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The effect of participation in the Ugandan National Agricultural Advisory Services on willingness to pay for extension services

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Uganda's National Agricultural Advisory Services (NAADS), established in 2001, is a demand-driven extension program for developing farmer organizations and improving farmer production and welfare. The program is expected to be 50% client funded after 25 years. However, varying returns to extension services and inconclusive evidence about their effectiveness suggest that farmers may not be willing to pay for these services. Using a choice experiment, this study found that longer participation in NAADS increased farmers' willingness to pay and that NAADS had a cost beneficial effect at farm level. The findings suggest that farmers are willing to pay for extension advice (US\$0.20, which is higher than that found for most other African extension systems) if they see they are given good information, though they should not be asked to pay the full cost. Longer association with NAADS promoted the adoption of new crops, reduced the vulnerability of farms by increasing technology adoption and improved farmer welfare.

Keywords: choice experiment; willingness to pay; extension services; Plan for the Modernization of Agriculture in Uganda; National Agricultural Advisory Services (NAADS)

JEL classification: O13; Q12; Q16; Q18

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Les Services Nationaux de Conseil Agricole ougandais (NAADS en anglais), créé en 2001, est un programme de vulgarisation régi par la demande, dont le but est de développer des organisations de fermiers et d'améliorer la production agricole et le bien-être. On estime que le programme sera, après 25 ans, financé par 50% des clients. Cependant, la variabilité du rendement des services de vulgarisation ainsi que l'évidence peu concluante de leur efficacité suggèrent que les fermiers ne seraient pas prêts à payer pour ces services. Grâce à une expérience basée sur le choix, cette étude a montré qu'une plus longue participation au NAADS motivait davantage les fermiers à payer et que le NAADS profitait aux fermiers du point de vue du coût. Les résultats indiquent que les fermiers veulent bien payer pour les conseils dispensés par le service de vulgarisation (US\$0.20, montant plus élevé que ceux trouvés pour la plupart des autres services de vulgarisation africains) s'ils pensent avoir été bien conseillés, mais on ne devrait pas leur demander de payer le plein tarif. Une plus longue association avec le NAADS a entraîné une adoption de nouvelles cultures, a réduit la vulnérabilité des fermes grâce à l'adoption accrue de technologies, et a amélioré le bien-être des fermiers.

Mots-clés : *expérience basée sur le choix; volonté de payer ; services de vulgarisation ; Plan de Modernisation de l'Agriculture en Ouganda (PMA) ; Services Nationaux de Conseil Agricole (NAADS en anglais)*

Catégories JEL : *O13 ; Q12 ; Q16 ; Q18*

1. Introduction

In 2001, the Plan for the Modernization of Agriculture established Uganda's National Agricultural Advisory Services (NAADS) and by the end of the financial year 2007/2008 NAADS was operating in all Districts across Uganda (MAAIF/MFPED, 2000). The program is a pioneer in sub-Saharan Africa, a demand-driven public-private system working to promote and develop farmer organizations and empower farmers to seek and secure advisory services. It is designed to make farmers not only users but clients of the extension services, which in theory should improve the responsiveness, accountability and impact of the program.

The agricultural extension system in many countries is a bi-directional linkage, disseminating technology and information to the farmer's field and in turn receiving information and results from the field to inform and drive national research priorities (Agbamu, 2000). The varying returns to extension access that have been observed (Gautam, 2000; Kidd et al., 2000; Anderson & Feder, 2007) and the inconclusive findings of the adoption literature on the effectiveness of extension services (Beckford, 2002; Chirwa, 2005) call into question the role and viability of the system. While the poverty-reducing potential of extension services is high (Kidd, 2001), Horna et al. (2007) suggest that these services are nevertheless often ineffective at increasing farmers' welfare. However, the initial assessment of the trail-blazing Districts (those participating from 2001/02) suggests that NAADS is having a beneficial effect in the sub-counties where it operates (Danida, 2005; Scanagri, 2005; Benin et al., 2007). The NAADS has, since 2007/08, included all Districts in Uganda. This paper provides an updated evaluation of the impact of NAADS on farmers' welfare and examines the effect, if any, that the program has had on their technology adoption decisions.

