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Leveraging Information and Communication Technology Infrastructure of Dairy Cooperative Network: An *ex-ante* Analysis of Potential Institutional Innovation§

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Abstract

The penetration of information and communication technology (ICT) is low in the rural areas due to several infrastructural bottlenecks. In this context, the institution of dairy cooperatives — with its ICT framework in the form of supplier-related data base — has enormous potential in bridging the information gap. Scant research attention has been given on ascertaining potential feasibility of launching information dissemination module by leveraging the ICT infrastructure of the dairy cooperative network. This study has attempted to bridge this information gap. It is based on the information gathered through structured interviews from a sample of 80 farming households, equitably distributed in Haldwani (plains) and Bhimtal (hills) blocks of Nainital district of Uttarakhand. In the sample, 44 were dairy cooperative society members and the remaining 36 were non-members for control. The study has revealed that that television and mobile phones are the principal ICT tools used in the study area. The major constraints to information accessibility have been identified as 'respondents' capacity related constraint in using modern ICT tools', 'network and mobile use related constraints' and 'accessibility to ICT services constraints', and these were common in both plains and hills. The contingent valuation exercise has shown that there is scope for fee-based delivery of information via internet. It thus becomes important that the potential offered by the ICT infrastructure of the dairy cooperative network in the country be adequately exploited.

Key words: Dairying, contingent valuation, multinomial logit, principal component analysis, information and communication technology

JEL Classification: Q18, Q28

Introduction

Information and communication technology (ICT), a major source of acquiring and exchanging of knowledge in dairy entrepreneurship, has made inroads into the technically under-privileged rural agricultural communities. The farmers find it fast and handy in resolving their problems related to dairy animal management, milk production and market outlets. However, ICT penetration is low in the rural areas due to several constraints including short supply of tools and lack of farmers' skill (Ghasura *et al*., 2011). In this context, the institution of dairy cooperatives has enormous potential in bridging the information gap.

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The 'Amul' experience on the development of supplier related database, containing information on the volume of milk delivered, its fat content, and price through ICT services has made the payments to individual farmer-suppliers faster and transparent and the marketing network more prophetic (Bowonder *et al*., 2005). Scant research attention has been given on ascertaining potential feasibility of leveraging ICT infrastructure of the dairy cooperative network to disseminate effectively quality information to the farming community. Feasibility assessment of ICT intervention is important as the ICT modules can be effective and sustained only on cost recovery basis.

In this context, it becomes pertinent to ascertain the amount farmers will be willing to pay for such a module. This will not only be useful in assessing the demand for such ICT services, but will also help in rational pricing of such services by eliciting farmers' willingness to pay (WTP) for such services. Analysis of factors influencing farmers' willingness to pay will also help the ICT services providers in better targeting their clients and will ensure quick uptake of such services. The present study has assessed the potential feasibility of a financially sustainable information dissemination system that can be established by leveraging the ICT framework of the dairy cooperative institutions. The study has also identified the various constraints faced by dairy farmers in accessing information.

Data and Methodology

The study was carried out in the state of Uttarakhand where livestock forms an important source of livelihood. Multi-stage random sampling technique was adopted in selecting milk producing households in the study area. From two administrative divisions of Uttarakhand, Kumaon division was selected on account of higher livestock density (Bardhan *et al.*, 2010). Then, Nainital district was selected purposively as the district is rich in livestock resources and comprises both Tarai & Bhabar and hilly areas. In this context, this study has compared the plains (Bhabar) vis-à-vis hills of the district. Out of total eight blocks in the district, Haldwani located in the plains (Bhabar) and Bhimtal located in the hills were selected. Both these blocks have extensive coverage of the dairy cooperative network and because of the good performance of the cooperative system in both these blocks, many dairy cooperative societies (DCS) are already equipped with computer facilities. Two DCS were selected from each block, one within a distance of 15 km from the market (peri-urban) and the other beyond 15 km from the nearest market (rural) in each of the two blocks. Thus, a total of four DCS were selected for the study. A complete enumeration of all the households, having at least one milch animal was carried out in the area covered by each DCS for developing a sampling frame. The households which were members of DCS were then identified. In the next step, 20 households were selected from each DCS having representation from the member and non-member categories, on proportionate basis. The total sample size was of 80 households, of which, 44 belonged to the member category and 36 to the non-member category. The data were collected through personnel interviewing the heads of sample households.

