Valuation of Cow attributes by Conjoint Analysis: A case study in Western Kenya

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Abstract

The objective of the study was to determine the value that different households attach to attributes of the dairy cow. The cow attributes were, milk yield, disease resistance, feed requirement. The valuation was done in order to quantify the economic trade-offs made during adoption of dairy technologies, assess resource availability, households' perceptions on dairy technologies and their farming priorities. This was necessary to understand the adoption patterns of dairy technologies observed and suggest intervention. The Marginal Rate of Substitution (MRS), Marginal Willingness to Pay (mWTP), and Marginal Willingness to Accept (mWTA) that were used were determined from conjoint (CJ) analysis using data from a survey of 630 households in Western Kenya. The household characteristics that influenced valuation were off-farm income, precipitation over evapo-transpiration (PPE), ethnicity, cultural values, education, and extension. In reference to the typical households, household characteristics that showed a higher mWTP for a cow with low feed requirement implied either scarcity of feed, high opportunity cost of using land for fodder or lack of information on feed resources. The latter indicates inefficiency in resource use. A higher mWTP for a cow with high milk yield gave an indication of the households' priorities. A mWTA payment for a cow with high milk yield in the face of potential markets showed different farming priorities and lack of information. A mWTA payment for a cow with low disease resistance shows risk aversion and limited information on disease control.

Keywords: Cow attributes, Conjoint , Marginal Willingness to Accept, Marginal Willingness to Pay

Introduction

Low dairy development in Western and Nyanza provinces is evident from a study by Waithaka et al., (2002). A study by Nabwile S.M (Unpublished PhD thesis, 2005) to determine the effect of different factors on adoption of dairy technologies showed; Non-significant positive association between adoption of dairy technologies and population density, thus showing the households'non-response to markets, off-farm income was not used to develop dairy, larger land sizes encouraged movement to other farming activities, and variable adoption rates of dairy technologies across spatial and ethnic factors. These factors showed some underlying factors influencing adoption of dairy technologies, thus justifying the study on how different households value different cow attributes.. The three technologies were the dairy cow, Napier production and use of anti-helminthics.

The stated preference methods are relevant in livestock attribute valuation in developing countries (DC's) because livestock is kept for both market and non-market reasons (Scarpa et al., 2003; Adamowicz et al., 1993), thus market prices do not measure the full value of livestock. In addition people in DC's exhibit different preferences for livestock attributes across regions, countries, communities, and production systems (Scarpa et al., 2003), thus necessitating valuation across these factors. The CJ analysis, one of the stated preference methods decomposes a given set of multi-attribute alternatives into marginal values. The approach provides a realistic situation to the respondent, because attributes are evaluated as combinations (Steenkamp et al., 1987). Inclusion of price as an attribute estimates marginal utility of money, and mWTP for other attributes (Mackenzie, 1992; Gan and Luzar, 1993). The maximum amount of money an individual is willing to pay for a commodity is the WTP, an indicator of the value attached to that commodity. This is a price above the effective demand price, and is an externality (cost or benefit) not included in the market price. The mWTP is related to the concept of opportunity cost (Markandya, 2000). Thus a high mWTP for fodder may reflect land scarcity or the value of the next best activity on the land. Individuals may state higher mWTP values if they believe that it would be difficult to get the good at a later date (List A., 2004). The mWTP/mWTA measures can only be equal in a perfectly competitive environment (Markandya, 2000). Disparities in the two measures mean that individuals do not value benefits and perceive costs the same way. Information asymmetry increases the WTP/WTA gap (List J.A., 2004), and it is an externality that causes inefficiency in resource use. The mWTP and mWTA therefore are good measures for social costs and also indicate imperfections in markets. Markets allocate resources, and disparity between market prices and mWTP may therefore be a measure of efficiency in allocation of resources in an economy.