Agricultural extension systems are expensive and potentially fiscally unsustainable (Purcell & Anderson, 1997; Horna et al., 2007), and with increasing draws on central government budgets they need to prove their value and realize effective outputs if they are to achieve

political support. In the past, measuring the value for money and effectiveness of extension services relied on easy-to-measure input factors, i.e. number of visits, rather than realized output effects (Anderson & Feder, 2007). Private sector involvement is expected to increase the efficiency and sustainability of service provision. For viable private funding and provision, such services require a strategy for private sector involvement. Client contributions could provide the key to this. In addition, fee based advice is likely to increase the accountability of the system and ensure that client preferences would be more closely adhered to, which has been shown to be important in implementing successful change (James, 2010).

Information that farmers obtain from the extension services enhances human capital and may be characterized as a production input, in the same way as land and labor. It is therefore likely that there is a market for extension advice. Those who receive the services could be asked to pay some of the costs, as happens in the UK. Agricultural extension may also give farmers more than just agricultural information, for example about using mosquito nets. These additional benefits carry wider positive externalities, such as reducing national health costs. Likewise, extension information directly relevant to agricultural production delivers wider economic benefits in terms of food security, food quality, and economic empowerment and development. These positive externalities suggest that those receiving the advice are not the only beneficiaries and therefore they should not bear the full cost of the services. The Plan for the Modernization of Agriculture aims for NAADS to be 50% public funded and 50% client funded after 25 years of operation, as in the case of the Netherlands extension service (MAAIF/MFPED, 2000). The expectation is therefore that farmers will be increasingly able and willing to contribute to the cost of the services they receive, thus reducing the burden on the state budget. The aim of the study this paper describes was therefore to establish farmers' willingness to pay (WTP) for the services provided by NAADS.

We used a stated preference technique, the choice experiment, to establish the WTP for extension services in a sample of nine sub-counties in Uganda, i.e. a sample was taken from each stratum, each stratum being a sub-county. Choice experiments have previously been used to assess individuals' attitudes to genetically modified crops and Indian farmers' preferences for organic farming and to evaluate cattle breeds in Kenya (Hu et al., 2004; Hope et al., 2006; Ruto et al., 2008; Birol et al., 2009). Choice experiments are widely used in the non-market valuation literature to provide WTP estimates for wetlands, climate mitigation measures and energy investments, among others (Kimenju et al., 2005; Bergmann et al., 2006; Ladenburg & Dubgaard, 2007; Yoo et al., 2008; Do & Bennett, 2009). The choice experiment has previously been used in Uganda to value the welfare benefits of nature based tourism (Naidoo & Adamowicz, 2005) and to measure the willingness of farmers to adapt to climate change (James, 2010). A number of studies have used stated preference techniques to investigate farmers' willingness to pay for information and extension services (Holloway & Ehui, 2001; Ajayi, 2006; Horna et al., 2007; Singh & Narain, 2008); however, this is the first study to use the choice experiment technique for this purpose. All prior studies report that farmers are willing to make a monetary contribution in order to receive extension advice.

In this paper we first explain the theoretical background to choice experiments and describe the study area and sampling procedure. Next we describe the construction of the experiment. We then analyze the livelihood survey findings and the results from the choice experiment and discuss the effect that NAADS participation has had on farmers and their decisions. In concluding we make some policy recommendations.

2. Theoretical background

2.1 Discrete choice models

Lancaster (1966) proposed that consumers derived utility from the attributes of a commodity rather than from the commodity itself. Random utility theory (Manski, 1977), when applied to Lancaster's (1966) 'new consumer theory', assumes that consumers act rationally to maximize their utility from a set of viable choices. A researcher can only observe the actual choices individuals make when they are confronted by a real or imaginary choice and cannot observe the true utility (U_{ni}) that individual n associates with alternative i as one of the $j=1\cdots J$ alternatives on offer. This means that the researcher must construct a choice model by estimating the representative utility (V_{ni}), which depends on the levels of the various attributes present in alternative i (\mathbf{x}_i) and the characteristics of the individual making the choice (\mathbf{s}_n):

$$U_{ni} = V(\mathbf{s}_n, \mathbf{x}_i) + \varepsilon_{ni} \quad (1)$$

A random disturbance term (ε_{ni}) accounts for the differences that arise from unobserved variation in individual preferences. In this framework the probability that individual n chooses alternative i (P_{ni}) is the probability that the true utility of alternative i is greater than that of the other j alternatives available:

$$P_{ni} = \text{Prob} (U_{ni} > U_{nj} \quad \forall j \neq i) \quad (2)$$

Preferences for the attributes of the choice alternatives can be estimated by adjusting the preferences for those attributes in a model of discrete choice behavior until the choice probabilities predicted by the choice model match the observed choice data as closely as possible.

