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IFAMA Business Office • P.O. Box 14145 • College Station, TX 77841-4145, USA
Tel: 1-979-845-2118 • Fax: 1-979-862-1487 • E-mail: ifamr@ifama.org • Web: http://www.ifama.org

International Food and Agribusiness Management Review
Volume 15, Issue 1, 2012

Table of Contents

RESEARCH

CASE STUDY

INDUSTRY SPEAKS

International Food and Agribusiness Management Review
Volume 15, Issue 1, 2012

EDITOR'S NOTE

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This issue features a Best Paper finalist from our June 2011 meeting in Frankfurt, a neat paper on dairy markets from the USDA, Washington, including authors from Europe, Taiwan, Brazil, and an important teaching case study focused on developing supply chains in developing countries. This was the case study utilized in the 2011 Student Case Competition in Frankfurt. Be sure to check out the video links where authors provide two minute video introductions on YouTube.

Finally, we are proud to serve the needs of scholars who would like to produce a special issue. Special issues can serve to elevate the impact of conferences, research projects, or industry collaborations. The Western Committee focused on Agribusiness provided the impetus for a recent special issue on the scholarship of Agribusiness. The Wageningen Conference on Chain and Network Management will produce a special issue later this year on the subject of "Wicked Problems." Wicked problems refers to the managerial problems firms face in complex business environments affected by environmental and social expectations. Finally, a special issue exploring the topic of human capital development is due to be released during the 2012 Shanghai conference in June. It will be available both in hard copy (and online). The issue is sponsored by industry and will contain 10-15 essays on developing agribusiness talent for the global marketplace.

Do not hesitate to contact me if you would like to produce a special issue of the IFAMR.

Peter Goldsmith, Executive Editor, IFAMR

International Food and Agribusiness Management Review
Volume 15, Issue 1, 2012

The Relationship Between Members' Trust and Participation in the Governance of Cooperatives: The Role of Organizational Commitment

Valérie Barraud-Didier[a], Marie-Christine Henninger [Φb] and Assâad El Akremi[c]

[a] *Professor, University of Toulouse (Institut National Polytechnique - Ecole Nationale Supérieure Agronomique de Toulouse) Department of Economics, Social and Management Sciences, Avenue de l'Agrobiopole, BP 32607, 31326 Castanet Tolosan, France*

[b] *Professor, University of Toulouse 2, Le Mirail, Department of Economics and Management Sciences, 5, Allées Antonio Machado, 31058 Toulouse, France*

[c] *Professor, University of Toulouse 1, Capitole, CRM, 2, rue du Doyen Gabriel Marty, 31042 Toulouse, France*

Abstract

This paper aims to explain the participative behavior of farmers-members of agricultural cooperatives in the governance of the latter. The study introduces two concepts from the organizational behavior literature: trust and organizational commitment. It tests a mediator effect of commitment in the relationship between the trust a farmer has in the cooperative and his/her participative behavior in its governance. Based on a sample of 259 members of French agricultural cooperatives, results showed that affective commitment had a mediating role in the relationship between trust and participation in the governance of cooperatives, notwithstanding the cognitive or affective nature of trust.

Keywords: Organizational commitment, cooperative members

[Φ]Corresponding author: Tel: + 33 561.502.506
Email: marie-christine.henninger@univ-tlse2.fr
V. Barraud-Didier: valerie.barraud-didier@ensat.fr
A. E. Akremi: assaad.el-akremi@univ-tlse1.fr

Introduction

Agricultural cooperatives are created by farmers to pool their means and increase their negotiating power on the market (Fulton and Hueth 2009). By definition, they are controlled by their members (Siebert and Park 2010). By belonging to a cooperative, farmers subscribe to a share of the capital and, they participate, as partners, in the running of the cooperative according to the democratic principal of "one man one vote". Now, certain studies have noted a decrease in members' participation in the democratic life of cooperatives even if these are indeed their "own" (Harte 1997; Holmström 1999; Levi and Davis 2008; Siebert and Park 2010). Whether members behave opportunistically (Cook 1995; Nilsson et al. 2009) or as free-riders (Bhuyan 2007), the main reason for this change in farmers' behavior seems to lie in the phenomenon of concentration and restructuring of agricultural cooperatives (Fulton and Giannakas 2001; Lang and Fulton 2004). In certain cases, farmers find themselves in huge cooperative groups; these are diversified and international with strategy so complex that farmers find it difficult to understand (Österberg and Nilsson 2009). In view of their members' detachment, it is important that cooperatives understand such attitudes and behaviors, for members contribute to the cooperatives' performance (Fulton and Adamowicz 1993; Birchall and Simmons 2004; Bhuyan 2007). The success of a cooperative depends on the degree of participation of its members, as is shown in Österberg and Nilsson's study (2009) carried out with over 2000 Swedish farmers. As voluntary organizations, cooperatives are based on a democratic decision-making process that rests upon collective participation, balance of countervailing powers, and cohesion among members (Hendriske and Bijman 2002). Moreover, members' participation in the governance of a cooperative is the distinctive characteristic of this form of organization (Gray and Kraenzle 1998). However, very few studies in management and organizational behavior have investigated the behaviors of farmers and the antecedents of these behaviors in the specific context of cooperatives (Hansen et al. 2002; Morrow et al. 2004).

The aim of this paper is to explore and test the mediator role of organizational commitment in the relationship between trust and members' participation in the governance of French agricultural cooperatives. These concepts are generally used in the organizational behavior literature to describe the relationship between an employee and his/her employer. Nevertheless, even if farmers are usually autonomous and independent workers, their relationship with their cooperative can be seen as a social exchange link in which trust and commitment are central phenomena (Blau 1964; Gouldner 1960). As participants in cooperative relationships, farmers desire: "(1) reciprocity, by which one is morally obligated to give something in return for something received (Gouldner 1960), (2) fair rates of exchange between utilitarian costs and benefits (Blau 1964), and (3) distributive justice, through which all parties receive benefits that are proportional to their investments" (Ring and Van de Ven 1992, 489). Further, the literature on cooperatives often makes use of trust to explain members' behavior (Birchall and Simmons 2004; Hansen et al. 2002; James and Sykuta 2006; Morrow et al. 2004), but this use has not been yet explored through the lens of a social exchange framework. Also, organizational commitment which is a multidimensional attitudinal concept devoted to describe the relationship between an individual and an organization, has not yet, to our knowledge, been studied in the context of agricultural cooperatives. Nevertheless, many studies show that commitment is both a consequence of trust (Dirks and Ferrin 2002; Mayer and Gavin 2005) and a determinant of participative behaviors

within an organization (Podsakoff et al. 2000; LePine et al. 2002). This paper integrates these different concepts and tests their links in the context of agricultural cooperatives.

The first part of this article deals with the theoretical framework. The second covers the methodological aspects of the study carried out on a sample of 259 members of French agricultural cooperatives in the cereals sector. The third part focuses on the results and the fourth on a discussion of these. The limitations and perspectives for future research are covered in the final part.

Theoretical Framework and Hypotheses

Members' Trust and Participation in the Cooperative

Trust is a "psychological state which consists of accepting the vulnerability resulting from the positive expectations of the intentions or behaviors of the other" (Rousseau et al. 1998, 394). Members' vulnerability towards the cooperative can be understood in view of their dependence on the latter in terms of revenue and information. The relationship between member and cooperative is based on information asymmetry: the cooperative holds information which the member does not: this may be information on market prices, or again on clients' behavior (Borgen 2001). It is this uncertainty about the behaviors of one of the parties of the exchange which makes trust a determinant of the attitudes and behaviors of the other party (Kollock 2009; Ring and Van de Ven 1992).

As in the work which Hansen et al. (2002) and Morrow et al. (2004) carried out in agricultural cooperatives, we retain the theoretical perspective focusing on the mental and psychological processes which determine the member's decision to put his or her trust in the cooperative. The decision to grant trust depends on processes which may be both conscious and cognitive or emotional and affective (Hansen and Morrow 2003; McAllister 1995; Schaubroeck et al. 2011). For McAllister (1995), although these two components of trust (cognitive and affective) are distinct because they have different antecedents and consequences, they are complementary. Indeed members may trust their cooperative both because it is competent, reliable and conscientious in making the best decisions and also because it shows goodwill and they feel that its intentions towards them are good (Hansen and Morrow 2003).

The cognitive component of trust is based on a considered and rational analysis of the "pros and cons" of the decision to trust. This decision is made by calculating the advantages and risks in order to maximize the hoped for gains or minimize the potential losses resulting from the interaction (Colquitt et al. 2007; Erdem and Ozen 2003). Members choose to trust their cooperative depending on what they consider to be "the right reasons". This choice depends on the information they have about the cooperative and is based on their beliefs about its competence, reliability and conscientiousness. Members thus evaluate the cooperative's capacity to satisfy their needs and create added value which is to their advantage (Theuvsen and Franz 2007). As for the affective component, it is based on more emotional and affective relationships between the two parties. "Individuals who commit emotionally to a relationship of trust show a sincere and special attention to the well-being of others" (McAllister 1995, 29). The affective component is based on a feeling of goodwill, mutual generosity and affective closeness between the parties. Hence, each party commits emotionally to a positive relationship, is truly concerned about the well-being of

the other party and believes that these feelings are mutual (Colquitt et al. 2007; Erdem and Ozen 2003). Consequently, if the cooperative pays attention to members showing itself to be highly concerned about them, the members will have an attitude of trust towards it. The affective component is therefore more subjective and emotional than the cognitive component.

In a relationship of exchange, trust is often used to explain an individual's behaviors towards his/her organization (Ferrin and Dirks 2003; Kramer 2009). The social exchange between two parties includes non-specified mutual obligations which are long-term; this is unlike economic exchange where a formal contract is used to ensure that both parties fulfill their short-term obligations (Blau 1964). The theory of social exchange is mainly based on Gouldner's norm of reciprocity (1960) which refers to the fact of being obliged to the other party from the moment that the latter acts in favor of the former (Cropanzano and Mitchell 2005; Shore et al. 2009). Thus, according to this theory, when mutually favorable actions take place between a cooperative member and the cooperative, the relation of exchange should be a lasting one where mutual obligations will be reinforced and respected. From the moment that the farmer is confident that the cooperative will fulfill its future obligations (find the best market for the crop, provide the best advice, etc.), he or she will act reciprocally and behave favorably towards the cooperative. Studies carried out on members' participation show clearly that trust is one of the main determinants of farmers' behavior. Based on a sample of over 2000 American corn and soya producers, James and Sykuta (2006) showed that trust is linked to members' behavior of loyalty towards their cooperative. Trust constitutes a determining factor in their choice to sell their crop to the cooperative rather than to a private entity. Nilsson et al. (2009) as well as Österberg and Nilsson (2009) found from samples of Swedish farmers, that trust is linked to members' participative behavior in their cooperative's governance. Also, Birchall and Simmons (2004) tested a model of the members' motivation to participate to the governance of their cooperative, and found that trust has a central role into farmers' participative processes.

Members' behaviors of participation in the governance of their cooperative may be displayed in various ways. A member may become an administrator of his/her cooperative. He or she will thus participate directly in the cooperative's governance because an administrator guides and controls the cooperative's strategy. He or she is the guarantor of its purpose and its long-term survival (Siebert and Park 2010). A member may also participate more indirectly in this governance during Annual General Meetings (AGM). The AGM is one of the members' means of expression, ensuring that the cooperative is run democratically according to the principal of "one man one vote". During the AGM, members participate in choosing for example, how the cooperative's outcomes will be spent or again in the election of administrators. Democracy within the cooperative takes the form of delegated democracy and is based on the results of this election. Nevertheless, cooperative democracy may also be participative. Members can increase their role in decision-making and in the cooperative's political life by taking part in non-statutory instances (section meetings, diverse commissions, etc.). The above types of participation are left to the discretion of each individual. There is no control, no sanction, and no reward or prize linked to farmers' participation to the governance of their cooperative. Consequently, a member's participation in the governance of the cooperative is conceptually similar to an organizational citizenship behavior of civic virtue. It is defined as an individual's mobilization and active participation in the life of his/her organization, and the fact of feeling concerned by what goes on within that organization (Organ 1988; Organ, Podsakoff, and Mackenzie 2006). It refers to responsible par-

ticipation in the political life of an organization (Graham 1991; Van Dyne et al. 1994). The interest of such behaviors for an organization is that they engender better performance (Podsakoff et al. 2009; Whitman, Van Rooy, and Viswesvaran 2010). This type of behavior can thus encourage the success of farming cooperatives (Gray and Kraenzle 1998; Bhuyan 2007).