Theoretical Framework

Attribute valuation by CJ analysis is based on the New Consumer theory, which states that consumers derive utility, from the goods' attributes and not directly from the goods themselves (Sy et al., 1994 ; Tano et al., 2003). The assumption is that utility is linearly related to product attributes (Sy et al., 1994), and utility can be decomposed into separate utilities (Tano et al., 2003). Preferences can then be measured in terms of utilities (U) for individual attributes, which when added together measure the total preference for various attribute combinations (Gan and Luzar, 1993). The marginal utilities can therefore be represented by; $\frac{\delta U}{\delta S_g} = V_g + Zb_g$

Where S is the main effect variables representing product attributes, Z is the individual's socio-economic background, V_g is the change in utility when only product attributes change, b_g is the variation in utility associated with the changes in the interaction between Z and the attribute levels, while g is the attribute level. Household characteristics have to be included to cater for heterogeneity in the sample size, meaning that decision makers may assign different values for the same attribute of the same alternative, Karugia, (1997).

At constant utility level, the MRS for two attribute levels can be measured if all other attributes are held constant except the two attribute levels. Given the utility function: $U = b_1 X_1 + b_2 X_2 + \ldots + \ldots. = 0$, where X_1 and X_2 are attributes, while b_1 and b_2 are coefficients. Constant utility means $\delta U = b_1 \delta X_1 + b_2 \delta X_2 + \ldots + \ldots. = 0$.

Rearranging the equation above gives: $\frac{\delta X_1}{\delta X_2} = -\frac{b_2}{b_1}$, thus giving the MRS.

If b_1 is the cost of the product, then the ratio becomes the mWTP if it is positive and mWTA if negative.

Methods

The attributes were obtained from the cattle breeds existent in the study area. Identification of the relevant attributes was by using information from a past participatory rural appraisal (Waithaka et al., 2002), and other past studies. The attributes considered were disease resistance, feed requirement, both categorized as high, medium, and low. Others were milk yield, with levels of 1, 5, and 15 litres of milk/cow/day, while the price of the cow had levels of Ksh 4,000, 15,000, and 28,000. The SPSS orthogonal design computer generator gave 27 orthogonal main attribute profiles. Blocking the profiles gave 9 block designs, each with 3 profiles. To provide a good comparison with the other levels, two extreme profiles for the Zebu and High Grade breed were included. The Zebu has a low feed requirement, high disease resistance, is affordable, but has low milk yield. While the High Grade breed has high milk yield, high feed requirement, low disease, with a high price. The inclusion of extreme profiles has also been done by (Lazari and Anderson, 1994), in their CJ analysis on food products. Blocking takes care of interaction effects and provides meaningful ranking for large profiles. It should also have equal representations of the attribute levels (Henscher, 1993; Mackenzie, 1992 and Greene, 1974). The profiles were ranked by 630 randomly selected households across 5 districts; Rachuonyo, Kisii, Kakamega, and Nandi. Each respondent ranked one of the 9 blocks. Data on household characteristics were also collected.

Empirical methods for conjoint analysis

Data was analysed using the OPM. From the decision maker's theoretical utility model (Y*), the OPM is based on the assumption of the existence of the following relationship as stated by Greene, (2000);

$Y^*_i = \alpha_{1\ldots n-1} + \beta X_i + \varepsilon_i$, Where; Y^*_i is unobservable utility, X are observable factors which is a matrix of coded attribute levels, household characteristics, and interaction variables of the attribute levels and household characteristics, α's are threshold parameters (n is the number of the categories of the dependent variable), and β are marginal utilities. The threshold concept is central to the economic theory of consumer behaviour, which states that a buyer ranks alternatives when utility of one alternative exceeds a threshold level of "satisfaction" (Sy et al., 1994). Finally, ε_i is the error term.

Profile rankings were treated as dependent variables, while the effect-coded attribute levels and the household characteristics were independent variables. Two attributes, disease resistance and feed requirement, had 3 effect-coded levels each, but the medium level of each attribute was omitted to avoid the dummy variable trap. Each level had its column, and code 1 was for the level present in the ranked combination, 0 for the other levels absent in that combination, and -1 for the column of the omitted attribute level. The other attributes, milk yield and cow price retained their real values. For the categorical household variables, 1 was for the characteristic present in the household, while -1 was for its absence. Continuous household variables were recorded as they appeared. Effect-coding enables direct measurement of marginal utilities (Tano et al., 2003). The variables used were:

Age of the household head in years (age), Education of the household head in years (education),

Cultural Values (trd) 1=households that value the zebu for bride price, gifts, and social status, -1=Otherwise,

Kisii households (kisii) 1=Kisii household heads, -1=Otherwise,

Nandihouseholds (kale) 1=Nandi household heads, -1=Otherwise,

Households with off-farm income (off-farm income) 1=had off farm income, -1=Otherwise,

Households that received extension services (Extension) 1=received extension on livestock, -1=Otherwise, and

PPE (ppe) 1=PPE>1, -1=PPE <1

Results

Table 1 shows the results estimated with and without household characteristics.