In this study farmers in Uganda were asked to choose between alternative farming systems. The alternatives were portrayed as varying sets of attributes relevant to this study. Individuals' relative preferences for, or aversions to, each attribute and its associated levels could then be quantified by estimating a multinomial logit model of the preference structure determined from the choices made by respondents.

2.2 Multinomial logit model

The multinomial logit (MNL) model provides a simple parameterization of choice probabilities within the random utility framework. The IIA (independence of irrelevant alternatives) assumption inherent in the MNL model assumes homogenous preferences

(McFadden, 1974). Choices are therefore assumed to be affected only by the levels of the attributes present in the alternatives (\mathbf{x}_j for $j = 1 \dots J$) and not by the individual characteristics of respondents. In the MNL model, the probability of individual n choosing alternative i (McFadden, 1974; Train, 2003) is

$$P_{ni} = \frac{\exp(\boldsymbol{\beta}'\mathbf{x}_i)}{\sum_{j=1}^J \exp(\boldsymbol{\beta}'\mathbf{x}_j)} \quad (3)$$

where $\boldsymbol{\beta}$ is the vector of preference parameters for the attributes of the alternatives, which are assumed to be constant across individuals. The $\boldsymbol{\beta}$ parameters identify the relative preferences of each of the attributes, so for this reason this investigation reports the $\boldsymbol{\beta}$ parameters. An MNL model can thus provide a statistically reliable portrayal of observed choice behavior when respondents' taste preferences are relatively homogeneous, or when taste preferences vary systematically with sociodemographic characteristics observable by the analyst (see Windle & Rolfe, 2005; Birol & Villalba, 2006; Zander & Drucker, 2008).

2.3 Willingness to pay estimates

When the preference parameters of the non-monetary attributes and the preference parameters of the fee attribute are both significant a marginal WTP can be calculated. The marginal WTP for a particular attribute is the ratio of the parameter estimate to that of the fee attribute:

$$WTP_{MNL} = \frac{\beta_i}{\beta_{Cost}} \quad (4)$$

where WTP_{MNL} is the willingness to pay a fee for the MNL model, β_i is the parameter expressing the preference for a marginal increase in the level of the attribute for which the fee is to be paid and β_{Cost} expresses the marginal aversion to an increase in the fee.

2.4 Monte Carlo analysis

The standard difference of means analysis used in a number of choice experiment studies to investigate respondents' sociodemographic characteristics was considered inappropriate for this model, because different models are estimated for each NAADS classification, leading to difference across multiple groups. The Monte Carlo analysis used here assumes that there are no differences between the groups and that the population is normally distributed. The population mean and standard deviation are calculated for each indicator and simulations are then repeated 10,000 times to obtain the group means. The means indicate whether the observed differences between the groups are statistically significantly different from the population mean: each group is directly compared to the expected population mean and distribution rather than the groups being compared to each other's mean values. The Monte

Carlo analysis allows for a clear difference in means, since a single test statistic is used to determine significance versus the population mean. The difference (if significant) can thus be attributed to group membership and therefore to length of NAADS participation.

3. Choice experiment design

The respondents were presented with choice profiles depicting two new farming systems, each described in terms of five attributes. In line with the aims of this paper, two extension related attributes (frequency of extension visits and cost of each visit) and two crop related attributes (number of crops grown and number of new crops) were included in the profile. In addition a risk attribute was included (the number of years in six for which there is a risk of a bad year occurring), because the perceived risk associated with different farming systems has been shown to influence individuals' choice (Marra et al., 2003; Gray, 2005; Bandiera & Rasul, 2006; Horna et al., 2007; Singh & Narain, 2008). The first four attributes were specified over three levels and the final attribute over six levels (Table 1). In line with the literature, the choice attributes were selected by sector experts from a number of different research organizations. The experimental design used corresponds to the recommendations made by Wattage et al. (2005) and Yoo et al. (2008).