The Mediating Role of Organizational Commitment

In this study, we suppose that organizational commitment plays a mediating role in the relationship between trust and members' involvement in the governance of their cooperative. Commitment is a multidimensional attitudinal construct which allows explaining the relationship between an individual and an organization (Meyer et al. 2002; Solinger et al. 2008). There are three components to this concept (affective, continuance and normative), but we focus on only two of these since the normative dimension is often excluded as too strongly correlated with the affective dimension (Meyer et al. 2002; Cooper-Hakim and Viswesvaran 2005). Hence, a member's commitment may be "desired": this is the affective component of the concept which corresponds to an emotional attachment, a feeling of belonging and a wish to remain a member of the organization. A member may also concede commitment because he or she feels that there is no other choice but to remain a member of the cooperative since leaving it would entail costs and the loss of acquired advantages. This is the continuance component of organizational commitment.

Previous research has shown that commitment is determined by trust. In marketing literature, several authors have highlighted the central role of trust (Moorman et al. 1993) and found a positive relationship between trust and commitment (Morgan and Hunt 1994; Wilson 1995). According to Dwyer, Schurr, and Oh (1987), commitment represents a relational bond between interdependent exchange partners, and connotes solidarity, durability, and consistency. These criteria underline the importance of trust as an antecedent of commitment. In human resource management, some authors found a positive link between affective commitment and trust (Aryee et al. 2002; Flaherty and Pappas 2000; Tan and Lim 2009). Others have also found a positive relationship between trust and continuance commitment (Hrebiniak and Alutto 1972). In the cooperative context and to our knowledge, organizational commitment has not been used to explain a members' attitude or behavior. However, Borgen (2001) has shown that there is a link between trust and members' identification with their cooperative; this identification covers part of the affective dimension of commitment as defined by Meyer and Allen (1997). Gray and Kraenzle (1998) also underlined the importance of members' identification with their cooperative. On the basis of a sample of over 1000 farmers, 60% identify strongly or very strongly with their cooperative. Thus, prior research posits a global positive influence of trust on organizational commitment whatever the dimensions of one construct and the other are. Following current standards of measurement of trust (McAllister 1995) and organizational commitment (Meyer et al. 2002), we make the hypothesis of positive links among various dimensions of both trust and commitment.

While the type of commitment (affective or continuance) does not seem to be a determining factor in the link between commitment and trust, this does not appear to be the case for the link between commitment and participation behaviors which are favorable for the organization. Affective commitment is positively linked to participation whereas continuance commitment is linked negatively or not significantly (Chen and Francesco 2003; Meyer et al. 2002; Norris-Watts and Levy 2004). Thus, we may expect that members who feel affective commitment towards their

cooperative behave positively towards it. On the other hand, members who remain within the cooperative because of their perception that the costs of leaving it are too high or because they have no alternative but to continue their membership (continuance commitment), may have feelings of frustration which result in distancing behaviors and non participation in cooperative governance.

We thus posit the following hypotheses:

Hypothesis 1: Members' affective commitment will positively mediate the relationship between affective trust in their cooperative and participation in its governance.

Hypothesis 2: Members' affective commitment will positively mediate the relationship between their cognitive trust in the cooperative and their participation in its governance.

Hypothesis 3: Continuance commitment will negatively mediate the relationship between members' affective trust in their cooperative and their participation in its governance.

Hypothesis 4: Continuance commitment will negatively mediate the relationship between members' cognitive trust in their cooperative and their participation in its governance.

The hypothetical model is shown in Figure 1.

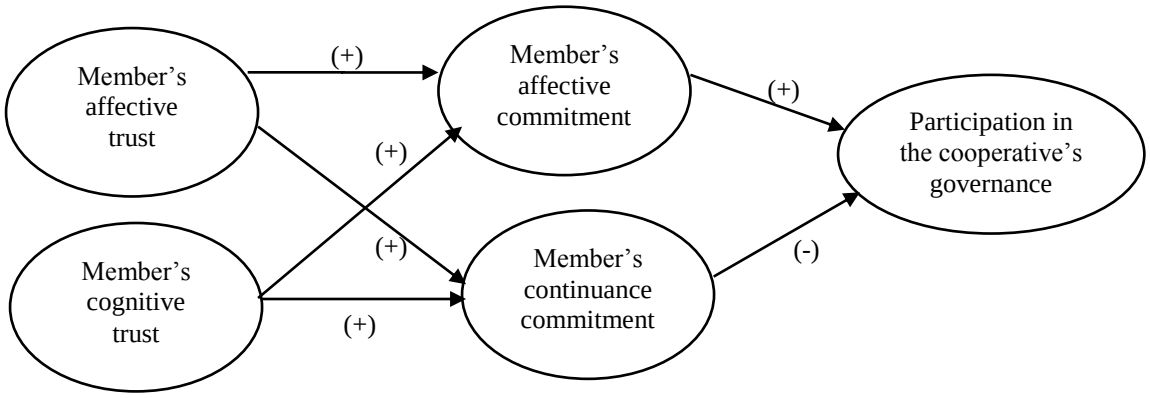

Figure 1. Hypothetical Model of the Research

Methods

Sample

The total sample consists of 322 farmer-members from French agricultural cooperatives from the cereal-supply sector. These cooperatives are located in the Midi-Pyrénées region of France where cereal production is a dominant activity and where cooperatives occupy a preponderant position. Farmers were encountered between 2007 and 2008. Some of them were encountered on the site of their cooperatives and others were contacted during several agricultural regional events unrelated to their cooperatives, for example agricultural shows. They were issued with a survey questionnaire which was followed up by a reminder phone-call. This methodology result-

ed in a highly satisfactory return rate of 58%. However, missing values reduced the sample used in this research to 259 farmers. The cooperative members questioned had an average age of 47 years; 38% were educated to the *Baccalaureate* (high school diploma) level or higher, and 62% to a lower educational level (no high school diploma). Men represent 92% of the sample. On average, members questioned had been members of their cooperative for 20 years (*SD.* = 12 years). Their farms have an average net agricultural surface area of 127 hectares.

Measures

For the set of items related to trust, commitment and participation in cooperative governance, respondents had to mention their degree of agreement according to a Likert type 5 point scale (from 1: *Totally disagree* to 5: *Totally agree*)

Trust. Farmers see their trust in the cooperative as the trust they grant to the cooperative's directors[1]. For farmers, the management team "is responsible for ensuring both good profitability for members and higher quality services from the cooperative" (Österberg and Nilsson 2009, 187). On the basis of Levinson's (1965) research, members personify the cooperative by attributing it with the human qualities of its directors. This is why we retained a measure of trust in the directors, as proposed by Campoy and Neveu (2007). This measure has two advantages: firstly it captures both the affective and cognitive components of trust proposed by McAllister (1995), and secondly, it has already been tested in a French context. Affective trust comprises 6 items. This scale had very high internal reliability with a Cronbach alpha of 0.90. "*I can trust the cooperative's directors because they sincerely share information about the cooperative*" is an example of an item from this scale. Cognitive trust groups 8 items. Its Cronbach alpha was 0.94. "*I can trust directors to make the right decisions about the future of the cooperative because they are competent*" is one of these 8 items.

Commitment. We measured commitment with the scale developed by Allen and Meyer (1990) and revised by Meyer et al. (1993). We adapted the items to the farmer-cooperative relationship. Thus affective commitment retains 6 items and Cronbach's alpha was 0.83. "*I feel emotionally attached to my cooperative*" is an example of an item from this scale. Continuance commitment, with a Cronbach alpha of 0.80, is comprised of 4 items, such as "*I think I have too few alternatives to consider leaving my cooperative*".

Participation in cooperative governance. The measure was inspired by the three items developed by Podsakoff et al. (1990), and Podsakoff and MacKensie (1994) to measure civic virtue behaviors. We adapted these items to measure the participation in governance in the context of agricultural cooperatives. Thus, on the basis of the original first item, relative to the individual propensity to remain informed about the organization future, we considered that the farmer's attendance to the cooperative's General Meetings is an indicator of this propensity. Also, the second item measured the farmer's active participation to votes in General Meetings and elections. The third item measured the voice and speaking up behaviors during the cooperative meetings. The Cronbach alpha of these three items was 0.74.

[1] Statement based on the results of a qualitative study previously carried out by the authors using interviews.

Control variables. Three control variables were used because they are often associated with the variables of our model: age, members' level of education and the size of the farm. (Meyer et al. 2002; Lind and Akesson 2005; Hoffman et al. 2007). We account for educational level under 5 terms: (1: no qualifications, 2: five years of education, *certificat d'études* - a secondary school diploma equivalent to five years of education, 3: 10 years of education *Brevet Professional* basic professional qualification equivalent to 10 years of education, 4: High school diploma *Baccalaureate*, 5: 2 years post High School and above). The size of the farm was determined using the indicator of net agricultural surface area measured in hectares. Indeed, farmers may display different attitudes or behaviors towards the cooperative depending on their age, education, or the size of the farm under their responsibility (Klein et al. 1997; Hansen et al. 2002; Österberg and Nilsson 2009).

Statistical Analyses

We firstly tested the measurement model with a series of confirmatory factor analyses (CFA) according to the procedure recommended by Anderson and Gerbing (1988) and using structural equations modeling with LISREL 8.80 (Jöreskog and Sörbom 1996). These confirmatory factor analyses allowed to ensure the convergent and discriminant validity of the variables retained in the study. Several nested models were compared with our hypothetical measurement model in order to show that our model fits better the data. Secondly, we tested our hypotheses about commitment as mediator using the *bootstrap* method for testing indirect effects *(*Preacher and Hayes 2008). We also used the Sobel test of significance of indirect effects as recommended by MacKinnon et al. (2002).

Tests for mediation effects often use the "step by step" procedure proposed by Baron and Kenny (1986). However, this procedure suffers from certain limits. Thus, its statistical power is limited in most situations and particularly in those where the sample under study is a small one with a non-normal distribution; moreover, the first step is not suitable as it requires a questionable significant direct link between the independent and dependent variables (MacKinnon et al. 2002). Furthermore, Preacher and Hayes (2008) suggested that "type I errors" are likely to occur with Baron and Kenny's (1986) method. This type of error may result in erroneous conclusions about the mediation effect.

The above reasons explain why we used the *bootstrap* method for indirect effects. This method for testing mediation effects is a recent alternative to Baron and Kenny's (1986) procedure. It overcomes the limits of the latter, notably by using confidence intervals to get around the problem of statistical power (Edwards and Lambert 2007; MacKinnon et al. 2002) and decrease type I errors (Preacher and Hayes 2008). Based on Preacher and Hayes's works (2008), the *bootstrap* method relies on using a SPSS macro which combines the Sobel test with a step by step procedure; this makes it possible to test all the indirect effects of mediation while at the same time controlling for the other variables of the model. Our analyses were based on 5000 replications generated by the *bootstrap* method.

Results

The descriptive statistics, reliability of scales and correlations between variables are shown in Table 1.