Assessing Information Seeking Behaviour

The respondents were asked to give their frequency of contact with different information sources on a seven point continuum, viz. daily, weekly, fortnightly, monthly, seasonally, yearly and never, with the respective scores of 6, 5, 4, 3, 2, 1 and 0.. The average score for different sources and channels across the respondents was calculated. ANOVA was then used to compare the frequency of contact between member and non-member households of DCS in plains and hills.

Ownership of ICT Tools and their Utilization Pattern

The ownership of ICT tools was measured in terms of number of ICT tools possessed by the respondents, viz. radio, television, mobile phone, landline phone, computer, internet, etc. Then 'z-test' was used to compare the proportionate difference between ownership of ICT tools among member and non-member households of plains and hills.

Data were collected on respondents' ICT utilization pattern and the responses were measured on a 3-point continuum (daily=2, weekly=1 and monthly=0). ANOVA was employed to test the significant difference in frequency of using different ICT tools across member and non-member households of plains and hills.

Identification and Ranking of Constraints Faced by Farmers

A list of constraints was prepared in the form of statements. These constraints were analyzed according to their severity based on a three-point continuum (very serious=2; serious=1; not serious=0). Factor analysis using principal component methods and varimax rotation was done to identify the category of constraints from the set of 15 specific constraints presented before the respondents for their ranking.

Intensity of Constraints Faced by Respondents in Using Modern ICT Tools

The respondents in both plains and hills were categorized into two groups on the basis of intensity of constraints faced by them in using ICT tools, viz. high intensity and low intensity. Four factors emerged in the principal component analysis having eigen values greater than 1. The factor scores of each respondent for each of these four factors were weighed by their respective contribution to the total variance and then aggregated across all the respondents. The median aggregate score for all the respondents was then obtained for both the data sets, viz. plains and hills. The entire sample was then categorized into respective groups, viz. Group I, i.e. high intensity of constraint perception (having score above the median) and Group II, i.e. low intensity constraint perception (having score below the median).

Binary choice regression model, viz. logit model was fitted to explain the factors that are associated with the farmers' likelihood of belonging to high or low intensity of constraints perception groups. The dependent variable took the value of 1 for Group I and 0 for Group II. The logit model used was of the form:

$$\ln (P_i/1 - P_i) = Z_i = \alpha + \Sigma\beta_i X_i + e_i \quad \ldots(1)$$

where, X is the vector of independent variables and β_i's are the coefficients to be estimated. The left hand side of Equation (1) represents the log of odds of belonging to high intensity constraints perception group. The explanatory variables included in the model, are given in Table 1.

Estimation of Willingness to Pay (WTP)

To elicit farmers' willingness to pay (WTP), a contingent valuation approach was adopted in this study. Contingent scenario places respondents in a hypothetical market situation and most researchers agree that contingent valuation studies give an approximation of true behaviour (Vanslembrouck *et al*., 2002). Further, the application of this approach is valid in the study area as some services had already been initiated by a few ICT services providers like ITC, IFFCO, etc. for which farmers were already paying some nominal charges.

Table 1. Explanatory variables included in logit analyses

Variable	Description	Nature
Cooperative membership	Dummy for cooperative membership (whether i^{th} household is a member of dairy cooperative: Yes=1; No=0)	Categorical
Education of household-head	Education level of household-head (0-Illiterate, 1-Read & write, 2-Primary, 3-Middle, 4-High school, 5-Intermediate, 6-Graduation & above)	Continuous
Family type	Family type of i^{th} household (joint=1, nuclear=0)	Categorical
Landholding	Land owned by i^{th} household (acres)	Continuous
Herd-size	Herd size of i^{th} household (measured as standard animal units)	Continuous
Extension worker contact	Dummy for extension worker contact (whether i^{th} household has a contact with extension worker: Yes = 1, No = 0)	Categorical
Market distance	Distance to market (km)	Continuous
Age	Age of member of i^{th} household (years)	Continuous
Non-farm income	Dummy for non-farm income (whether i^{th} household has a non-farm income source: Yes = 1, No = 0)	Categorical
Credit access	Dummy for access to credit (whether i^{th} household has access to credit: Yes = 1, No = 0)	Categorical

Three ICT modules were proposed to the farmers. The contingent scenario presented before the farmers explained clearly the relevance and mode of operation of each of these three modules. It was also explained to them that they can avail such services only after paying a certain price. They were then asked to choose a card (Green, Red, Blue) which was associated with the corresponding module. The hub regulator of these cards was a Central Data Centre, compatible with internet placed in the dairy cooperative society. Once, a farmer chose a card, he was asked to elicit his WTP from various offer prices associated with that card. The services associated with these cards were as follows:

Green Card — This card holder gets information regarding various animal husbandry related topics like production, feeding, breeding, marketing, etc.