The effect of participation in the Ugandan National Agricultural Advisory Service on willingness to pay for extension services

Table 1: Attributes and levels used in the choice experiment

Attribute	Definition	Levels	Coding used in preference model
<i>Crop diversity</i>	<i>The number of different crops which the farming system will require to be grown.</i>	<i>2 crops</i>	<i>Diversity = 1</i>
		<i>4 crops</i>	<i>Diversity = 2</i>
		<i>6 crops</i>	<i>Diversity = 3</i>
<i>New crops</i>	<i>The number of crops in the farming system which the individual will have no experience of.</i>	<i>No new crops</i>	<i>New = 1</i>
		<i>1 new crop</i>	<i>New = 2</i>
		<i>2 new crops</i>	<i>New = 3</i>
<i>Extension visits</i>	<i>The frequency of extension visits.</i>	<i>Once per year</i>	<i>Visit = 1</i>
		<i>Once a season</i>	<i>Visit = 2</i>
		<i>Monthly</i>	<i>Visit = 3</i>
<i>Cost of visits</i>	<i>The cost per extension visit that the individual will be required to pay.</i>	<i>Zero</i>	<i>Cost = 0</i>
		<i>UGX400*</i>	<i>Cost = 400</i>
		<i>UGX1000</i>	<i>Cost = 1000</i>
<i>Bad years</i>	<i>The number of years in a</i>	<i>1 in 6 bad years</i>	<i>Base level = 0</i>

<i>period of 6 that a farming system risks having a bad production year.</i>	<i>2 in 6 separate bad years</i>	<i>Bad 2S = 1</i>
	<i>2 in 6 consecutive bad years</i>	<i>Bad 2C = 1</i>
	<i>3 in 6 separate bad years</i>	<i>Bad 3S = 1</i>
	<i>3 in 6, 2 consecutive bad years</i>	<i>Bad 2+1 = 1</i>
	<i>3 in 6 consecutive bad years</i>	<i>Bad 3C = 1</i>

* 1900 Uganda shillings (UGX) = one US dollar (USD)

The experiment used a balanced orthogonal main effects only background design. Disregarding interaction terms was considered appropriate to reduce sample numbers; this is compatible with general principles discussed in Louviere et al. (2000) and Hensher et al. (2005). A fractional factorial set of 18 choice profiles was compiled and blocked using a sixth orthogonal blocking variable. A standard ‘plus one’ generator (1111) was used on the first four attributes, to produce the second farming system to be represented on the choice cards. The risk of bad years was a six-level attribute and therefore generators 10, 01 and 11 were used to provide the second farming system. This procedure is in accordance with recommendations by Burgess and Street (2007). As a consequence of the presence of the six-level attribute, the full choice set totaled 54 paired choice profiles.

On each choice card respondents were presented with two profiles, labeled ‘farming system A’ and ‘farming system B’ (Figure 1). In accordance with experimental design requirements and investigations by Haaijer et al. (2001) an opt-out option was included on each card, worded as ‘I do not like farming system A or B’. Respondents were requested to make one choice from the three options presented to them on each card.
















	Number of Different Crops grown	Number of New Crops	Extension Visits	Extension Cost per Visit	Bad Years	Choice (ONE (1) only)												
Farming System A		None	Once a Year	 Ush 1,000	<table border="1"> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> </table>							1	2	3	4	5	6	<input type="checkbox"/>
																		
1	2	3	4	5	6													
Farming System B		1	Once a Month	Ush 0	<table border="1"> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> </table>							1	2	3	4	5	6	<input type="checkbox"/>
																		
1	2	3	4	5	6													
I do not like farming system A or B						<input type="checkbox"/>												

Figure 1: Example of choice card used in the Ugandan choice experiment survey

The objective of the experiment was to measure individual preferences for the various attributes, so the respondents were given no contextual statement. Before proceeding, enumerators described the experimental procedure to ensure that the respondents understood what was required of them. Seven choice sets were presented to each of the respondents; an orthogonal block of six plus a repeated choice set to check for consistency. Nine respondents were therefore needed to complete one full set of choice profiles. Local experienced enumerators administered the experiment and the accompanying livelihood survey. Attribute levels (see Table 1) were depicted pictorially on the cards and also described verbally by the enumerators (Figure 1). The enumerators ensured that the respondents understood each choice profile before they made their choices.