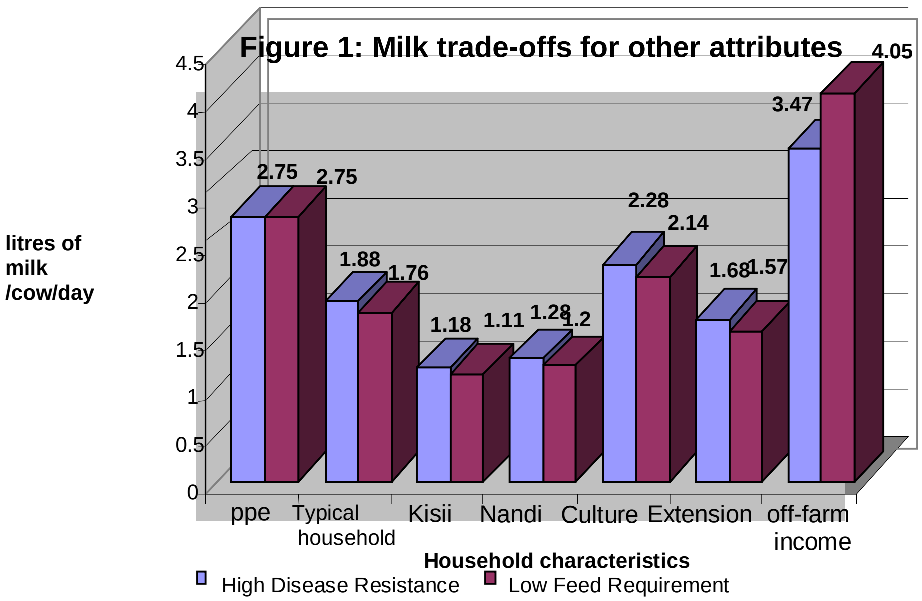
Table 1: Ordered Probit estimates on attribute valuation by a typical household and with household characteristics.

	Coefficient	Marginal WTP (Ksh)
Typical household		
Low disease resistance	-0.32(0.03)***	-16,000
Price	-.00002(2.46(10^{-6}))***	
Milk yield	0.17(0.005)***	8,500
Low feed requirement	0.09(0.03)***	4,500
High disease resistance	-0.02(0.03)	
High feed requirement	-0.30(0.03)***	-15,000
Likelihood ratio 1707*, No. of observations- 3146, Degrees of freedom**		**14**
Interactrion effects		
Milk yield●Kisii	0.10(0.01)***	3,333
Milk yield●trd	-0.03(0.01)***	-1,000
Milk yield●kalenjin	0.08(0.02)***	2,666
Milk yield●high PPE	0.03(0.01)***	1,000
Extension● milkyield	0.02(0.01)**	666
Low feed requirement● Kisii	0.31(0.16)**	10,333
Low feed requirement● Kalenjin	0.64(0.22)***	21,333
Low feed requirement● off-farm income	-0.50(0.13)***	-16,666
High feed requirement● high PPE	-0.25(0.13)*	8,333
High feed requirement● off-farm income	-0.39 (0.13)***	-13,000
High feed requirement● Education	0.03 (0.01)***	2,000
High disease resistance●off-farm income	0.29 (0.14)**	9,666
Low disease resistance●off-farm income	-0.23 (0.13)*	-7,666
Low disease resistance●high PPE	-0.23 (0.13)*	-7,666
Likelihood ratio 1938*, No. of observations 3126, Degrees of freedom 59**		