Red Card — This card holder gets information regarding both agriculture and animal husbandry sector and can use the IT facilities at the dairy cooperative only.

Blue Card — This card holder gets in addition to the information related to animal husbandry and agricultural sector, information on other aspects also like job opportunities outside, various government policies, education for children, etc. Only members who have paid for Blue card can use the facilities at the dairy cooperative centre.

Focused group discussion was held with farmers to determine various offer prices that were presented before the farmers for each of the ICT module. The ICT module specific offer prices that were presented before the farmers in the final survey to determine their WTP are presented in Table 2.

Table 2. Various offer prices presented to the respondents for ICT tools

Green card	Red card	Blue card
>250	>400	>600
250	350	550
200	300	500
150	250	450
100	200	400
50	150	350
<50	<100	<300

Farmers' WTP for ICT Modules

To identify the factors that influence the respondents' choice for a particular module (green, blue or red card), a multinomial logit model (as used by Lawson, 2004) was fitted, wherein the dependent variable assumed four discrete values, viz. 0 (when the respondent was not willing to pay for any of the three cards), 1 (when the respondent was willing to pay for the green card), 2 (when the respondent was willing to pay for the red card) and 3 (when the respondent was willing to pay for the blue card). Given the alternatives before a respondent, the probability that an individual i chooses alternative j, therefore, can be expressed by Equation 2:

$$Pr[Y_i=j] = \exp(\beta'_j X_i) / \Sigma \exp(\beta'_j X_i) \quad \ldots(2)$$

where,

$Pr[Y_i=j]$ = The probability of choosing no card, greed card, red card or blue card

$j = 0, 1, 2, 3$

$i = 1, 2, 3, \ldots\ldots, 224$

X_i = Vector of the predictor variables, and

β_j = Vector of the estimated parameters.

The multinomial logit model can determine the effect of independent variable on the probability that a farmer will be willing to pay for a particular card from several alternatives before him. This model was estimated by keeping the dependent variable 0 (i.e. not WTP) as the reference category. The e^{β} calculated, gives the odd's ratio associated with change in independent variable. Odds of 2, associated with WTP for a particular card for example, means that likelihood of willingness to pay for that card is twice that of not being WTP.

Results and Discussion

Information Seeking Behaviour of Respondents

Table 3 presents the information seeking behaviour of member and non-member respondents in terms of frequency of accessing information from different sources. Overall, significant differences across all the information sources were observed among the respondents from the plains and the hills. The information sources which were accessed most

Table 3. Average information seeking behaviour of farmers in Uttarakhand

Sources	Plains			Hills		
	Members	Non-members	Pooled	Members	Non-members	Pooled
Personal–localite channel						
Family members	0.45	0.611	0.52[a]	4.36[b]	1.67[a]	3.15[b]
Friends/relatives	0.77	0	0.42[a]	4.23[b]	2.56[a]	3.47[b]
Neighbours/fellow farmers	0.09	0.16	0.12[a]	4.32[b]	1.33[a]	2.97[b]
Progressive farmers	0.31	0	0.17[a]	3.36[b]	1.22[a]	2.4[b]
Personal–cosmopolite channel						
Officials of state AH department	4.47[a]	2.94[b]	3.8[a]	2.00	2.94	2.3[b]
Representatives of private input agencies	0.09	0	0.05[a]	0.82	0.61	0.7[b]
Progressive farmers from other villages	0.22[a]	0.94[b]	0.55	0.36	0.67	0.5
Impersonal-cosmopolite channel						
Radio	0.90	0.72	0.82[a]	5.00[b]	2.94[a]	4.1[b]
Television	6	5.66	5.8[a]	4.82[a]	3.00[b]	4.0[b]
Magazine/journal	0.22	0	0.12	0.05	0.00	0.02
Newspapers	6	6	6[a]	4.09[b]	5.67[a]	4.8[b]
Clinical camps	0	0.55	0.25[a]	0.59	1.11	0.8[b]
Kisan mela / pashu melas	1.22[a]	0.66[b]	0.97[a]	0.32[a]	0.78[b]	0.52[b]
Campaign	0	0	0	0[a]	0.22[b]	0.1
Demonstrations	0	0	0	0[a]	0.44[b]	0.2
Internet	0.5	0	0.27	0	0.00	0

Note: Figures having different superscripts across groups are significantly different up to 5 per cent level of significance

frequently in the plains were: newspapers, television and officials from Animal Husbandry Department for both member and non-member respondents. Narula (2009) has also reported that farmers mostly use newspapers and television as their source of information. In the hills, a newspaper was the most frequently accessed information source at the overall category, followed by radio and television.