4. The sample

The choice experiment and livelihood survey were conducted in October and November 2008 in nine sub-counties across six Districts of Uganda.¹ Sub-counties were chosen on the basis of NAADS participation and development domains as defined by Ruecker et al. (2003). A random sample of farmers were interviewed at a central meeting location in each area (school, community centre or sub-county office). This made it possible for more than 21 repeats of the full choice set to be completed. A total of 1182 useable responses were recorded, with 0.5% of the sample being rejected because of inconsistent responses. Of the sample, 39% were

¹ The sub-counties were Buwenge, Jinja; Nutenjeru, Mukono; and Nabbale, Mukono (in eastern Uganda); Mijjunnwa, Mubende; Lugazi, Sembabule; Mulagi, Kiboga; Nasambya, Kiboga; and Kibiga, Kiboga (in central Uganda); and Kasongi, Mbarara (in western Uganda).

characterized as long-term NAADS participants (becoming participants by the close of the financial year 2002/03), 18% as medium-term (becoming participants in the financial year 2005/06) and 43% as short-term (becoming participants in the financial year 2007/08).

5. Discussion of results

5.1 Summary of choice experiment results

The MNL models for short-, medium- and long-term NAADS participants provided a statistically good portrayal of each group's decision-making structures (Table 2). Each model passed the Hausman test for IIA at greater than the 5% level. The pseudo- R^2 of each model sits comfortably within the good fit range suggested by Louviere et al. (2000), with models for short- and long-term participants approaching the top end of this range. Likewise, standard tests for comparing different models, AIC-2, BIC and pseudo- R^2 , suggested that the MNL model was likely to be the most suitable and the assumption of homogeneous preferences could therefore be considered appropriate. Respondents' verbal reasoning and anecdotal evidence of choice behavior supported the preference structures observed in the MNL models.

Table 2: Parameter estimates for the MNL models for recent, late and early NAADS participants

<i>Choice model</i>	Short-term NAADS participants			Medium-term NAADS participants			Long-term NAADS participants		
	Parameter	Std err.	Sig.	Parameter	Std err.	Sig.	Parameter	Std err.	Sig.
Crop diversity	0.0268	0.0946	0.777	0.1019	0.1394	0.465	0.1937	0.0937	0.036 **
New crops	0.2936	0.0951	0.002 ***	0.4360	0.1425	0.002 ***	0.1624	0.0945	0.086 *
Extension visits	0.0522	0.0897	0.560	0.0822	0.1343	0.540	0.2179	0.0907	0.016 **
Cost of visits	-0.0004	0.0002	0.017 **	-0.0002	0.0003	0.503	-0.0006	0.0002	0.002 ***
Bad 2S	-1.6231	0.3266	<0.001 ***	-1.4056	0.3922	<0.001 ***	-1.5357	0.3113	<0.001 ***
Bad 2C	-1.8690	0.3214	<0.001 ***	-1.3339	0.3945	<0.001 ***	-1.8040	0.3098	<0.001 ***
Bad 3S	-3.4805	0.3558	<0.001 ***	-2.2214	0.4105	<0.001 ***	-2.6326	0.3152	<0.001 ***
Bad 2+1	-3.5700	0.3558	<0.001 ***	-2.8419	0.4436	<0.001 ***	-3.2782	0.3419	<0.001 ***
Bad 3C	-3.7716	0.3615	<0.001 ***	-3.8879	0.5471	<0.001 ***	-3.6509	0.3582	<0.001 ***
Opt out	-4.0444	0.4823	<0.001 ***	-1.6004	0.5786	0.006 ***	-3.2957	0.4684	<0.001 ***
Choice obs	510			216			456		
Log likelihood	-277.8507			-161.1750			-274.8951		
Pseudo-R ²	0.3650			0.2680			0.3125		

* = 10% significance level, ** = 5% significance level and *** = 1% significance level.

Crop diversity had no significant influence in the choice decisions of both short- and medium-term NAADS participants, but it did have a positive and significant influence in the decisions made by long-term NAADS participants. The number of new crops had a significant positive influence in the choice decisions of all the respondents. The frequency of extension visits was only significant in long-term NAADS participants' choices. Using the associated significant cost attribute, a WTP for extension services of UGX380 (US\$0.20 at US\$1=UGX1900) was established. All the respondents who took part in the experiment reacted in a consistent way to the risks associated with each farming system. Preference results show that on average respondents were risk averse, and more averse to the risk of consecutive bad years than to the same number of separate bad years.

This rest of this section discusses individuals' willingness to pay for NAADS visits and the effect at the farm level of NAADS participation, highlighting key evidence from the literature, the choice experiment, the wider livelihood survey and the Monte Carlo analysis (Table 3).

