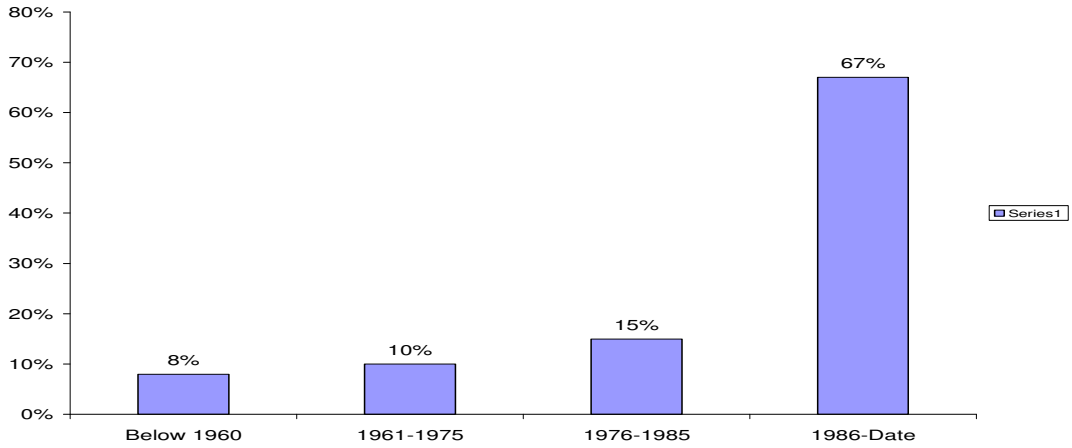

Figure 2: Adoption rate by period (Colonial period - date)

Factors Influencing Adoption of improved Dairy Cattle Technologies in 16 States of Northern Nigeria

The results in Table 4 present the multinomial logit estimates for the factors influencing the adoption of improved dairy cattle production technologies in the study area. The -2log likelihood estimate of 122.95 and the MCFadden R^2 value of 0.38 is acceptably high, particularly for logit models where evidence of goodness of fit points to a range of 0.20 to 0.40 (Sonka*et al.,* 1994).The estimated parameter for age was negative and significant at 1% level of probability. The negative sign of this variable implies that as age increases the adoption of these technologies decreases. This could suggest that younger farmers are more likely to adopt innovations and they have lower risk aversion and longer planning to justify their investments in technologies whose benefits are realized overtime. It is well known that, the older the farmers the less their willingness to try innovations or take risk. The result was consistent with the report of Ibulale (2000) who found age to have no influence on adoption of dairy production technologies.Household size was positive and significant at 1% level of probability. The positive coefficient implies that as family size increases the adoption of those technologies would increase. This result suggests that respondents with large household size adopt improve dairy production technologies compared to those with low household sizes. The significant of household size in agricultural production is attached to the availability of labour for farm production. The herd size may increase if the household have access to family labour. Households with large size tends to attach greater importance to food security than those that are small in size (Odoemenen and Obinne, 2010) and this may enable them to concentrates more on livestock

production with the adoption of improved technologies for greater productivity of animal products which attracts more income thereby raise their standard of living.

The estimated parameter for education was positive and significant at 1% level of probability. The positive coefficient of this variable implies that increase in the year spent in formal education will raise the adoption of improved dairy production technologies. This result was similar to the finding of Teressa (1997) and Walday (1999) they reported the higher the level of education a farmer attains the better the chances of understanding and adoption of a technology. However, Cramt and Nelson (1998) found education not to be important in explaining adoption. They explained that whether and individual has formal education or not has no relationship with his or her adoption behaviour. Education has been reported as a tool in shaping management skills (Kassie*et al.,* 2009)). The significant estimate of education could suggest that the use of technologies such as artificial insemination in Dairy production is relatively knowledge-intensive and thus that management skills are crucial in its adoption.

Experience in dairy production was significant at 1% and positively related to the adoption of improved dairy cattle technologies. This implies that increase in the experience of the farmer would increase the adoption of these technologies. This is not surprising because farmers tend to acquire skill over time as they continue in livestock production. This could also give them the opportunity and the awareness of possible benefit associated with improved dairy production technologies.Income was found significant at 10% and exert positive influence on the adoption of roughages and preventive animal care. This suggests that as the income increases, the adoption of these technologies increases. Studies have shown that there is a positive relationship between level of income of farmers and adoption of innovation (Gerlide, 2011). It has also been observed by Kinucan*et al.*(1990) that farmers having higher level of income make better use of innovative farming techniques. The higher the level of income of farmers, the more comfortable it is for them to be in the position of taking financial risks.Herd size was significant at 1% and positively influential to the adoption of improved dairy cattle technologies. The positive coefficient of this variable implies that as the herd size increases the adoption of improved dairy production technologies increase. This also suggest that farmer with large herd size adopts faster than those with smaller herd size. This result could be as a result of the fact that the cost of technologies being examined is reduced as the herd size increases.Access to credit was

significantly and positively influential to the adoption of improved dairy cattle technologies at 1% level of probability. The positive coefficient suggests that increase in the amount of credit received by the farmers, the adoption rate will also increase. Access to credit may reduce the liquidity constraint faced by the farmers which may encourage the adoption of improved dairy production technologies and investment in the technologies in the study area.