A comparison of information seeking behaviour across regions revealed that the role of personal-localite channels was definitively higher in the hills as the frequency of acquiring information from family members, friends/ relatives, neighbours/ fellow farmers and progressive farmers was significantly higher in the hills than in the plains. In the case of personal-cosmopolite channels, the frequency of accessing information from officials of State Department of Animal Husbandry was significantly higher in the plains than in the hills. On the other hand, respondents in the hills acquired information from the representatives of private input agencies more frequently than in the plains. Mittal and Tripathi (2009) have also reported that farmers mostly seek information from other progressive farmers and input dealers. The role of television, newspapers and *kisan melas* in information dissemination was more prominent in the plains than in the hills. The findings of Halakatti *et al.* (2010) also support the results of present study.

The frequency of accessing information from radio and clinical camps was significantly higher in the hills than in the plains. Thus, a clear pattern in information seeking behaviour of farmers could be delineated from the above findings pertaining to personal-localite channels. Reliance on personal-localite channels was definitively more in the hills than in the plains. A comparison of information seeking behaviour among member and non-member households in the plains revealed that frequency of accessing information from officials of AH department and *kisan melas* was higher for member respondents than non-member

respondents. On the other hand, non-member respondents accessed information from the progressive farmers at a significantly higher rate than the member respondents.

In the hills, frequency of accessing information from personal-localite channels was significantly higher for member respondents than non-member respondents. These findings are similar with those of Sharma *et al.* (2008). Significant differences in preferences for personal-localite information sources were observed among the respondents in the plains and hills. No statistical difference was observed between the member and non-member categories in the plains for different personal-localite channels. The results imply that conventional ICTs (radio, television and telephones) still remain the most accessible ICTs in the study area. This might be due to focus of government on electronics and media sector.

Ownership and Utilization Pattern of ICT Tools

Table 4 shows the distribution of member and non-member respondents according to ownership percentage of different ICT tools. Overall among different ICT tools, TV and mobile phones were owed by the highest proportion of respondents in both the regions. The percentage of TV and mobile owners was significantly higher in the plains (97.5%) than in the hills (82.5%). The other major ICT tools which were owned by the respondents were radio and landline phones (45% and 35% in the plains and 55% and 25% in the hills respectively).

Table 5 presents the frequency of utilization of different ICT tools by the respondents. Overall, the respondents in the plains used TV more frequently (2.92) than the respondents in the hills (2.47). On the other hand, the frequency of using radio was significantly more among respondents in the hills (1.37)

Table 4. Ownership of different ICT tools in plains and hills

(in per cent)

ICT source	Ownership (%)					
	Plains			Hills		
	Member	Non-member	Pooled	Member	Non-member	Pooled
Radio	50	39	45	59	50	55
TV	100	94	97.5[a]	82	83	82.5[b]
Mobile phone	100	94	97.5[a]	73	94	82.5[b]
Landline phone	40	28	35	27	22	25
Computer	9	0	5	0	0	0
Internet	9	0	5	0	0	0

Note: Figures having different superscripts across groups are significantly different up to 5 per cent level of significance

Table 5. Utilization pattern of ICT tools by different category of respondents

ICT source	Utilization pattern of ICT tools					
	Plains			Hills		
	Member	Non-member	Pooled	Member	Non-member	Pooled
Radio	0.27	0.33	0.3[a]	1.36	1.38	1.37[b]
TV	3	2.83	2.92[a]	2.45	2.50	2.47[b]
Mobile phone	2.86	2.83	2.85	2.18[a]	2.83[b]	2.47
Landline phone	1.14	0.67	0.925	0.82	0.66	0.75
Computer	0.27	0.00	0.15	0	0	0
Internet	0.36	0.17	0.22	0	0	0

Note: Figures having different superscripts across groups are significantly different up to 5 per cent level of significance

than in the plains (0.3). Kubkomawa and Salihu (2010) have also reported that farmers use radio more frequently than other ICT tools to acquire information. No significant difference was observed between member and non-member respondents in the plains regarding frequency of using other ICT tools. In the case of hills, mobile phone was used more frequently by non-members (2.83) than members (2.18). Overall, the respondents in both the regions used TV and mobile phone more frequently than other ICT tools, for accessing information.