Table 3: 10,000 run Monte Carlo simulation results

Factor	Short-term NAADS participants	Medium-term NAADS participants	Long-term NAADS participants
WTP for NAADS	US\$0	US\$0	US\$0.20
Visited once a month or more	35% ^b	61%	80% ^a
Farmer group members	44% ^b	67%	78% ^a
Able to borrow	31%	36%	42%
Strongly agree extension visits improved farm techniques	35% ^b	61%	80% ^a
Strongly agree extension visits improved yields	9% ^b	22%	35% ^a
Strongly agree extension visits improved income	8% ^b	25%	39% ^a
Average income group	7.9 ^b	7.2	27.2 ^a
Poor year income group	5.1 ^b	4.7	15.8 ^a
Favourable year income group	10.7	9.8	27.5 ^a
Numbers using chemical fertilizer	15% ^b	28%	31% ^a
Numbers using irrigation	24%	25%	40% ^a
Coffee grown	25% ^b	69% ^a	34%
Maize grown	86% ^a	78%	53% ^b
Low level only adaptation measures – perceived rainfall change	34% ^b	61%	51%
No changes made to perceived changes in rainfall	34% ^a	19%	16% ^b

Notes: ^a = significantly higher observed occurrence than simulation estimate at 5% level, ^b = significantly lower observed occurrence than simulation estimate at 5% level

5.2 Willingness to pay for extension services

The WTP of US\$0.20 identified by the choice experiment in this paper corroborates findings by Gautam (2000), Holloway and Ehui (2001), Ajayi (2006) and Horna et al. (2007), who all indicate that farmers across Africa are willing to pay for extension service visits. Holloway and Ehui (2001) use a transactions cost model to show that Ethiopian livestock farmers have a positive WTP for extension advice at US\$0.075 per visit, and Horna et al. (2007) find that farmers in Benin and Nigeria have an average WTP for on-farm visits of US\$0.149 per visit. Ajayi (2006), however, reports a WTP from Nigeria of US\$3.10, which is significantly higher than that found for Uganda in this paper. This is surprising, given the notably lower WTP finding by Horna et al. (2007) for the same country and the fact that the Nigerian extension services are of poorer quality than those supplied by NAADS in Uganda. The apparent over-valuation by Ajayi (2006) may be attributed to the methods used in the study, as contingent valuation tends to over-value a good when compared to other preference methods or market based analysis used in the above studies. The WTP finding in the present study of US\$0.20 is slightly higher than that reported in the other WTP literature. This WTP for extension services by the users, although low in comparison to the total extension budget (Akroyd & Smith, 2007), could make a significant contribution to the total amount spent on agriculture in the country.

Willingness to pay has been shown to vary with extension service quality. For example, the extension system in Malawi is considered inefficient and this is likely to be why Chirwa (2005) finds it to have no effect on adoption decisions. Gautam (2000) suggests that a deterioration in the extension services in Kenya has reduced information access and contributed to a decline in agricultural productivity. The choice experiment demonstrated that short-term NAADS participants were not willing to pay for extension visits, which suggests that the perceived quality of extension services may affect a respondent's WTP for those services. Monte Carlo analysis of the livelihood data collected (Table 3) suggests those who were willing to pay for NAADS (long-term NAADS participants) perceived the quality of the information provide by NAADS as being significantly higher than those who were not willing to pay for the advice. Significantly greater numbers of long-term NAADS participants believed that the information and assistance received from extension agents improved their farming techniques, increased their yields and increased their incomes. This indicates a marked increase in belief and trust in information provided by NAADS on the part of those with a longer history of NAADS participation. This may be because the program is demand-driven and therefore more reactive to individual needs and likely to carry greater returns. It suggests that time is required for individuals to perceive the higher quality of advice to instill a WTP and therefore initial free access will eventually lead to individuals becoming willing to pay for the advice.

The perception evidence from the livelihood survey also suggests that longer NAADS association may have a strong welfare improving effect. Analysis of actual income data (Table 3) supports this proposition, showing that long-term NAADS participants did have significantly higher incomes in poor, favorable and average production years than short-term NAADS participants. This suggests that once the benefits of the 'free' system have been developed and demonstrated to farmers they will be better off and more willing and able to pay for extension services. This welfare improving effect suggests that the key targets of the NAADS program should be the poorer sections of society and not those who already have some capabilities.

Our choice experiment established that a willingness to pay exists among those with greater experience of and trust in the NAADS. We also demonstrated that participation in the NAADS has a welfare improving effect. The following section looks at the impacts at the farm level and consequently where the welfare improvements may come from.