Extension contact was positive and significant at 1% level of probability. Contact with the extension enhances farmers' accessibility to information on the improved technologies. Access to information on new technologies is crucial to creating awareness and attitudes towards technology adoption (Place and Dewees, 1999). Kassie*et al.* (2009) noted that contact with extension services give farmers access to information on innovation, advice on inputs and their use and management technologies.Level of living was significantly and positively influential to adoption of improved dairy cattle technologies at 1% level of probability. The positive coefficient implying that increase in this variable will increase the adoption of improved dairy cattle technologies and vice versa.

Table 4: Results of multinomial logit regression analysis of farmers adopting improved dairy cattle production technologies

Variables	Concentrates	Roughages	Cross Breeding	Artificial Insemination	Curative Animal Care	Preventive Animal Care
Age (X_1)	-0.018^{NS} (0.024)	0.001^{NS} (0.034)	-0.316* (0.169)	-0.083*** (0.027)	-0.266*** (0.067)	-0.054* (0.030)
Household Size (X_2)	0.060*** (0.19)	0.025^{NS} (0.024)	2.493*** (0.105)	0.013^{NS} (0.023)	0.717*** (0.083)	0.023^{NS} (0.025)
Education (X_3)	0.104*** (0.038)	-0.066^{NS} (0.051)	4.768*** (0.253)	-0.058* (0.037)	0.148* (0.095)	0.009^{NS} (0.043)
Income (X_4)	0.048^{NS} (0.059)	0.142* (0.078)	-10.591^{NS} (0.553)	0.012^{NS} (0.061)	-0.121^{NS} (0.216)	-0.293*** (0.090)
Experience (X_5)	-0.441*** (0.197)	-0.340** (0.166)	0.806^{NS} (74.392)	-0.502** (0.250)	-0.251^{NS} (0.216)	-0.372^{NS} (0.256)
Herd size (X_6)	-0.073*** (0.024)	-0.076*** (0.031)	2.470 (0.147)***	-0.066** (0.028)	-0.318*** (0.063	-0.079** (0.038)
Lactating cow (X_7)	0.014*** (0.005)	0.010^{NS} (0.007)	-0.177^{NS} (0.968)	0.017^{NS} (0.005)	-0.002^{NS} (0.012)	0.010^{NS} (0.009)

Credit (X_8)	-0.077***	-0.043*	1.450*	-0.089***	0.197***	-0.050^{NS}
	(0.026)	(0.023)	(0.794)	(0.029)	0.023	(0.047)
Extension	-3.409***	-0.642	0.917*	-3.212***	-2.510***	-3.006***
Contact (X_9)	(0.631)	(0.0001)	(0.535)	(0.335)	(0.279)	(0.191)
Level of living	0.667	0.005***	-0.641	-0.144^{NS}	0.693**	-0.276**
(X_{10})	0.269**	(0.001)	(0.997)	(0.108)	(0.280	(0.135)

Note figures in parentheses are standard error
- 2log likelihood : 122.95
Chi-square : 152.83
McFadden Psedo R-square : 0.383
*** Significant at 1%
** Significant at 5%
* Significant at 10%

Ranking the Constraints of Adoption of Improved Dairy Cattle Technologies

Table 6 shows the constraints associated with adoption of improved dairy cattle technologies in the area. The major constraints observed were low prices, poor power supply, and inadequate veterinary services being the number 1, 2 and 3 respectively. Other notable constraints included high costs of inputs and low extension service coverage.

Table 6: Ranking the Constraints of Adoption of Improved Dairy Cattle Farmers in the Area

Ranking	Frequency*	Percent	Rank
Low output prices	35	19	1
Poor power supply	28	15	2
Inadequate/lack of veterinary services	23	12	3
High cost of exotic bulls	22	12	3
Poor extension services	19	11	5
Inadequate sources of artificial insemination	17	9	6
Inadequate Credit Facilities	12	6	7
Transportation Problems	11	6	7
Poor soil to grow improved fodder	8	4	9
Diseases and pests	6	3	10
Problems of feeding the animals in dry season	4	2	11
Input Scarcity	1	1	12
Total	183	100	

* = number greater than n=61 due to multiple responses

CONCLUSION

Adoption of improved dairy cattle technologies is capital intensive. Therefore, adoption rate of total

package of improved dairy cattle technologies was 55%. This is relatively low considering demands of dairy products by growing human population of the country. However, the rate for the period 1986 to 2015(67%) was an improvement and a signal that the rate would keep increasing due to market demand of dairy products. The major problems observed were low output prices, poor power supply, inadequate/lack of veterinary services and high costs of inputs.

RECOMMENDATIONS

The results of this study have some implications on policy and professional practices. Therefore, following recommendations were made for policy and practical actions:

1. Adoption rate was relatively low in the area and this call for creation of more virile extension services for awareness of the importance of keeping improved dairy cattle in northern Nigeria.
2. Poor prices for dairy products was one of the major problems identified, this can be solved creation of attractive prices for dairy products both in Nigerian and foreign markets

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