Table 1. Means, Standard Deviations and Correlations

	M	SD	1	2	3	4	5	6	7	8
1. Age	46.5	9.83								
2. Level of education	3.59	1.35	-0.35**							
3. Net agricultural surface	127.	83.36	-0.18*	0.23**						
4. Affective commitment	3.12	0.81	0.23**	-0.16*	-0.10	(0.83)				
5. Continuance commitment	2.76	0.75	0.14*	-0.18*	-0.21*	0.43**	(0.80)			
6. Affective trust	3.47	0.75	0.06	-0.11	0.00	0.71**	0.55**	(0.90)		
7. Cognitive trust	3.68	0.74	-0.12†	-0.11†	0.02	0.66**	0.50**	0.87*	(0.94)	
8. Participation in the cooperative governance	2.73	1.05	0.10	0.02	0.10	0.36**	0.02	0.22*	0.22*	(0.74)

N = 259, Cronbach's Alpha is presented on the diagonal
†p<.10; *p<.05; **p<.01

Analysis of the Common Method Variance Bias

We tested the common method variance bias in as much as the data were collected from the same persons on a single period of measurement (Podsakoff et al. 2003). To limit such bias, we followed Podsakoff et al.'s (2003) recommendations. First, we separated predictor and criterion variables sections in survey questionnaires, insured response confidentiality, and explicitly assured the participants that there were no right or wrong answers to the survey questions. We also distributed the surveys directly to the farmers, who returned them directly to the study team. Over and above these precautions, we carried out a series of statistical analyses recommended by Podsakoff et al. (2003) in order to check whether the data were affected by the Common Method Variance bias. We first examined a single factor model for data (i.e., Harman's single factor test). This test revealed a very poor fit to the data (cf. Table 2); this indicated the weak probability of the existence of a hypothetical common method factor (χ^2 [319] = 2273.75, p < .001, CFI = .91, NNFI = .90, RMSEA = .154).

Second, we tested the baseline measurement model with an additional latent common method factor (LCMF) on which every item in the baseline model was allowed to load (in addition to its loading on its respective construct). This model presents a level of fit which is very slightly better than that of our hypothetical model ($\Delta\chi^2$ [6] = 28.77, p<.001; RMSEA = .07). However, the LCMF accounted for only 7% of the total variance, which is considerably less than the median method variance (25%) in studies of self-reported perceptions (Lance et al. 2010; Williams, Cote and Buckley, 1989). In addition, correlations among substantive latent factors were virtually the same whether generated by the CFA with or without the LCMF. Together, these results indicate the absence of CMV bias.

Confirmatory Factor Analysis

As shown in Table 2, six measurement models were compared using several fit indices. The χ^2 test should give the smallest possible value, the CFI[2] and the NNFI[3] should be higher, at .90, the RMSEA[4] should be less than .08 (Kline 2010). To compare the goodness of fit of the nested models, the difference of χ^2 test ($\Delta\chi^2$) was retained (Medsker et al. 1994). The hypothetical model included five factors: affective trust, cognitive trust, affective commitment, continuance commitment and participation in the governance of the cooperative. Table 2 shows that the fit of this model to the data was highly satisfactory (χ^2 = 804.66, df. = 309, p<.001; NNFI = .96; CFI = .96; RMSEA = .07).

This model was compared to five others: model 1 (4 factors) combined affective trust and cognitive trust in one construct ($\Delta\chi^2$ = 393.68, Δdf = 4, p<.01); model 2 (3 factors) merged in one construct affective trust and cognitive trust and as another, affective and continuance commitment ($\Delta\chi^2$ = 527.85, Δdf = 7, p<.01); model 3 (3 factors) integrated affective commitment and affective trust and continuance commitment and cognitive trust ($\Delta\chi^2$ = 758.94, Δdf = 7, p<.01); model 4 (2 factors) merged both types of trust and both types of commitment into the same construct ($\Delta\chi^2$ = 1187.76, Δdf = 9, p<.01); and finally, model 5 was made up of only one factor (Harman 1976) ($\Delta\chi^2$ = 1469.09, Δdf = 10, p<.01).

These analyses show that the hypothetical model is the one that presents the best fit to the data. In spite of the strong correlation between affective trust and cognitive trust, these two constructs are therefore distinct according to our Confirmatory Factor Analyses. Previous research also showed up this strong correlation while maintaining the same distinction (McAllister 1995; Yang and Mossholder 2010).

Table 2. Confirmatory Factor Analysis of Measurement Models: Fit Indices

Models	**χ^2**	**df**	**$\Delta\chi^2$**	**Δdf**	**NNFI**	**CFI**	**RMSEA**
Hypothetical model	804.66	309	-	-	0.96	0.96	0.07
Model 1[a]	1198.34	313	393.68**	4	0.95	0.95	0.10
Model 2[b]	1332.51	316	527.85**	7	0.94	0.95	0.11
Model 3[c]	1563.60	316	758.94**	7	0.93	0.94	0.12
Model 4[d]	1992.42	318	1187.76**	9	0.92	0.93	0.14
Model 5[e]	2273.75	319	1469.09**	10	0.90	0.91	0.15

N=259

[a] combines affective and cognitive trust.

[b] combines affective and cognitive trust and affective commitment and calculated commitment.

[c] combines affective trust and affective commitment and cognitive trust and calculated commitment.

[d] combines affective trust, cognitive trust, affective commitment, calculated commitment.

[e] combines the 5 constructs (Harman's test, 1976).

** p < .01.

[2] Comparative Fit Index.

[3] Non Normed Fit Index.

[4] Root-Mean-Square Error of Approximation.

Test of the Hypotheses on the Mediator Effect of Commitment

We tested the indirect effects of affective and cognitive trust on participation in the governance of the cooperative *via* affective and continuance commitment using the *bootstrap* procedure recommended by Preacher and Hayes (2008). Table 3 shows the regression coefficients of the mediator effect of *affective commitment* in the relationships between affective and cognitive trust and members' participation behavior in cooperative governance. In Table 4, we present the results of the test of the mediator effect of *continuance commitment* in the relationships between trust and participation in cooperative governance.

Hypothesis 1 specified that the members' affective commitment acts as a positive mediator in the relationship between affective trust in their cooperative and participation in its governance. Affective trust was positively and significantly linked to affective commitment ($\beta = .58$, $p<.01$); the latter also had a positive and significant impact on participation ($\beta = .38$, $p<.01$). Sobel's test of the significance of the indirect effect of affective trust on a member's participation was satisfactory ($z = 3.59$; $p<.001$). The *bootstrap* confidence interval [.07; .40] did not contain zero, thus it corresponds to the criterion of significance of the mediator effect (Preacher and Hayes 2008). Hypothesis 1 was thus verified.

According to Hypothesis 2, members' affective commitment acts as a positive mediator in the relationship between their cognitive trust in the cooperative and their participation in its governance. Cognitive trust was positively and significantly linked to affective commitment ($\beta = .56$, $p<.01$). Affective commitment was also positively and significantly linked to participation in the cooperative's governance ($\beta = .37$, $p<.01$). The Sobel test was consistent with this result ($z = 3.56$; $p<.001$). This result was also confirmed by the *bootstrap* test with a confidence interval excluding the null value [.08; .39]. Hypothesis 2 was also verified.

In Hypothesis 3, members' continuance commitment acts as a negative mediator in the relationship between their affective trust in their cooperative and their participation in its governance. According to Table 4, affective trust had a significant impact on continuance commitment ($\beta = .50$, $p<.01$). However, the latter was not significantly linked to participation ($\beta = .02$, *ns*.). The Sobel test was not significant ($z = –.08$; *ns*.) and the *bootstrap* confidence interval contained a 0 value [–.10; .12]. Hypothesis 3 was therefore rejected.

Finally, according to hypothesis 4, members' calculated commitment acts as a negative mediator in the relationship between cognitive trust in their cooperative and their participation in its governance. Table 4 shows that cognitive trust significantly influences calculated commitment ($\beta = .51$, $p<.01$). However, calculated commitment is not significantly linked to participation ($\beta = .02$, *ns*.). This result is confirmed both by the Sobel test which is not significant ($Z = –.04$; ns.) and by the confidence interval of the bootstrap which contains a null value [–.09; .12]. Hypothesis 4 is thus not verified.

Table 3. Regression Results for Mediator Effects of Affective Commitment

	Model 1 [a]			**Model 2** [b]		
Variables	β	*SE*	t	β	*SE*	t
Partial effects of control variables						
Age	.01	.00	1.05	.01	.00	1.17
Level of education	.07	.05	1.62	.08	.05	1.63
Net agricultural area	.19*	.09	2.05	.18*	.09	1.98
Direct and total effects						
Effect of affective trust on affective commitment (a)	**.58****	**.05**	**10.72**			
Effect of affective commitment on participation, controlling for affective trust(b)	**.38****	**.09**	**4.02**			
Effect of affective trust on participation (c)	.07	.08	.81			
Effect of affective trust on participation, controlling for affective commitment (c')	-.15	.10	-1.55			
Effect of cognitive trust on affective commitment (a)				**.56****	.06	9.71
Effect of affective commitment on participation, controlling for cognitive trust (b)				**.37****	.09	4.01
Effect of cognitive trust on participation (c)				.06	.08	.70
Effect of cognitive trust on participation, controlling for affective commitment (c')				-.14	.10	-1.47

Indirect effects in cases of normal distribution				
Sobel	Value	*z*	LL 95% CI	UL 95 % CI
Model 1	.21	**3.59****	.10	.33
Model 2	.20	**3.56****	.09	.32

Bootstrap results for indirect effects				
Effect	*M*	*SE*	LL 99% CI	UL 99 % CI
Model 1	.22	.06	**.07**	**.40**
Model 2	.21	.05	**.08**	**.39**

Note. N = 259. The regression coefficients are non standardized. The size of the bootstrap sample = 5000.
LL = lower limit; UL = upper limit; CI = confidence interval. M = mean; SE = standard error.
* $p < .05$; ** $p < .01$.
a.: Affective trust as independent variable and affective commitment as mediator; b.: Cognitive trust as independent variable and affective commitment as mediator.

Table 4. Regression Results for Mediator Effects of Continuance Commitment

	Model 3 [a]			Model 4 [b]		
Variables	β	*SE*	t	β	*SE*	t
Partial effects of control variables						
Age	.01	.00	1.64	.01	.00	1.60
Level of education	.07	.05	1.47	.08	.05	1.46
Net agricultural area	.15	.09	1.55	.15	.09	1.58
Direct and total effects						
Effect of affective trust on continuance commitment (a)	**.50****	**.07**	**7.28**			
Effect of continuance commitment on participation, controlling for affective trust (b)	**.02**	**.07**	**.26**			
Effect of affective trust on participation (c)	.07	.08	.81			
Effect of affective trust on participation, controlling for continuance commitment (c')	.06	.09	.63			
Effect of cognitive trust on continuance commitment (a)				**.51****	**.07**	**7.06**
Effect of continuance commitment on participation, controlling for cognitive trust (b)				**.02**	**.07**	**.32**
Effect of cognitive trust on participation (c)				.06	.08	.70
Effect of cognitive trust on participation, controlling for continuance commitment (c')				.05	.09	.51

Indirect effects in cases of normal distribution				
Sobel	Value	*z*	LL 95% CI	UL 95 % CI
Model 3	-.01	**-.08**	**-.08**	**.07**
Model 4	-.00	**-.04**	**-.08**	**.08**

Results of Bootstrap for indirect effects				
Effect	*M*	*ES*	LL 99% CI	UL 99 % CI
Model 3	.01	.04	**-.10**	**.12**
Model 4	.01	.04	**-.09**	**.12**

Note. N = 259. The regression coefficients are non standardized. The size of the bootstrap sample = 5000.
LL = lower limit; UL = upper limit; CI = confidence interval. M = mean; SE = standard error.
* $p < .05$; ** $p < .01$.
a.: Affective trust as variable and continuance commitment as mediator; b.: Cognitive trust as independent variable and continuance commitment as mediator.