Constraints in Using Modern ICT Tools

The factor analysis using principal component methods and varimax rotation reduced the 15 specific constraints presented before the respondents for ranking, to four factors with eigen value greater than one in both the plains and hills. A similar factor analysis was used by Ajani and Agwu (2012) in their study.

In the plains, the constraints which had high factor loadings in case of Factor 1 were illiteracy, non-use of vernacular language, and lack of knowledge about computers, e-mail and internet services. Thus, Factor 1 was named as 'respondents' capacity constraints in using ICT tools'. These findings are in agreement with those of Patil *et al.* (2008) who found illiteracy as the major impediment in the use of ICTs. The constraints which loaded highly on Factor 2 were: long distance to business centres for e-mail and internet services, unavailability of business centres for internet services and lack of access to computer, e-mail and internet. Therefore, Factor 2 was named as 'accessibility to ICT services constraint'. The constraints, viz. high cost of mobile phones, and of their recharge cards and too-tiny to-read screen displays loaded highly on Factor 3. Hence, Factor 3 was termed as 'mobile-use related constraints'. Only one constraint, viz. poor network coverage for mobile phones, TV and internet services loaded highly on Factor 4 and as such, Factor 4 was named as 'network coverage related constraints'. Thus, the analysis revealed that there were four constraints faced by respondents in the plains.

In the hills, the constraints that loaded highly on Factor 1 were: illiteracy, non-use of vernacular language, and lack of knowledge about computer, e-mail and internet services. Hence, Factor 1 was named as 'respondents' capacity related constraint in using modern ICT tools'. Poor network coverage for mobile phones, TV and internet services and too-tiny-to read screen displays were the constraints that loaded highly on Factor 2. Thus, Factor 2 was named as 'network and mobile use related constraints'. The findings were in conformity with those of Dhaka and Chayal (2010) who reported inadequate internet connectivity as a major constraint in using ICTs by the farmers. The constraints which had high loadings on Factor 3 were: unavailability of business centres for internet services and poor access to computer, e-mail and internet. Thus, Factor 3 was termed as 'accessibility to ICT services constraints'. Only one factor loaded highly on Factor 4 in the hills, viz. lack of proper training. Thus, Factor 4 was named as 'constraint related to lack of training in using ICT tools'. Thus, in hills also, four broad categories of constraints were identified.

Factors Affecting Intensity of Constraints Faced by Respondents in Using Modern ICT Tools

An attempt was made to identify the factors significantly influencing the intensity of constraints faced by respondents in using modern ICT tools. For this purpose, logit model was fitted, as described under methodology and the results of the analysis are presented in Table 6. The level of education ($P < 0.01$) and non-farm income source ($P < 0.1$) emerged as the significant variables and the signs of regression coefficients for both these variables were negative. This implies that the likelihood of facing constraints in using ICT tools decreased with increase in the education level of respondents. In the case of non-farm income, this negative sign indicated that additional income source, other than from farm, significantly reduced the constraints pertaining to modern ICT tools accessibility and utilization. The odds ratio associated with these variables indicated that the likelihood of facing high intensity of constraints in using ICT tools decreased to almost one-third with one unit increase in education level of respondents. On the other hand, likelihood of facing high intensity constraints in using ICT tools increased by 92 per cent when the respondent household had no non-farm source of income.

In the case of hills, extension worker contact ($P < 0.05$) and non-farm income ($P < 0.1$) have emerged as the significant variables and the signs of their regression coefficients were negative. The negative sign associated with the variable extension worker contact implied that the probability of facing constraints in

Table 6. Factors influencing intensity of constraint faced by respondents in Uttarakhand in using modern ICT tools