5.3 Adoption of new crops

The positive preference for new crops identified during the analysis of the choice experiment was supported by anecdotal evidence obtained during the livelihood survey. For example, farmers in Mijjunnwa sub-county remarked that they could ‘learn about the possibilities of other crops’ or ‘gain more experience’, and a farmer in Kasongi said he could ‘test the market and see if it is good’. Likewise, Monte Carlo analysis showed that fewer long-term NAADS participants also grew food crops such as maize and significantly lower numbers of short-term NAADS participants grew coffee. Evidence from other Uganda-based studies supports these findings. James (2010), using a stated preference method, found that farmers in Uganda were willing to change their methods if opportunities were available. Revealed preference results from Grisley (1994) showed that in practice farmers are willing to experiment with new crops.

Analysis of the full livelihood survey revealed more detail about the process used by respondents to introduce new crop varieties. Twenty percent of the sample said they would act on advice and introduce a new crop without first undertaking a trial period. Forty-two percent said they would trial the method first by using small test plots, then consider slowly introducing the new crop more widely to their farm. Thirty-one percent said they would skip the small test plots stage and convert a portion of their farm to trial the new crop.

Evidence is mixed regarding the effect of extension access on adoption intensity. Teklewold et al. (2006) find it has no effect on adoption intensity, whereas Baidu-Forson (1999) shows that it increases adoption intensity. Duflo et al. (2007) also show that follow-up information is critical in determining the continued use of a technology after a trial. More long-term than short-term NAADS participants wanted to increase the amount of information and advice they received on their farms, demonstrating a perceived value in the information from the NAADS. This, together with only long-term NAADS participants being willing to pay for advice, suggests that information and advice are important to those who perceive it to be of good quality and offering a positive cost-benefit return. If the crop fails for the 20% who do not trial, then it is likely that these farmers will not risk trying another experimental crop and will continue to grow crops with lower potential productivity and value and thus be trapped in a poverty cycle. The failure to trial the crop may make these individuals more susceptible to poor advice. Conversely, if these farmers are those who perceive the quality of information to be high and are most likely to be willing to pay for extension advice, their future perceptions will deteriorate and their willingness to pay will be severely reduced if their crop fails for controllable reasons such as lack of inputs, problem identification or poor implementation.

WCC-3 (2009) highlights the need for information to come from a trusted source, with community experts agreeing that communities will tend to more fully implement advice from sources in which they have high levels of trust. To increase the adoption of the new crop varieties, it is important that during the trial phase (or first planting for those who skip the trial phase), follow-up information and support are provided from a trusted source. Trust in the information provided by NAADS was higher the longer the participation; longer participation was also shown to increase the demand for information from the program. NAADS can thus be considered a good channel for information dissemination because it is seen as a trusted

source and NAADS access is therefore likely to increase the adoption of new crops. The evidence presented in this section suggests that longer NAADS association may increase actual new crop adoption, thereby potentially increasing productivity and income. This suggests that the effect of accessing NAADS advice is cost beneficial and thus the advice could be supplied, in time, through private channels.

A factor described as significant by farmers in their crop choice is what their neighbors grow. Respondents saw neighbors as a trusted source of information, indicating that this could be a strategy to reduce the learning cost associated with adoption and increase information associated with their farming system options. The formation of farmers' associations has been shown to increase the flow of information and, according to the livelihood survey, these associations carry a high level of trust. This suggests that farmer associations are a vital channel for information dissemination in Uganda. The Monte Carlo analysis showed that longer participation in NAADS significantly increased the level of membership of farmer associations, which means that information is likely to be spread to members of associations that do not have direct NAADS access. This suggests there is a positive multiplier effect associated with those individuals who do access the NAADS services and therefore these individuals should not be expected to pay the full cost of the services.

This section has shown that some farmers are willing to pay for the NAADS and that NAADS is potentially a good channel for providing trusted information to the farm level and thus increasing adoption.

5.4 Effect of NAADS participation on risk and vulnerability

The perceived risk associated with the adoption of a new farming system has been shown as important in farmers' adoption decisions (Marra et al., 2003) and was therefore included as an attribute in the choice experiment. Access to extension services also potentially reduces the individual's vulnerability to a range of risks by increasing market access and input supply, improving credit access and identifying disease, all of which were highlighted by respondents in the livelihood survey as barriers to the adoption of new technologies. There is some evidence from the choice experiment that longer NAADS participation increased the willingness to use more complex farming systems, proxied by crop diversity. Choice experiment evidence does not, however, suggest that longer NAADS participation changed individuals' willingness to take on different or higher risks.