Discussion

In order to adapt to a changing economic context which has lead French agricultural cooperatives to modify their structures and strategies, it now seems important to analyze the relationships members develop with their agricultural cooperative. In this paper, we explored the links between trust, organizational commitment and members' participation in the governance of their

cooperative. Previous studies on agricultural cooperatives have shown the importance of members' trust in the managers of their cooperatives, and the participation of members in the life of the cooperative (Fulton and Giannakas 2001; James and Sykuta 2005; Gall and Schroeder 2006). Our research completes these previous studies in the sense that it tested the mediator effect of organizational commitment in the relationship between members' trust and their participative behaviors. We showed that members' trust impacted their participation through their affective commitment and the mediator effect of affective commitment between trust and participation was complete.

The results of this study have shown that trust is the starting point which explains a member's favorable behavior towards his/her cooperative. Members' trust in their cooperative, represented by the directors, depends on the cooperative's capacity to act competently and reliably and to take the right decisions while still showing goodwill, remaining close to members, heedful of their demands and showing strong concern for their interests. The two facets of trust - cognitive trust and affective trust - have an almost identical impact on organizational commitment, whether this be of an affective or continuance nature. This positive link between trust and commitment conforms to that mentioned in previous studies (Flaherty and Pappas 2000; Aryee et al. 2002; Kramer 2009).

Regarding the link between commitment and participation, the results of this study have shown that members participate in the governance of their cooperative when they are attached to it affectively. On the contrary, members' continuance commitment is not significantly linked to participation in the cooperative's governance. These findings are consistent with those of recent studies that found a significant and positive relationship between affective commitment and member's favorable behavior towards the organization (Peng and Chiu 2010; Rezaiean et al. 2010). Results concerning the link between continuance commitment and member's favorable behavior towards the organization lack consistency. Some studies attest to a negative link and others, like our own research, to an absence of significant link (Meyer et al. 2002). However, results obtained for continuance commitment remain coherent with the findings of other studies (Cook 1995; Nilsson et al. 2009). Linking one's economic fate with a cooperative and being aware of the potential losses resulting from leaving it do not exclude individualistic behavior (Bhuyan 2007). In such cases where we would expect a negative effect, our results only show that the economic aspect of this link has no influence on the member's behavior towards the cooperative as far as participation in governance is concerned. Only if the member is affectively attached to the cooperative and trusts the directors, is he or she likely to participate more in its governance independently of his/her continuance commitment. On the other hand, continuance commitment probably retains its potential mediating effect on trust towards other types of behavior which are more closely linked to economic aspects, such as loyalty in terms of supply and sales for example.

Managerial Implications

From a practical point of view, these findings show the directors of agricultural cooperatives that it is useful to create the conditions which generate cooperatives' members' trust because this is a source of affective attachment and favorable behaviors.

The social exchange theory and the norm of reciprocity stipulate that from the moment that mutually favorable actions are developed, the relationship of exchange will be a lasting one and the obligations between the parties will be reinforced and respected (Shore et al. 2009). Thus, the relationship between farmers and their cooperative cannot be maintained unless the cooperative acts favorably towards their members. Indeed, the affective component of trust is determined by the frequency of interactions (McAllister 1995; Levin et al. 2006). We can therefore suppose that if cooperatives communicate more and share information with their members, the latter will be more attached to the cooperative and will feel more at ease in showing greater participation in decision-making. Their participation behaviors will thus be strengthened. The literature shows that practices of information-sharing are considered as the basis of individuals' commitment and motivation (Guerrero and Barraud-Didier 2004; Lawler et al. 1992). Moreover, we can also suppose that if those who represent the cooperative, in other words the directors, adopt altruistic or helpful behaviors towards members (Smith et al. 1983; Organ 1988; Organ et al. 2006), those members will feel obliged to the cooperative and will in exchange adopt favorable attitudes and behaviors towards it, such as participating in its governance.

In a more practical vein, cooperatives have every interest in getting closer to their members by taking as many opportunities as possible to exchange with them and help them. However, this close relationship cannot be set up overnight. The relationship between a member and the cooperative has to be built up gradually over time. Indeed, trust based on affect corresponds to a highly specific relationship, one which is imprinted with goodwill and emotional attachment; as such it is a difficult thing to construct (Jeffries and Reed 2000). Affective trust is associated with an investment in terms of time and feelings; this is far more demanding than in the case of cognitive trust (McAllister 1995; Erdem and Ozen 2003; Hansen and Morrow 2003). In order to build up cognitive trust, the cooperative must show members that it is reliable and competent through its everyday actions. Its reputation depends on this. The cooperative can demonstrate its reliability and competence through the advice it gives members, whether this advice be technical, economic, strategic, environmental or regulatory in nature. Competence can also be shown through decisions made relative to investments, marketing cereals, ensuring outlets, etc. Even if a cooperative has economic objectives, it must not neglect its social relationship with its members.

Limits of Study and Future Avenues of Research

We have shown that members' affective commitment is a mediator in the relationship between the affective and cognitive trust granted to the cooperative and members' participation in its governance. However, the results of this study should not hide a certain number of limitations which enable us to propose future avenues for further research.

The first limit is methodological. The study undertaken is cross-sectional. Yet, the relationship between a member and his/her cooperative is a dynamic one. The member may be in different psychological states at different times during this relationship and to varying degrees. Thus, it would be wise to take account of this evolution of psychological states by undertaking a longitudinal study. Such a study would make it possible to envisage retroactive loops between the member's trust, commitment and participation. Regarding our transversal procedure, a longitudinal study would allow a more robust test of the causal relationships among these three concepts. Nevertheless, we verified whether the "causal chain" presented here was the right one. For this,

by using methods of structural equations we compared our trust-commitment-participation model (χ^2 = 265.78, df. = 111, p<.001; RMSEA = .07) to two other models changing the direction of the relationships among the concepts. Model 1 (participation-commitment-trust) presented poor fit indices (χ^2 = 432.24, df. = 112; RMSEA = .11). The fit indices of model 2 (commitment-trust-participation) were also not as good as those of our model (χ^2 = 289.17, df. = 111; RMSEA = .08).

The second limitation of the study has to do with the exclusion of the normative facet of commitment and the sub-dimensions of continuance commitment. Since the original definition, works on organizational commitment have revealed two sub-dimensions to the continuance component: perceived sacrifice and absence of alternatives (McGee et Ford 1987; Vandenberghe et al. 2004; Vandenberghe 2009). Introducing these two sub-dimensions and the normative dimension into our model would certainly contribute to enriching our knowledge of members' behavior towards their agricultural cooperative. Concerning the concept of trust, we retained the managing directors of the cooperative as targets of trust. However, the direction of a cooperative is a "two-headed beast". The managing directors are employed by an agricultural cooperative to manage it on a day to day basis; but there are also administrative directors. These make up the board whose role is to guide and control the cooperative's strategy. The administrators are farmers who are members of the cooperative elected by their peers in a General Assembly (AGM). It would be interesting to change the target of trust from managing directors to the board: we might then suppose that members would have a higher level of affective trust in the directors of the board of administration than in the managing directors (Vandenberghe 2009). Concerning members' behaviors, we limited ourselves to the behavior of participation in the cooperative's governance. One future research track could explore transactional members' behaviors and their economic loyalty to the cooperative in order to integrate the profit motive in the analysis. Indeed, in an uncertain economic climate, farmers do not hesitate to set their cooperative in competition with others, or even with private dealers. This is why members' loyalty is a central concern for the directors of agricultural cooperatives. Finally, other variables could determine both farmers' participation and economic loyalty such as the level of price received, outcomes satisfaction, the duration of the relationship between a farmer and a cooperative. Including these variables in future research will shed new light on the complex relationships between farmers and cooperatives.

The theory which underlies our model is that of social exchange. This supposes reciprocity between two parties. In order to better understand this exchange, it would be wise to examine the actions which cooperatives could undertake in favor of their members. Indeed, each of the parties needs to believe that the other will fulfill future obligations and each will therefore engage in reciprocity. We suggest, for example, studying the impact which could result from practices of communication and information sharing or of sustainable development and Corporate Social Responsibility on the attitudes and behaviors of members of agricultural cooperatives. Finally, applying the norm of reciprocity to exchanges among members of cooperatives raises the question of membership expansion, power dilution, and voting rights of new members (Hart and Moore 1996). Indeed, "existing members are less willing to invest in the exchange since they anticipate that new members will enjoy the benefits later on, and as a result there is too little investment. Here, 'investment' can be financial, or it can be in the less tangible form of becoming involved in running the exchange and planning for its future" (Hart and Moore 1996, 67). Future research

could therefore investigate the impact of trust among existing and new members of cooperatives on the participation in the governance of cooperatives.

Conclusions

This research contributes to a better understanding of the members' participation in the governance of agricultural cooperatives. We showed that members' trust impacted their participation through their affective commitment; this mediator effect of affective commitment between trust and participation was complete. We encourage the directors of cooperatives to create the conditions which generate cooperatives' members' trust because this is a source of affective attachment and favorable behaviors like participation. More precisely, we believe that cooperatives' directors should pay attention to their members on a daily basis, by encouraging and maintaining reliable relationships with them.

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U.S. Fluid Milk Demand: A Disaggregated Approach

Christopher G. Davis[ⓘa], Diansheng Dong[b], Donald Blayney[c],
Steven T. Yen[d], and Richard Stillman[e]

[a]*Economist, Markets and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. 335 E. Street, S.W., Washington D.C., 20024, U.S.A.*

[b]*Economist, Food and Economic Division, Economic Research Service, U.S. Department of Agriculture, 335 E. Street, S.W., Washington D.C., 20024, U.S.A.*

[c]*Economist, Markets and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. 335 E. Street, S.W., Washington D.C., 20024, U.S.A.*

[d]*Professor, Department of Agricultural Economics, University of Tennessee, 308D Morgan Hall, 2621 Morgan Circle, Knoxville, Tennessee, 37996-4518, U.S.A.*

[e]*Economist, Markets and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. 335 E. Street, S.W., Washington D.C., 20024, U.S.A.*

Abstract

In this study, we examine retail fluid milk data from Nielsen 2007 Homescan. The objective of this study is to determine the impact of demographic variables, retail prices and total milk expenditure on flavored and non-flavored milk purchases. A censored AIDS model is used in estimate the demand for fluid milk. Results reveal that demographic variables have statistically significant impacts on fluid milk purchases, and own-price elasticities are unity or elastic for almost all fluid milk categories. All expenditure elasticities are unity or greater except whole milk and 1% milk.

Keywords: censored demand, fluid milk, Nielsen Homescan

ⓘCorresponding author: Tel: + 1 202. 694.5167
Email: chrisdavis@ers.usda.gov
D. Dong: ddong@ers.usda.gov S. T. Yen: syen@utk.edu
D. Blayney: dblayney@ers.usda.gov R.Stillman: stillman@ers.usda.gov

Introduction

The milk industry faces a complex set of issues as it provides farm milk for the production of retail dairy products demanded by consumers. Having some assessment of the demographic and economic effects on milk and dairy product demands will allow both managers of retail outlets and dairy processors of milk and dairy products to develop more complete marketing and production strategies for their businesses.

Fluid milk is a major component of U.S. dairy consumption that has been widely studied by economists. The focus of this study is beverage fluid milk, not cream-based processed products such as half-and-half, sour creams, or drinkable yogurt. There is a long record of praise for the merits of milk and its products — not always derived from dairy cows — throughout the world. The role played by fluid milk products in promoting health, especially of young children, has long been emphasized. More recently, dairy products have been promoted as sources of vitamins and minerals that support bone health. However, not all discussions of milk products emphasize positive attributes. The dietary intake of fat, saturated fat in particular, in dairy products has been associated with risks of developing obesity, diabetes, and coronary heart disease (Frazao 1999). Positive and negative arguments aside, milk products are consumed and/or used as ingredients by most people on a daily basis.