*** - significant at 10 % level, ** - sign ificant at 5% level, *** - significant at 1% level, and ● - interaction**

For a typical household, apart from the coefficient for the high disease resistance attribute level, all other coefficients were significant with the expected signs. This is expected from any rational household that is driven by economic reasons of rearing dairy cattle. The significant and positive sign of the coefficient for milk yield attribute means households gave a higher rating to the profile with higher milk yield. Conversely households gave a lower rating to the profile with higher price of the cow. The Ksh 8,500 is the households' mWTP for a cow with a higher milk yield. This amount is almost the same as the difference between the price of the Zebu and the Dairy Cross and more than the price between the Dairy Cross and the High Grade cow, making it easier for households to move from having a Zebu to a Dairy Cross than from a Dairy Cross to a High Grade breed.. The actual market price of the Zebu was from Ksh 4,000 to 8,000, the Dairy Cross from Ksh 13,000 to 15,000, while that of the High Grade was from Ksh25, 000 to 30,000. The mWTP for a cow with a low feed requirement was Ksh 4,500, while Ksh 15,000 was mWTA for a cow with higher feed requirement, and mWTA of Ksh 16,000 for one with a lower disease resistance. Therefore milk yield is the most important attribute, followed by feed requirement and disease resistance.

From Table 1, the overall mWTP was obtained by summing the main and interaction coefficients of a particular household characteristic. The marginal mWTP for high milk yield for a household in Kisii was Ksh 11,166 (8,500+2,666). Households located in areas with a PPE greater than 1 increased the m WTP for high milk yield by Ksh 1,000 (an increase from Ksh 8,500). Households with extension services are willing to pay Ksh 9166 (8,500+666) for a cow with a higher milk yield. When compared with the mWTP from other factors, it shows that extension is not doing enough to promote the improved dairy technologies. The high marginal mWTP for a cow with a higher milk yield among the Nandi and Kisii suggests a preference for improved dairy breeds in these areas. The high mWTP for low feed requirement among the Kisii is expected because of the small parcels of land while the high value among the Nandi may imply that planting fodder faces a higher opportunity cost of land. This result and the one that shows high mWTP for low feed requirement in PPE areas emphasises the different sources of feed to avoid over-dependence of fodder from the farms. Figure 1 shows the trade-offs between milk yield and other attributes.



It is important to look at the MRS of milk yield, the most important attribute, for other attributes, since breed choice is about making attribute trade-offs. With respect to the typical household, households in Nandi and Kisii showed lower milk trade-offs, while high cultural values, off-farm income and extension gave higher milk trade-offs. The MRS of milk yield for higher disease resistance was: - (-0.32/0.17) =1.88 litres/cow/day. This means that holding other attributes constant, a typical household trades off 1.88 litres of milk/cow /day for higher disease resistance. It also trades off - (-0.30/0.17) =1.76 litres/cow/day for lower feed requirement. Households in high PPE areas (meaning more fodder) gave higher milk trade-offs for lower feed requirement than expected. The high milk trade-off for higher disease resistance in high PPE areas could be because high PPE areas are prone to high diseases (Waithaka et al., 2002). The higher trade-offs could be lowered through provision of information on disease management and feed. Increased awareness of the economic benefits of dairy will also increase adoption of the dairy technologies.

Conclusions and Recommendations

Variations in the valuation of cow attributes occurred across several characteristics, namely education, PPE, extension, off-farm income, the ethnic factor, and cultural practice. Lack of information was the main determining factor in the valuation, to the extent that scarcity of feed was considered a constraint even in high PPE areas. The government should take the lead in giving information at this initial stage of dairy development, because the former has the infrastructure established in the form of extension agents. Provision of information is a public good at this stage, and is therefore unattractive for the private sector to provide. The private sector can only provide services if consumers are able to buy their services or products. Researchers should also look for ways of using the locally available resources to produce feed, other than fodder. The WTP/WTA and MRS explained the adoption patterns observed and gave the economic trade-offs during adoption. By use of this valuation method, potential users of a technology can evaluate a technology to adopt. It also gives feedback signals to researchers to either incorporate the relevant attributes, or address the factors that cause undesired distortions in the valuations of some attributes, thus saving on resources.

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