Variables	Plains		Hills	
	ß	Odds ratio	ß	Odds ratio
Intercept	4.817 (3.354)		-0.272 (6.578)	
Age (years)	0.052 (.049)	1.054	0.222 (.145)	1.249
Education	-1.455 (.584)***	2.233	0.564 (.821)	1.757
Family type (joint=1,nuclear=0)	.817 (1.063)	2.265	-0.758 (1.973)	0.469
NFI (Y=1,N=0)	-2.623 (1.543)*	0.073	-8.027 (5.008)*	0.021
Land (acres)	0.357 (.532)	1.429	-2.483 (1.618)	0.084
Market distance (km)	0.049 (.079)	1.050	-0.606 (.442)	0.546
Extension worker contact (Y=1, N=0)	0.731 (1.116)	2.077	-5.36 (3.045)**	2.900
Herd size (SAU)	2.252 (1.533)	9.509	-0.043 (.481)	0.958
Credit access (Y=1, N=0)	-1.303 (.997)	.272	-6.124 (4.595)	0.002
-2 log likelihood	36.667		15.739	
R^2 (Cox & Snell)	0.375		0.629	

Note: ß indicates the value of regression coefficients of respective independent variables considered in the model
***, ** and * depict significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.
Figures within the parentheses indicate standard error.

operating ICT tools decreased with increase in contact with extension worker. Mama (2010) has also reported in the study on farmers in the district of Ada of Ethiopia that frequent extension participation increased their access to knowledge and information. The odd's ratios indicated that the likelihood of facing high intensity constraints in using ICT tools decreased to almost one-third with each unit increase in contact with extension worker, while it increased by 97 per cent when there was no non-farm income source.

Farmers' Willingness to Pay for Proposed ICT Modules

An attempt was also made to identify the reasons for not willing to pay in both the regions. Among the not-WTP respondents in the plains, 22 per cent opined that they were satisfied with the present situation, 27 per cent said that they had other important areas where they would like to spend money instead of spending on ICT, and 20 per cent did not feel that the information had much relevance to them. In the hills, among the non-WTP respondents, 30 per cent said they were satisfied with the present situation, 40 per cent said that they would like to spend in other areas and 25 per cent felt that information did not have much relevance to them. The majority of the respondents in the plains were willing to pay for the red card (20%), followed by blue card (15%) and green card (10%). In the hills, the proportion of respondents who were willing to pay for the blue card (20%) was more than that for red card (17%) or green card (10%).

Mean Willingness to Pay Amount for Proposed ICT Modules

It may be mentioned here that the offer price was highest for a blue card, followed by red card and green card. In the plains, the members were willing to pay a higher price for a red card (₹ 63) and a blue card (₹ 50) than their non-member counterparts (₹ 33 for a red and ₹ 30 for a blue card) (Table 7). For a green card, non-members were willing to pay a higher price (₹ 27) than members (₹ 20). A similar situation was observed in the hills also. Across regions, on average, the respondents in plains were willing to pay a higher price for green (₹ 23) and red (₹ 50) cards than in the hills (₹ 16 for green card and ₹ 40 for red card). As a blue card had a higher offer price, very few people opted for this card. In both the regions, member respondents were willing to pay more for blue card than the non-member respondents. The offer price associated with blue card was higher than that of red card. In spite of a higher price, a greater proportion of respondents were willing to pay for blue card in the hills. This implied that among the respondents who

Table 7. Mean Willingness to pay amount for each in Uttarakhand

(in rupees)

Respondents	Green card	Red card	Blue card
	Plains		
Members	20.45	63	50
Non-members	27	33	30
Pooled	23	50	41.25
	Hills		
Members	15	43	84
Non-members	16	36	33
Pooled	16	40	61.25

were willing to pay, the percentage of farmers, who considered information to be important for their livelihood, was high in the hills than in the plains. The respondents in the hills were willing to pay, irrespective of the price, for quality information indicating the urgent need of developing information dissemination networks in the region.

Factors Influencing Choice of ICT Modules

To identify the factors that significantly influenced the respondents' choice of a particular module (green, blue or red card), a multinomial logit model was fitted, and the results of this analysis are presented in Table 8. In the plains, the variables significantly associated with farmers' willingness to pay for a green card were cooperative membership ($P < 0.1$), market distance ($P < 0.1$), age ($P < 0.1$) and land size ($P < 0.05$). The signs of regression coefficients for all these variables, except market distance were positive. The positive sign associated with dairy cooperative membership implied that likelihood of respondents' willingness to pay for a green card increased with the cooperative membership. This might be due to the reason that green card provides information mainly on animal husbandry. The willingness to pay for a green card increased with increase in age and landholding size, but decreased with increase in market distance. No significant factors were found associated with farmers' WTP for red and blue cards.