Milk processors and suppliers in the U.S. have faced challenges over time, a major one being addressing concerns related to health and the consumption of milk fat. Changing consumption patterns among fluid milk products may have resulted in shifts in their demand functions, as shown in existing studies (e.g., Maynard 2000; Maynard and Liu 1999). In addition, existing studies have focused largely on aggregated fluid milk products, and such aggregation can mask changes in relative demand across fluid milk products at the retail level.

Figure 1 shows fluid milk sales by selected product categories from 1975 to 2009. The sales are defined in terms of gallons, the most frequently sold beverage milk container size and a more traditional way to think of liquid product measurement.

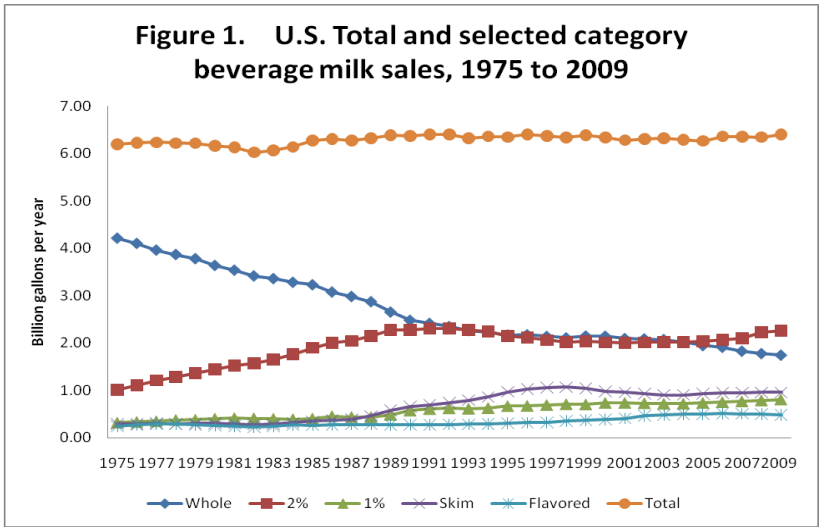

Figure 1. Beverage Milk Sales, 1979 – 2005.

Total fluid milk sales have been relatively stable over the 1975 - 2009 period at approximately 6,300 million gallons. However, whole milk sales declined over the period while sales of reduced-fat milks (2%, 1%, and skim) have mostly trended upward. A growing population over the 1975 – 2009 period combined with the relatively flat sales implies that the per capita total fluid milk demand have fallen. The aggregate trend masks an important point— total sales of reduced-fat milk products (the sum of 2%, 1% and skim milk) had been trending upward for some time but essentially leveled off beginning in 1991 then declining in 1996-97 and again leveled off around 2004. Flavored milk sales have more than doubled over the 25 years with a slight decline in 2009.

Numerous studies have examined the retail demand for fluid milk (Gould, Cornick, and Cox 1994; Gould and Lin 1994; Schmit et al. 2002; Dong and Kaiser 2005; etc.). However, this study differs from most fluid milk studies in that it includes demographic information for households that purchased flavored and non-flavored milk products. The objective of this study is to determine the impact that changing demographics, retail prices, and total milk expenditures have on flavored and non-flavored milk purchases.

The level of product disaggregation in this study allows for a more in-depth assessment of fluid milk demand. Using 2007 Nielsen data, competing products such as flavored and non-flavored whole, 2%, 1%, and skim milks are included in the analysis. Previous studies did not include all of these products. Because flavored milk products are a part of consumers' food basket, omitting them from the demand analysis may give rise to inaccurate estimations of consumers' demand for fluid milk. The factors affecting fluid milk demand are not static; therefore, periodic analysis of those factors is warranted given new product mixes and changing economic and demographic relationships. All nine disaggregated fluid milk elasticity estimates are important to the food industry. They can be used to enhance the ability of dairy industry and retail chain decision-makers to make more informed decisions about changes in fluid milk purchases.

The rest of the paper is organized as follows: a summary of related studies on the topic is presented, then a discussion of methods, data, empirical results, and concluding remarks.

Previous Studies of Demand Elasticities for Fluid Milk

Analysis of fluid milk demand has taken many forms and has revealed many factors that influence that demand. Early studies tended to identify milk as a single aggregate category, but as differentiated fluid milk types were produced, more data became available which allowed analysis of the set of differentiated products. While differences in packaging can be studied, the differences in demands for milks of varying fat content took—and still hold—center stage. This study identifies the gaps that exist in the dairy demand literature related to the number of fluid milk categories analyzed in previous studies, the lack of sufficient demographic information that measures the influence of non-economic factors, and the censored demand estimators used by other analysts.

Boehm and Babb (1975) published one of the earlier fluid milk demand studies that estimated consumer demand for four milk categories—whole milk, 2% milk, buttermilk, and canned milk. They used two models, the first was based on cross-sectional approach and the second was based

on time-series approach. The empirical data used for the study was household panel data from the Market Research Corp. of America which was accessible by the United Dairy Industry Association for the time period April 1972 to April 1973. Using both Model A (cross-sectional data) and Model B (time-series data) to determine fluid milk demand, their findings showed that estimates from Model B were inelastic and less sensitive to changes in price than the estimates from Model A. While this study provides baseline elasticity estimates using cross-sectional data on fluid milk products, it fails to explore the availability of other competing disaggregated fluid milk products.

Gould, Cox, and Perali (1990) specified an almost ideal demand system (AIDS) model that included only two fluid milk products, whole milk and low fat milk. They examined change in fluid milk demand using time-series data from 1955 to 1985. Gould, Cox, and Perali (1990) provided historical estimates of whole and low fat milks that have been widely referenced by other studies. However, one of the shortcomings of this study is the aggregation of 2% milk, 1% milk, and skim milk into low fat milk, which overlooks and disregards the information that each disaggregated product provides. Another shortcoming is that the study did not show the impact that different non-economic factors have on fluid milk purchases.

In 1996, Gould again examined milk demand factors, but this time three categories were considered—whole milk, 2% milk, and combined 1%/skim milk. Nielsen Homescan data from April 1991 to March 1992 were used for the analysis. Gould's study was one of the first to provide elasticity estimates for 1%/skim milk. Similar to his earlier study, 1% milk and skim milk were combined, losing invaluable information that could have been used to measure consumers responsiveness to changes in the price and expenditure of 1% milk and skim milk separately.

Maynard and Liu (1999) investigated how demand for fluid milk products has become more elastic over time and, given the range of models available to derive elasticity estimates, evaluated the sensitivity of estimates to the type of demand model used. Their study made use of Nielsen retail scanner data from November 1996 through October 1998, and used three models to estimate own-price elasticities: the double-log, the static linear approximate AIDS (LA/AIDS), and the National Bureau of Research (NBR) differentiated models. Elasticity ranges across the models were the widest for the various milk types with the NBR model resulting in the most elastic estimates. This study does well in providing estimates using some of the most familiar methods utilized in the economic literature, but falls short in that it only has estimates for two types of fluid milk products, white milk and flavored milk.

Maynard (2000) and Chouinard, et al. (2010), estimated four fluid milk products, whole, 2%, 1%, skim or non-fat, using an AIDS model. Maynard (2000) study tested the hypothesis that less volatility of retail milk prices actually benefits consumers, while Chouinard, et al. (2010), determined how various demographic groups are affected by milk marketing orders. Although both Maynard (2000) and Chouinard, et al. (2010) examine all four types of white fluid milk products, their studies omit other fluid milk products such as flavored whole, 2%, 1%, and skim milks.

Akbay and Jones (2006) estimated demand elasticities and price-cost margin ratios for grocery products in different socioeconomic groups. They analyzed private and national branded items for lower and higher income stores using an AIDS model along with weekly store level scanner

data for nine food categories from six supermarket chains in Columbus, Ohio from June 1998 through September 2000. Fluid milk is one of the dairy products analyzed. Their study analyzed the demand for fresh gallon milk (private), a half gallon milk (private), gallon milk (Sealest), and Nestle chocolate milk purchased at lower income stores. While the Akbay and Jones (2006) study does include flavored milk, it provides only the estimate of one flavored milk product, and it does not disaggregate fluid milk based on the different levels of fat content that are widely marketed in retail stores.

Another gap that exists in the literature is the lack of studies on non-economic factors that are closely related to fluid milk purchases. Purchases and/or consumptions of fluid milk products have been influenced by demographic factors as well. Gould, Cox, and Perali (1990) used data from 1955 to 1985 and found that children less than five years old, children from five years old to 13 years old, and the nonwhite population had a significant and positive coefficient for whole milk. Some of the non-economic or demographic factors that Gould, Cox, and Perali (1990) failed to include in their analysis were region and income. Regional and household income variables will help retailers target specific geographical areas and neighborhoods in the United States where fluid milk demand are highest.

Gould (1996) estimated a three fluid milk product demand system using weekly purchase data from April 1991 to March 1992. His findings showed that factors such as household composition, region of residence, ethnicity, income, and education had significant impacts on the demand for fluid milk. The use of household composition, region of residence, ethnicity, income, and education are important variables in any fluid milk analysis, but are incomplete in that they do not specifically account for children and teenagers in the home. Schmit and Kaiser (2004) estimated fluid milk elasticities and showed that income and children less than six years old had significant and positive elasticities for fluid milk. Similar to Gould, Cox, and Perali (1990), this study did not analyze the impact of geographic variables on fluid milk demand.

In addition to the studies mentioned, others have analyzed fluid milk products from different perspectives (e.g., Liu and Forker 1988; Gould, Cornick, and Cox 1994; Gould and Lin 1994; Schmit et al. 2002; Dong and Kaiser 2005). These analyses suggest that empirical estimates of the demand and expenditure elasticities are dependent on model specification. Like most of the analyses focusing on fluid milk in the literature, the majority of the studies mentioned used time series data created by aggregating weekly or monthly data. Such an approach circumvents problem of zero observations or purchases that are often encountered when using micro-level (household) data.

Many of the studies that used censored demand estimators have shortcomings. Some censored demand systems have problems with inconsistent estimates (Wales and Woodland 1983; Lee and Pitt 1986; Amemiya 1974; Ransom 1987), while other censored demand estimators have problems with satisfying the adding-up condition (Golan, Perloff, and Shen 2001; Yen and Lin 2006; Shonkwiler and Yen 1999; Sam and Zheng 2010; Perali and Chavas 2000; Meyerhoefer, Ranney, and Sahn 2005; Heien and Wessells 1990). Dong, Gould, and Kaiser (2004) implemented a mapping mechanism to achieve adding-up in the Tobit system of Amemiya (1974) that was suggested by Wales and Woodland (1983). This study utilizes the censored AIDS model developed by Dong, Gould, and Kaiser (2004).

The present study differs from other fluid milk demand studies in that it estimates the demand for white milk and flavored milk products using four different levels of fat content, whole, 2%, 1%, and skim. One other distinct difference is that this study includes several demographic variables that some fluid milk research studies omit such as the presence of children, teenagers, and elderly in the home, regional and ethnic or race variables, educational attainment, and household income level. And finally, this study satisfies the add-up conditions that other studies using censored demand analyses do not.

Methods

Because our data are censored, we used a censored demand system to estimate selected variables to avoid bias estimates. In demand system estimation with microdata, the most prominent statistical issue confronting analysts is censoring, or observed zero purchases, in the data. Such censoring has to be accommodated in order to obtain consistent parameter and elasticity estimates. Two challenges are usually involved in the estimation of a large censored demand system: imposing theoretical constraints among parameters and the evaluation of high order probability integrals. Among the various censored demand systems used in demand analyses, the Dong, Gould, and Kaiser (2004) approach is the one that satisfies the necessary adding-up condition. In this study, a censored AIDS model developed by Dong, Gould, and Kaiser (2004) is employed to derive elasticity estimates. The model estimation is an Amemiya-Tobin approach that imposes adding-up constraints on both latent and observed expenditure shares (Wales and Woodland, 1983). A simulated probability procedure is used in the model estimation to evaluate the high order probability integrals.