The adoption of new methods and higher technology levels is generally associated with reductions in the risk and vulnerability of farm systems. Evidence that access to extension advice about technology adoption may reduce risk vulnerability is mixed: Baidu-Forson (1999), Beckford (2002) and Awotide et al. (2004) find it to be significant, whereas Chirwa (2005) and Amsalu and De Graaff (2007) report the effect of extension access as insignificant. Data from the livelihood survey and Monte Carlo analysis in this paper allow some insights into the specific role of NAADS in reducing risk and vulnerability within the farming system.

The Monte Carlo analysis of the livelihood survey data collected in Uganda about individuals' farm systems strongly suggests that longer NAADS participation was linked to higher technology levels on farms, since the long-term participants reported higher use of chemical fertilizer and irrigation on their farms than the other two groups (Table 3). Using these technologies helps to buffer a farm against nutrient loss and drought and increases yields and reduces the farm's vulnerability to shocks. Longer NAADS participation is also associated with higher levels of adaptation to perceived climate changes, which suggests a

greater level of flexibility in the farming system and consequently a reduction in vulnerability. The reduction in vulnerability is a significant benefit associated with NAADS participation and could explain the welfare improving effect of NAADS identified in Section 5.2 above. If this is perceived by farmers, then it is likely that those who are willing to pay for NAADS consider the protection against farm vulnerability to be cost beneficial. This also suggests that the NAADS should target those who are most vulnerable: the reduction in vulnerability and increase in trust and adaptation will then be likely to feed through to a potential willingness to pay on the part of all the NAADS participants.

7. Conclusion

This paper used a choice experiment model to assess farmers' willingness to pay for agricultural extension services and adopt new crop varieties, and the nature of the risks they are willing to bear. The multinomial logit model for short-, medium- and long-term participants in NAADS (43%, 18% and 39% of the total sample, respectively) provided a statistically sound portrayal of individuals' preferences.

Length of NAADS participation is shown to affect the willingness to pay for the services and this paper has offered a number of insights into the effects at the farm level that may contribute to this. The analysis of the choice experiment results demonstrated that there exists a willingness to pay a small amount (UGX380 = US\$0.20) for the services offered by NAADS. The study further demonstrates that willingness to pay is closely linked to NAADS association over time and is likely to be affected by the perceived quality of the services.

NAADS was designed to respond more effectively to the needs of farmers and help improve their livelihoods. The perception of respondents was that this is being done. Crucially, income data analysis suggested that NAADS does, over time, improve individuals' welfare. This welfare improvement is likely to be sustained, as NAADS was also shown to reduce vulnerability at the farm level; longer participation was associated with increased technology use and greater flexibility in adapting to change.

Farmers in the sample were in favor of introducing new crops on their farms, and the majority said they would run some form of trial before introducing them. They recognized that support during the initial introduction stages needs to be provided by a trusted information source. The analysis suggested that NAADS information is trusted by those with experience of the program and that this trust increases over time. The quality of the information provided by NAADS was considered higher by those who had been participants longer and this fed through to NAADS being considered a good channel for information dissemination. It was also associated with increased access to other information channels such as farmers' associations. A further key information channel was farmer's neighbors. This suggests that the NAADS advice accessed by farmers has high potential multiplier effects through farmers' local business and social networks.

NAADS appears to have a positive cost-benefit return at the farm level, which suggests that farmers may be willing to pay for the services. However, the significant multiplier effects mean that those accessing the information are also increasing the information available to others and therefore should not be asked to pay the full economic cost of the service. The data suggest that there is a need to first introduce a 'free' service targeted at the poor and vulnerable, so that farmers' vulnerability is reduced. It is likely that these farmers will then

perceive a benefit from the service and this will feed through into a general willingness to pay.

While this issue requires further country- and topic-specific research, the preferences identified in this paper support the view that the previously widespread failure to increase agricultural productivity in Uganda is due to a failure of the institutions responsible for the research, distribution and dissemination of agricultural technologies and information. A dynamic and effective extension service can serve to increase farmers' awareness of options and address the science-practice gaps. Although there remain issues to be addressed, the preference results here suggest that the farmer-NAADS relationship is cost beneficial at the farm level, improves the participants' welfare and develops over time.

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