The odds ratio associated with each significant variable indicated that the likelihood to pay for a green card increased by 1.55-times with each one year increase in respondents' age. The odds of WTP increased by almost 4-times with increase in landholding size and 3-times with increase in cooperative membership. On the other hand, likelihood to pay for this card declined by 36 per cent with each one-km increase in market distance.

In the hills, no significant factors were found to significantly affect respondents WTP for a green card. On the other hand, the market distance negatively influenced the likelihood to pay for a red card. With each one-km increase in market distance, WTP for red card reduced by 25 per cent. Age, education level of household head, herd size, extension worker contact and credit access emerged as the significant variables that influenced respondents WTP for a blue card in the hills. The higher number of variables that significantly influenced WTP for a blue card might be because of the fact that a higher proportion of respondents indicated their willingness to pay for this card as compared to green and red cards in the hills.

The signs of regression coefficients for age, education and extension worker contact were positive, while those for herd size and credit access were negative. This implied that respondents' WTP for a blue card increased with increase in age, education level and frequency of contact with extension worker. On the other hand, likelihood to pay for this card declined with increase in herd-size and credit access. In contrast, Mikinay (2008) has reported that access to credit plays a significant role in enhancing the willingness to use improved technologies and is significantly related with adoption. The negative association between likelihood to pay for blue card with herd-size can be explained as respondents having smaller farm size relied on other sources of income for their livelihood, so they probably required more information regarding the job opportunities. While the respondents having access to credit would like to spend money somewhere else, so were not willing to pay for this card as price associated with this card was high.

The odds ratio associated with the significant variables indicated that the likelihood to pay for a blue card increased by 1.3-times with each one year increase in respondents' age, 6-times with increase in each unit of education level of household-head, and 10 per cent with increase in extension worker contact. On the other hand, WTP for blue card declined by 60 per cent and 99 per cent with increase in one unit of herd size and incidence of credit access, respectively.

Table 8. Factors influencing farmers' willingness to pay for different cards

Variables	Plains						Hills					
	Green card		Red card		Blue card		Green card		Red card		Blue card	
	ß	Odds ratio	ß	Odds ratio	ß	Odds ratio	ß	Odds ratio	ß	Odds ratio	ß	Odds ratio
Intercept	-67.62(8.68)***		.148(5.44)		.733(7.2)		22.66(7.46)***		2.75(7.76)		-15.05 (10.21)	
Cooperative membership	14.27(9.94)*	3.70	.177(1.62)	1.194	-1.96(2.2)	.141	-2.69(10.33)	.068	-4.439(4.62)	.012	-4.859 (3.39)	.008
Market distance (km)	-.564(.33)*	.56	.050(.09)	1.051	.152(.158)	1.16	.052(.11)	1.05	-.279(.16)*	.756	-.073 (.106)	.930
Age (years)	.440(.28)*	1.55	-.019(.07)	.981	.017(.092)	1.01	.182(.14)	1.20	.033(.147)	1.03	0.280 (.17)*	1.3
Education level	2.49(3.62)	2.15	-.377(.37)	.686	-.279(.53)	.756	.704(.94)	2.02	1.424(1.04)	4.15	1.80 (.86)**	6.00
Family type (joint=1, nuclear=0)	-2.98(4.40)	.051	.606(1.35)	1.832	-.571(1.878)	.565	.495(1.58)	1.64	-1.49(2.19)	.22	-1.255 (1.99)	.285
Non-farm income (Y=1,N=0)	28.90(.00)	3.58	-.391(1.25)	.676	-.442(1.645)	.643	17.60(.00)	4.44	-2.00(2.31)	.13	-1.505 (2.057)	.222
Land (acres)	4.03(2.10)**	4.01	.256(.49)	1.292	.783(.522)	2.188	-.93(1.27)	.391	-.070(2.27)	.93	-.551 (1.402)	.576
Herd size (SAU)	.139(.94)	1.15	.039(.35)	1.040	-.086(.487)	.918	-.50(.55)	.604	-.133(.46)	.87	-0.93(.484)**	.395
Extension worker contact (Y=1,N=0)	30.01(.00)	1.08	1.406(1.59)	4.081	.950(2.257)	2.58	2.082(10.32)	8.018	5.236(4.015)	187.848	7.296 (3.889)*	1.10
Credit access (Y=1,N=0)	-2.43(2.775)	.088	-.673(1.13)	.510	-.680(1.353)	.507	-2.747(2.43)	.064	1.011(2.354)	2.748	-5.166(2.232)**	.008

Notes: ***, ** and * depict significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.
Figures within the parentheses indicate standard error.