Following the method used by Dong, Gould, and Kaiser (2004), the AIDS model is defined based on the latent shares for K commodities as

$$(1)\quad Q^* = A + \gamma \ln P + \theta \ln Y + \varepsilon$$

where Q^* is a K-vector of latent expenditure shares on milk products, P is a K-vector of milk product prices, and $Y = y^* / P^*$ is the deflated total expenditures, with y^* is total expenditure, and P^* is the Translog price index, and ε is a K-vector of error terms. Household demographic variables are incorporated by transforming the intercept in (1). That is, the intercept is defined as $A = \alpha + \beta X$, where X is an N-vector of demographic characteristics. The parameters are α ($K \times 1$), β ($K \times N$), θ ($K \times 1$), and γ ($K \times K$).

Given the budget constraint, the latent shares must sum to one (adding-up). This adding-up condition can be attained through parametric restrictions. Other theoretical constraints such as homogeneity and symmetry can also be imposed on equation 1. The adding-up restriction implies that the joint density function of ε is singular. Consequently, one of the K latent share equations must be dropped during estimation. By dropping any equation from the estimation, it is assumed that the remaining $K - 1$ share equations' error terms, ε in equation (1), are distributed (K–1)-dimensioned normal with a joint probability density function.

As in all censored regression models, estimation of the model requires a mapping between the observed and latent dependent variable(s). In the present context, the mapping of the vector of latent shares (Q^*) to observed shares (Q) must take into account that the observed shares lie between 0 and 1 and also sum to unity for each observation. The following mapping rule imposes these two characteristics (Wales and Woodland, 1983)

$$(2)\quad Q_i = Q_i^* / \sum_{j \in \Omega} Q_j^* \quad \text{if} \quad Q_i^* > 0$$
$$= 0 \quad \text{if} \quad Q_i^* \leq 0,\ i = 1, 2..., K$$

where Ω is a set of all positive shares' subscripts. The way equation (2) maps Q^* to Q is simple and has the property that the resulting density function is independent of whatever set of elements in Q^*s is used in its derivation. By assuming that at least one milk product is purchased, one can write the likelihood function for each household according to its observed purchase pattern (regime). Consistent and efficient model estimates can be obtained by maximizing the sum of log likelihood function over all households. Since the likelihood function contains high order probability integrals, the simulated probability procedure is used in model estimation. Details can be found in Dong, Gould, and Kaiser (2004).

Elasticities are evaluated based on the expected expenditure share values. Expected values of observed expenditure shares can be obtained by summing the product of each regime's probability and the expected conditional share values over all possible regimes. Let C_s represent a particular purchase regime:

$$(3)\quad C_s = (Q_1 = Q_2 = \cdots = Q_s = 0; Q_{s+1} > 0, \cdots, Q_K > 0).$$

This is the regime where the first *s* shares are zero. Given these *s* zero-valued shares, other possible purchase patterns can be transformed to this pattern by rearranging the share ordering. Under this definition, regime *Cs* is actually the sum of all the purchase patterns with *s* zero-valued shares. The expected value of the *j*th observed expenditure share is

$$(4)\quad E(Q_j) = \sum_{s=1}^{K} \alpha_{C_s} E(Q_j \mid C_s)$$

where α_{C_s} is the probability that regime *Cs* occurs. The expected share value conditional on purchase regime *Cs* can be represented as

$$(5)\quad E(Q_j \mid C_s) = E[(Q_j^* \mid C_s) / \sum_{i=s+1}^{K} (Q_i^* \mid C_s)] \quad \text{if} \quad j > s$$
$$= 0 \quad \text{if} \quad j \leq s.$$

From (4) the impact of changes in prices, demographic characteristics and total expenditures on milk demand can be obtained, by evaluating *K*–1 dimension integrals. Given that there are 2^K–1 purchase regimes, one may need to evaluate these integrals a large number of times for a reasonably sized demand system. In this study, we follow Dong, Gould, and Kaiser (2004) to simulate the elasticities using the procedure developed by Phaneuf, Kling, and Herriges (2000) for a censored demand system applied to recreation choices. Thus, assume *C* replicates of the *K* error term vectors ε in equation 1. The *c*th simulated latent share vector, Q_c^*, evaluated at the sample means of our exogenous variables (indicated by a bar over a variable) is

$$(6)\quad Q_c^* = \alpha + \gamma \ln \bar{P} + \theta \ln \bar{y}^* / \bar{P}^* + \varepsilon_c$$

where ε_c is the cth replicate of ε. The cth replicate of the ith observed share then is

$$(7)\quad Q_{ic} = Q_{ic}^* / \sum_{j \in \Delta} Q_{jc}^* \quad \text{if} \quad Q_{ic}^* > 0$$
$$= 0 \quad \text{if} \quad Q_{ic}^* \leq 0.$$

The expected observed share vector for C replicates is then calculated as a simple average of these simulated values:

$$(8)\quad E(Q) = \frac{1}{C} \sum_{c=1}^{C} Q_c.$$

Given a small change in price j, ΔP_j, the elasticity vector with respect to this price change is

$$(9)\quad \psi_j^Q = -\Lambda_j + \frac{\Delta E(Q)}{\Delta P_j} \times \frac{P_j + \Delta P_j / 2}{E(Q) + \Delta E(Q)/2}$$

where Λ_j is a vector of 0's with the jth element equal to 1, and $\Delta E(Q)$ is the change in the simulated $E(Q)$ given the change of price, ΔP_j. To derive elasticities for total expenditure and demographic variables we used:

$$(10)\quad \eta_j^Q = \frac{\Delta E(Q)}{\Delta Z} \cdot \frac{1}{E(Q) + \Delta E(Q)/2},$$

where ΔZ denotes the change of total expenditure or demographic variables. Using the Slutsky's equation, the compensated elasticities are estimated by regular means.

Data

The data used in the analysis are 2007 household data provided by Nielsen Homescan. Based on the uniform product code and designated codes for each item, nine categories are considered: (1) whole milk, (2) 1% milk, (3) 2% milk, (4) skim milk, (5) whole flavored milk (6) 1% flavored milk, (7) 2% flavored milk, (8) skim flavored milk, and (9) other milk products (see Table 1 for sample statistics). The first eight categories are clearly fluid-milk beverage products. Other milk products consist of milk products that are labeled low-sodium, extra-rich, Passover, lactose, lactose-free, raw, goat milk, buttermilk, etc. There are 63,061 households that purchased at least one of the nine products in the 2007 data. Each purchase record is matched to a household record that contains information on the size and composition of the household, income, origin, age, race, gender, education and occupation of household members and market location. Information on head of household is provided based on gender, age, occupation, marital status and education. The head of household is self defined by the person participating in the survey and can be a single person or two persons, regardless of gender and marital and employment statuses. For an extensive discussion of the characteristics of the 2007 Nielsen Homescan data, see Zhen et al. (2009).

Quantities and expenditures are reported for all the nine products. Prices (unit values) are derived from observed quantities and expenditures after accounting for any coupons or promotions that might have been in effect. Prices used in this study are unit values. For households that pur-

chased any of the products, we used the observed expenditures and quantities to calculate the unit values for each of the nine fluid milk products. For households that did not purchase any of the products, we estimated the unit values based on household variables. That is, we estimated a unit value equation for each of the nine products and used the predicted unit values for the missing prices. This is called first-order missing regressor procedure by Cox and Wohgenant (1986). In Table 1, there is information about the percentage of the 63,061 households that purchased each of the nine fluid milk products.

Summary Statistics

Based on the 2007 Nielsen Homescan data, consumers on average purchased more 2% milk and skim milk than they did any other non-flavored milk products (Table 1). Of the four flavored milk categories, consumers purchased more 2% flavored milk than they did any other. The highest average expenditures for non-flavored milk products are 2% milk ($32.85), followed by skim milk ($22.11). Among the flavored milks, expenditures are highest for 2% flavored milk ($1.05), followed by whole flavored milk ($1.01). The cost of fluid milk per ounce is not extremely different for whole milk, 1% milk, 2% milk, and skim milk. In contrast, there is more of a difference in the price of whole flavored milk and the other flavored milks. Table 2 shows the definitions and sample statistics of demographic variables used in the censored demand system. The demographic variables include one continuous variable, household size, and several dummy variables; including presence of children ages less than 6 years old in household, children ages 6 –12, and teenagers ages 13–17, male head age 65 years and older, females head age 65 years and older, Whites, Blacks, Asians, and Other race and ethnicity, Central, South, West, and East regions, female head of households with various levels education attainment[1] including college degrees, some college training, high school diploma only, and no high school diploma. In addition, there are seven different household income categories ($19,999 or less, $20,000–$34,999, $35,000–$49,999, $50,000–$69,999, $70,000–$99,999, $100,000–$149,999, and $150,000 or more). The variables Blacks, South, household income $20,000–$34,999, and female head of household with no high school diploma will serve as the base.

Results

Estimated Demand System Demographic, Price, and Expenditure Coefficients

Table 3 shows the coefficient estimates derived from a demand system consisting of nine different products and 21 demographic variables, a total of 189 demographic coefficients, nine expenditure coefficients, and 45 price coefficients. The system is estimated by programming the likelihood function in GAUSS. Of the 189 demographic coefficients, 112 are statistically significant at the one percent level, two at the five percent level, and 11 at the 10 percent level. All own-price coefficients are significant, and 34 of the 45 cross-price coefficients and eight of the nine expenditure coefficients are statistically significant. The next sub-sections present the price and expenditure elasticities, demographic elasticities related to the nine fluid milk products and the concluding remarks.

[1] The justification for using binary variables for education is to assess the impact educational attainment has on different types of milk purchases. Typically one would expect low fat milk purchases to be influenced by high educational attainments.

Table 1. Sample Statistics of Quantities, Expenditures, and Prices (Sample Size = 63,034)

Variable		Mean	SD	% Purchased
Quantities [e] (average gallons per household over 12 mo.)				
Whole		4.76	13.64	44
1 % milk		4.84	14.21	42
2 % milk		9.98	19.86	66
Skim		6.90	17.38	40
Whole flavored		0.18	1.40	11
1% flavored milk		0.18	1.66	06
2% flavored milk		0.26	2.08	09
Skim flavored milk	0.20	1.85	06	
Other milk		0.11	1.78	03
Expenditures (average dollar spent per household over 12 mo.)				
Whole		16.91	45.93	
1 % milk		16.19	45.60	
2 % milk		32.85	61.93	
Skim		22.11	52.98	
Whole flavored		1.01	8.04	
1% flavored milk		0.76	6.80	
2% flavored milk		1.05	8.31	
Skim flavored milk		0.76	6.68	
Other milk		0.53	7.77	
Prices (average price paid per household over 12 mo.)				
Whole		3.55	0.009	
1 % milk		3.34	0.008	
2 % milk		3.29	0.010	
Skim		3.20	0.008	
Whole flavored		5.61	0.008	
1% flavored milk		4.22	0.010	
2% flavored milk		4.04	0.007	
Skim flavored milk		3.80	0.006	
Other milk		4.81	0.010	

[e] Fluid milk mean quantities were reported in fluid ounces and then converted into gallons. A gallon equals 128 fluid ounces.

Table 2. Definitions and Sample Statistics of Explanatory Variables

Variable	Definition	Mean
Continuous explanatory variables		
Household size	Number of members present in household	2.44
		(1.31) [a]
Binary explanatory variables (yes = 1; no = 0)	All binary variables are reported sample means.	
Young children	A child age < 6 present in household	0.09
Older children	A child age 6 -12 present in household	0.06
Teenagers	Teenagers in household ages 13 - 17 years old	0.13
Elderly Male	A Male in household age 65 and older	0.15
Elderly Female	A Female in household age 65 and older	0.17
Region		
Central	Household resides in the Central region of the U.S.	0.27
South [b]	Household resides in the Southern region of the U.S.	0.36
West	Household resides in the Western region of the U.S.	0.20
East	Household resides in the Eastern region of the U.S.	0.17
Educational level		
College degree	Female head has college education	0.34
Some college	Female head has some college education	0.29
High School diploma	Female head has a High School diploma	0.24
Less than High School [b]	Female head has no High School diploma	0.13
Race		
White	Head of household is Caucasian	0.84
Black [b]	Head of household is African-American	0.09
Asian	Head of household is Asian-American	0.02
Other race and ethnicity	Head of household is Other American	0.05
Household Income		
Income ≤ $19,999	Annual household income ≤ $19,999	0.11
Income $20,000–34,999 [b]	Annual household income $20,000–34,999	0.20
Income $35,000–49,999	Annual household income $35,000–49,999	0.19
Income $50,000–69,999	Annual household income $50,000–69,999	0.20
Income $70,000–99,999	Annual household income $70,000–99,999	0.18
Income $100,000–149,999	Annual household income $100,000–149,999	0.10
Income ≥ $150,000[b]	Annual household income ≥ $150,000	0.02

[a] Standard deviations in parentheses. [b] References category.

Table 3. Censored Demand System Parameter Estimates

Variable	East	Central	West	White	Other race and ethnicity	Asian	Children 5 years old and younger	Children ages 6 -12
Whole	−0.025***	−0.372***	−0.226***	−0.398***	−0.130***	−0.161***	0.296***	0.004
1% milk	0.279***	0.063***	0.192***	0.129***	0.011	0.101***	0.046***	0.049***
2% milk	−0.342***	0.108***	0.118***	0.044***	0.079***	0.071*	−0.188***	0.062***
Skim	0.024***	0.093***	−0.088***	0.208***	0.011	0.046	−0.168***	−0.178***
Whole flavored	−0.018***	0.020***	−0.056***	−0.010***	−0.001	−0.035***	0.001	0.008*
1% flavored milk	0.016***	0.014***	0.040***	0.016***	0.011**	0.006	0.002	0.017***
2% flavored milk	−0.007*	0.010***	−0.019***	−0.002	0.001	−0.011	0.011***	0.013***
Skim flavored milk	0.022***	0.015***	0.002	0.005*	0.004	−0.004***	0.002***	0.012***
Other milk	0.051***	0.049***	0.038*	0.007	0.013	−0.013	−0.001	0.014

Variable	Teenagers age 13-17	Males age 65 and older	Females age 65 and older	Household size	Female HH with college degree	Female HH with some college	Female HH with HS diploma	Income > $19,999
Whole	−0.083***	−0.032***	−0.133***	0.065***	−0.227***	−0.075***	0.001	0.259***
1% milk	0.060***	0.039***	0.079***	−0.047***	0.074***	0.024***	−0.014*	−0.135***
2% milk	0.119***	0.009	−0.011	0.071***	0.008	0.133***	0.203***	0.114***
Skim	−0.117***	0.050***	0.106***	−0.091***	0.131***	−0.110***	−0.214***	−0.222***
Whole flavored	0.007**	−0.021***	−0.017***	0.005***	−0.007***	0.005	0.008***	0.000
1% flavored milk	0.002	−0.008***	−0.009***	0.002	−0.006*	−0.001	−0.000	0.001
2% flavored milk	0.004	−0.015***	−0.014***	0.001	0.012***	0.018***	0.015***	−0.007***
Skim flavored milk	0.006*	−0.010***	0.008***	0.002*	−0.000	0.002	0.001***	−0.009***
Other milk	0.000	−0.011	0.008	−0.007	0.014	0.005	0.000	−0.001

Note: HH means head of household; and HS means High School.

Table 3. Censored Demand System Parameter Estimates (Continued)

Variable	Income $35,000 – 49,999	Income $50,000 – 69,999	Income $70,000 – 99,999	Income $100,000 – 149,999	Income ≤ $150,000
Whole	0.009	–0.122***	–0.178***	–0.228***	–0.282***
1% milk	0.014	0.051***	0.103***	0.131***	0.156***
2% milk	0.015	0.022***	–0.072***	–0.176***	–0.257***
Skim	–0.036***	0.053***	0.137***	0.268***	0.430***
Whole flavored	–0.010***	–0.011	–0.020	–0.031	–0.042
1% flavored milk	0.009***	0.001	0.008***	0.007*	0.013*
2% flavored milk	–0.004	–0.003	–0.004	–0.006	–0.009
Skim flavored milk	–0.002	–0.001	0.004	0.003	–0.006
Other milk	0.005	0.010	0.021	0.026	–0.003

Note: Asterisk *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Variable	Whole	1% milk	2% milk	Skim	Whole flavored	1% flavored milk	2% flavored milk	Skim flavored milk	Other milk
Expenditure coefficients	–0.05***	–0.02***	0.02***	0.00*	0.01***	0.01***	0.01***	0.01***	0.00
Price coefficients									
Whole	–0.67***								
1% milk	0.18***	–0.44***							
2% milk	0.14***	0.01***	–0.71***						
Skim	0.23***	–0.00	0.42***	–0.80***					
Whole flavored	0.05	0.05***	0.03***	0.03***	–0.09***				
1% flavored milk	0.00	–0.01***	0.09***	0.01**	–0.02***	–0.08***			
2% flavored milk	0.03	0.19***	–0.01***	–0.01***	–0.02***	0.01***	–0.16***		
Skim flavored milk	0.03***	0.04***	0.03***	0.03***	0.00	–0.04***	–0.03***	–0.03***	
Other milk	0.01	0.01	0.02	0.11***	–0.06***	0.00	0.01	0.01	–0.09***

Note: Asterisk *** indicates statistical significance at the 1% level, and * at the 10% level.

Table 3. Censored Demand System Parameter Estimates (Continued)

Variable	Whole	1% milk	2% milk	Skim	Whole flavored	1% flavored milk	2% flavored milk	Skim flavored milk	Other milk
Expenditure coefficients	–0.05***	–0.02***	0.02***	0.00*	0.01***	0.01***	0.01***	0.01***	0.00
Price coefficients									
Whole	–0.67***								
1% milk	0.18***	–0.44***							
2% milk	0.14***	0.01***	–0.71***						
Skim	0.23***	–0.00	0.42***	–0.80***					
Whole flavored	0.05	0.05***	0.03***	0.03***	–0.09***				
1% flavored milk	0.00	–0.01***	0.09***	0.01**	–0.02***	–0.08***			
2% flavored milk	0.03	0.19***	–0.01***	–0.01***	–0.02***	0.01***	–0.16***		
Skim flavored milk	0.03***	0.04***	0.03***	0.03***	0.00	–0.04***	–0.03***	–0.03***	
Other milk	0.01	0.01	0.02	0.11***	–0.06***	0.00	0.01	0.01	–0.09***

Note: Asterisk *** indicates statistical significance at the 1% level, and * at the 10% level.

There are two sets of demand elasticities derived from the censored demand models. The first is the uncompensated demand (Marshallian) elasticities. According to economic theory, the uncompensated demand curve does not allow income to change to account for any changes in price. The second set of elasticity estimates is called compensated (Hicksian) elasticities. Unlike uncompensated demand elasticities, the compensated demand elasticities do allow income to change to "compensate" for the price change. Policymakers may be most interested in knowing how much additional income support is needed to help a consumer purchase the same or comparable quantities of dairy products after prices increase. The uncompensated results show expenditure elasticities for identifying goods as normal, inferior, or luxury, which would be of interest to researchers. This is also a concern to retail store managers who are responsible for moving products into and out of their stores. Retail store managers would take an interest in consumers' responsiveness to changes in prices as well as changes in household expenditures – both will affect the quantity of products flowing into and out of retail stores.

Uncompensated Demand Elasticities

Estimates of the uncompensated price and expenditure elasticities are presented in Table 4. Consistent with theoretical expectations, all own-price elasticities are negative and statistically significant, –1.07 (the smallest) for other milk to –1.39 for 2% milk, –1.40 for 1% milk, –1.48 for whole milk, –1.94 for skim flavored milk, –2.39 for 1% flavored milk, –2.52 for whole flavored milk, –3.24 skim milk, and –3.82 for 2% flavored milk. All own-price elasticities for fluid milk are above unity in absolute value, which imply that a 1-percent change in price will cause an impact greater than 1-percent change in the quantity purchased of fluid milk. These empirical findings suggest that consumers are more sensitive to changes in fluid milk prices today than they were two or three decades ago.

For most fluid milk demand studies, elastic own-price elasticities may seem counter-intuitive because analysts typically view fluid milk prices as being inelastic. Boehm and Babb (1975) estimated fluid milk demand using two different models. One model used time-series model and data, while the other used cross-sectional model and data. The cross-sectional study yielded elastic own-price elasticities similar to the present study. Boehm and Babb suggested that their estimates were counter-intuitive. However, more and better substitutes for a product make the demand for that product more elastic. Previous studies disaggregated competing fluid milk into two, three, or four categories, while this study uses nine categories. As the products become more and more disaggregated, one would expect to find better substitutes and more elastic demands.

Estimates from this study, particularly the own-price elasticities for whole, 1% milk, 2% milk, and skim are similar to those reported by Boehm (1975), but larger than those estimated by Gould (1996). The own-price elasticity for flavored milk is more similar to estimates derived by Maynard and Liu (1999) and Akbay and Jones (2006). The findings from this study are important because they suggest to policymakers who are concerned about inducing calcium intake for specific segments of the population that changes in fluid milk prices will have a larger impact on quantity demanded.

As expected, there are many substitution relationships among the milk products, which support the conventional wisdom of consumers' purchasing behavior. Of the 72 cross-price elasticities, 67 are statistically significant. Forty-two of the uncompensated cross-price elasticities suggest substitute relationships among the fluid milk products. According to our findings, 1% milk serves as a gross substitute for all fluid milk products. Whole milk is also a gross substitute for 1% milk, 2% milk, skim milk, whole flavored milk, 2% flavored milk, and skim flavored milk. Likewise, skim milk is found to be a substitute for all fluid milk products except 2% flavored milk. The implications of these findings suggest that consumers will substitute one fluid milk product with another fluid milk product to satisfy changes in taste, health preference, or personal budget constraint. For example, results from this study suggest that consumers will purchase skim non-flavored milk if the price of skim flavored milk should increase, and vice versa. Consumers will also respond in a similar fashion if there are increases in the price of whole milk. Similarly, estimates by Gould (1996) showed that whole milk is a substitute for reduced-fat milk (2% milk), and skim milk. Retail managers may find these results useful as well as important in devising marketing strategies to increase fluid milk sales.

There are also statistically significant complementary relationships shown in Table 4. Twenty-five of the cross-price elasticities are negative and suggest complementary relationships. Just to highlight a few, whole milk is found to be a gross complement for 1% flavored milk and other milk products. Also, consumers are likely to purchase more 2% flavored milk given a reduction in the price of whole milk, 2% milk, skim milk, whole flavored milk, skim flavored milk and other milk.

Expenditure elasticities derived from the censored demand model are all positive and statistically significant (Table 4). Seven of the nine fluid milks have expenditure elasticities equal to or greater than 1. For six of those products, a 1-percent increase in total fluid milk expenditures will yield more than a 1-percent increase in the purchase of those fluid milk products. The implications of these findings are that as fluid milk expenditures rise the quantity demanded for six of the fluid milk products will increase by a percentage greater than the rise in expenditure. In this study, the expenditure elasticity estimates are similar to those reported by Gould (1996), who reported expenditure elasticities of 1.01 for whole milk and 2% milk and 0.98 for skim/1% milk. Policymakers may find these results important as they determine how they can increase supplemental payments to recipients of the Women, Infants, and Children program to boost intake of low fat fluid milk products.