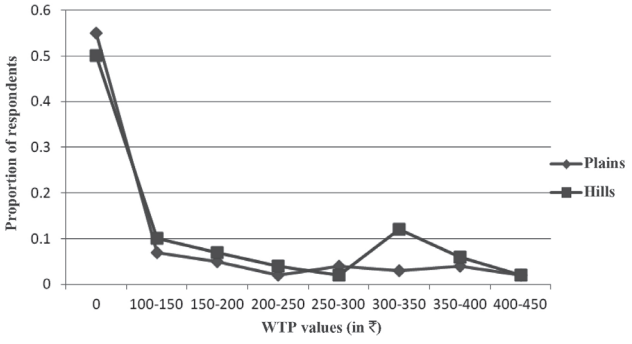

Figure 1. Distribution of respondents willing to pay for use of proposed ICT modules across different WTP values in Uttarakhand

Distribution of Respondents across Different Offer Prices for ICT Modules

The percentage distribution of WTP households, in both the regions, in terms of their offer prices for ICT modules is presented in Figure 1. This analysis was done to ascertain the nature of demand of ICT services in the study area, rather than analyzing the demand for each of three ICT modules. Both the curves (corresponding to plains and hills) are negatively sloped indicating that a higher proportion of respondents was willing to pay for ICT services when they had a lower price tag. The proportion of WTP-respondents declined with increase in module price. This is consistent with the classical economic rationale of a negative relationship between demand and price of a commodity/service.

A look at Figure 1 reveals that the curve corresponding to the hill region lies above that of the plains. Thus, it can be inferred that for each elicited WTP value, a higher proportion of hill respondents were willing to pay for availing ICT services than respondents of the plains. It could be attributed to greater difficulty encountered by the hill farmers in getting updated ICT services throughout the year than the farmers in the plains. The higher importance of dairying in the livelihoods of the hill respondents might also explain their greater likelihood of willingness to pay.

The contingent valuation exercise has shown that there was scope for fee-based delivery of information via internet. Also, the application of ICT in livestock can emerge as an important pillar of livestock extension focusing on the enhancement of agricultural and rural development. The effective utilization of ICT has the potential to mprove the economic status of the rural community.

Respondents in both the regions preferred to access information via ICT tools suggesting that ICT tools could be a useful way to reach farmers, provided the service is accessible. The role of public–private partnership in the provision of livestock information needs to be explored further in this context. Thus abilities of existing Dairy Cooperatives to serve farmers could be increased with the use of modern ICT tools. Government should encourage new investments in the Indian dairy sector because of its significant contribution in the national GDP.

Conclusions

The study based on a comparison of information seeking behaviour across regions, has revealed that the role of personal-localite channels was higher in the hills than in the plains. The result implies that conventional ICTs (radio, television and telephones) still remain the most accessible ICTs in the study area. The respondents in the plains had easy access to advanced ICT services on account of their geographical location and their higher educational level enabled them to use such services effectively. On the other hand, respondents in the hills had accessed modern ICT tools (computer and internet) less frequently and thus depended more on the close socialite group for acquiring information.

The major constraints to information accessibility as identified in the study, were 'respondents' capacity related constraint in using modern ICT tools', 'network and mobile use related constraints', and 'accessibility to ICT services constraints'; and these were common in both plains and hills. There is a need higher focus on improving the information delivery system. The public extension system should focus on timely delivery of quality information. Awareness generation through newspapers and television among farmers would be helpful. Adequate training of farmers in using computer, e-mail and Internet; adequate connectivity of Internet services in the rural community; and delivery of information through appropriate communication channels will go a long way in helping the farmers to make effective use of ICTs for greater productivity.

The contingent valuation exercise has shown a considerable scope for fee-based delivery of information via Internet. The potential offered by the ICT infrastructure of the dairy cooperative network in the country be adequately exploited. The capacities of the existing cooperatives to serve farmers could be increased with the use of modern ICT tools. The investments in the form of public-private partnerships in ICT initiatives should be increased in the cooperative sector because of its significant role in information dissemination. It is also essential to install a regulatory and supervisory mechanism to ensure proper working of module and fulfilling the information needs of farmers.

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