Compensated Price Elasticities

Estimates of the compensated price elasticities are presented in Table 5. Similar to their uncompensated counterparts, all own-price elasticities are negative and statistically significant, implying an inverse relationship between the prices and quantities demanded of milk products. Also, both sets of own-price elasticities are elastic and suggest high consumer sensitivity to changes in fluid milk prices.

Compensated cross-price elasticity estimates display stronger net substitution relationships than net complementary relationships. Among the 61 statistically significant cross-price elasticity estimates, 46 suggest net substitutions and 15 suggest net complementary relationships. Consumers

Table 4. Uncompensated Price and Expenditure Elasticities

Product	Price of Whole	1% milk	2% milk	Skim	Whole flavored	1% flavored milk	2% flavored milk	Skim flavored milk	Other milk
Whole	–1.48***	0.19***	0.14***	0.24***	0.01***	–0.02***	–0.01***	–0.01***	–0.03***
1% milk	0.20***	–1.40***	0.01***	0.05***	0.02***	–0.03***	0.16***	0.02***	–0.02***
2% milk	0.05***	0.02***	–1.39***	0.27***	0.01***	0.03***	–0.02***	0.00***	0.00
Skim	0.64***	0.03***	1.20***	–3.24***	0.07***	0.01	–0.06***	0.06***	0.30***
Whole flavored	0.50***	0.75***	0.42***	0.40***	–2.52***	0.34***	–0.28***	0.06	–0.89***
1% flavored milk	–0.15***	0.15***	1.55***	0.12**	0.37***	–2.39***	0.14***	–0.70***	0.02
2% flavored milk	0.30***	3.26***	–0.24***	–0.25***	–0.28***	0.16***	–3.82***	–0.54***	0.18**
Skim flavored milk	0.33***	1.06***	0.62***	0.68***	0.09	–1.07***	–0.92***	–1.94***	–0.22*
Other milk	–0.06***	0.03***	–0.01***	0.19***	–0.04***	–0.01***	–0.01**	–0.02***	–1.07***

Note. Asterisk *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level

Table 4. (Continued)

Product	Expenditure Elasticity
Whole	0.96***
1% milk	0.99***
2% milk	1.02***
Skim	1.01***
Whole flavored	1.23***
1% flavored milk	1.19***
2% flavored milk	1.23***
Skim flavored milk	1.37***
Other milk	1.00***

Note. Asterisk *** indicates statistical significance at the 1% level.

Table 5. Compensated Price Elasticities

	Price of								
Product	Whole	1% milk	2% milk	Skim	Whole flavored	1% flavored milk	2% flavored milk	Skim flavored milk	Other milk
Whole	–1.28***	0.34***	0.51***	0.46***	0.02***	–0.02***	0.00	0.00	0.02***
1% milk	0.41***	–1.25***	0.38***	0.28***	0.03***	–0.02***	0.16***	0.02***	–0.01***
2% milk	0.27***	0.18***	–1.00***	0.50***	0.02***	0.04***	–0.01***	0.01***	0.00*
Skim	0.85***	0.18***	1.58***	–3.01***	0.08***	0.01	–0.06***	0.07***	0.31***
Whole flavored	0.75***	0.94***	0.88***	0.68***	–2.51***	0.34***	–0.27***	0.06	–0.88***
1% flavored milk	0.10*	0.03	1.99***	0.39***	0.38***	–2.38***	0.15***	–0.69***	0.02
2% flavored milk	0.56***	3.46***	0.23***	0.03	–0.27***	0.16***	–3.82***	–0.53***	0.18**
Skim flavored milk	0.62***	1.27***	1.13***	0.99***	0.11	–1.06***	–0.91***	–1.93***	0.22*
Other milk	0.15***	0.18***	0.37***	0.42***	–0.03***	–0.01***	0.00	–0.01***	–1.07***

Note. Asterisk *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level

Table 6. Estimated Marginal Effects for Demographic Variables

Variable	East	Central	West	White	Other race and ethnicity	Asian	Children 5 years old and younger	Children ages 6 -12
Whole	–0.001	–0.077***	–0.034***	–0.270***	–0.005***	–0.003	0.020***	0.001***
1% milk	–0.049***	0.018***	0.038***	0.099***	0.001***	0.002	0.005	0.004***
2% milk	–0.030***	0.016***	0.013***	0.011***	0.002	0.001*	–0.007***	0.003***
Skim	0.013***	0.072***	–0.050***	0.490***	0.001	0.003*	–0.037***	–0.028***
Whole flavored	–0.045***	0.088***	–0.181***	–0.144***	–0.001	–0.014***	0.003	0.008**
1% flavored milk	0.053***	0.070***	0.146***	0.235***	0.010***	0.002	0.005	0.019***
2% flavored milk	–0.015*	0.045***	–0.064***	–0.040	0.001	–0.005***	0.017**	0.014***
Skim flavored milk	0.110***	0.124***	0.009	0.126**	0.006	–0.003	0.006	0.020***
Other milk	0.007***	–0.001*	0.004***	–0.039***	0.000	–0.001***	0.004***	0.002***

Table 6. Estimated Marginal Effects for Demographic Variables (Continued)

Variable	Teenagers age 13-17	Males age 65 and older	Females age 65 and older	Household Size	Female HH with college degree	Female HH With some college	Female HH with HS diploma	Income > $19,999
Whole	–0.007***	–0.006***	–0.020***	0.131***	–0.063***	–0.015***	0.003***	0.023***
1% milk	0.008***	0.004***	0.012***	–0.102***	0.023***	0.009	–0.001	–0.014***
2% milk	0.008***	–0.001*	–0.003***	0.102***	–0.001	0.023***	0.029***	0.008***
Skim	–0.038***	0.021***	0.051***	–0.605***	0.126***	–0.091***	–0.147***	–0.069***
Whole flavored	0.014**	–0.056***	–0.052***	0.193***	–0.041***	0.024**	0.033***	0.000
1% flavored milk	0.004	–0.026***	–0.033***	0.088***	–0.040***	–0.005	0.000	0.002
2% flavored milk	0.010***	–0.043***	–0.045***	0.028	0.070***	0.092***	0.064***	–0.013**
Skim flavored milk	0.022**	–0.049***	–0.044***	0.135***	–0.001	0.017	0.006	–0.030***
Other milk	0.002***	–0.003***	–0.004***	0.026***	–0.008***	0.004***	0.007***	0.004***

Note. HH means head of household; and HS means High School.

Table 6. Estimated Marginal Effects for Demographic Variables (Continued)

Variable	Income $35,000 – 49,999	Income $50,000 – 69,999	Income $70,000 – 99,999	Income $100,000 – 149,999	Income ≤ $150,000
Whole	0.002*	–0.020***	–0.026***	–0.019***	–0.006***
1% milk	0.003*	0.009***	0.017***	0.012***	0.003***
2% milk	0.002*	0.001**	–0.008***	–0.011***	–0.004***
Skim	–0.020***	0.029***	0.069***	0.073***	0.031***
Whole flavored	–0.032***	–0.037***	–0.061***	–0.050***	–0.018***
1% flavored milk	0.033***	0.000	0.027***	0.012**	0.006**
2% flavored milk	–0.013*	–0.010	–0.014**	–0.003	–0.005*
Skim flavored milk	–0.008	–0.007	0.023*	–0.008	–0.005
Other milk	–0.002***	–0.003***	–0.003***	–0.003***	–0.002***

Note. Asterisk *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

respond most strongly to changes in prices for 1% milk as it relates to the demands for 2% flavored milk and skim flavored milk. A 1-percent decrease in the price of 1% milk will yield a 3.46% increase in the purchase of 2% flavored milk and 1.27% increase in the purchase of skim flavored milk. Also, a 1-percent reduction in the price of 2% milk and 1% flavored milk will give rise to purchases of skim flavored milk that exceed 1-percent. Like Maynard (2000), this study found whole milk to be a net substitute for 1% milk, 2% milk, and skim milks, as well as for the whole flavored milk and other fluid milk products. Cross-price elasticity estimates suggest that other fluid milk is a net complement to 1% milk and whole flavored. Similarly, skim flavored milk is a net complement to 1% and 2% flavored milks and other milk. Complementary relationships are found among flavored milks, which imply that consumers purchase both non-flavored and flavored milks and serve and/or consume them together.

Demographic Influence

Estimated demographic effects are presented in Table 6. A total of 21 demographic variables are included in the demand system. Several demographic variables have positive impacts on purchases of fluid milk products. Whole milk purchases are positively influenced by children ages 12 and younger, household size, female head of household with high school diploma, households earning less than $20,000 annually, and those earning $35,000 – $49,999. Gould, Cox, and Perali (1990) also found children ages 13 and younger to have a positive influence on whole milk purchases. Retail purchases of 1% milk are influenced positively by Whites and other races and ethnicities (of the heads of household), children ages 6 to 12, teenagers, males and females age 65 and older, female head of household with a college degree, households with income earnings of $35,000 and more, and people residing in the Central and Western regions of the United States. According to our findings, people residing in the Central and Western regions, children ages 6 to 12, teenagers, size of household, White heads of household, female head of household with some college experience and those with a high school diploma, and households with earnings less than $20,000 and those earning $35,000 to $69,999 annually positively influence the purchase of 2% milk. Demographic variables that positively influence purchases of skim milk include people residing in the Eastern and Central regions of the United States, White and Asian heads of household, male and female heads of household 65 years and older, females head of household with college degrees, and households with incomes of $35,000 and more annually.

Flavored milk products are also positively influenced by demographic variables. Of the four flavored milk categories, 1% flavored milk is influenced the most by demographic variables (Table 6). Purchases of 1% flavored milk are influenced positively by people residing in the Eastern, Central and Western regions of the United States, children ages 6 to 12, teenagers, size of household, White and of other race and ethnicity heads of household, and households with income earnings of $35,000 to $49,999 and $70,000 or more annually.

As displayed in Table 6, demographic variables have statistically significant impacts on fluid milk purchases. The demographic variables that have the broadest influence across most fluid milk categories are the Central region of the United States, children ages 6 to 12, teenagers, and household size. One reason the Central region has a positive effect on fluid milk purchases is that, on average, the Central region is an important dairy region that ranks in the top ten states in number of dairy animals and operations and raw milk production. What this finding suggests is

that people in the Central region purchase more fluid milk products than people residing in the Southern region, which is the reference. Gould (1996) also found region of residence to have a positive influence on fluid milk purchases. This finding is important to retailers and dairy manufactures because it informs them where milk is most desired and where they can possibly increase sales.

It is no surprise that children ages 6 to 12 and teenagers influence the purchase of fluid milk products. For most American children and teenagers, milk is an essential food product in their diet. Reduced-fat fluid milk products are encouraged by the USDA food pyramid and the 3-Every-Day program as a source of vitamin D needed to help support strong bones and healthy diets. Gould, Cox, and Perali (1990) found that children less than 5 years old, children from 5 years old to 13 years old had a positive influence on whole milk, but a negative effect on low fat milk. Similarly, Schmit and Kaiser (2004) showed that children less than 6 years old had a positive impact fluid milk purchases. This finding is important and it conveys to retailers and dairy manufactures that their marketing strategies and commercials that emphasize the benefits of drinking milk are effective.

Household size is also expected to positively influence fluid milk purchases. Large households have more people, particularly more children present in the home. The more children present in the home the greater the demand for fluid milk. Most of previous studies have used the age of children present in the home as a proxy for household size. Household size is an important finding because it gives retailers and dairy manufactures a clear indication of whether there are households with no children that also impact fluid milk purchases.

Household income is also an important factor in determining the demand for fluid milk. In table 6, each of the seven-income categories shows some statistical significance for one or more fluid milk product. Households that earned $35,000 or more annually have a positive influence on the purchase of 1% milk, while households that earned $50,000 or more annually have a positive influence on the purchase of skim milk. Results also suggest that households whose total income is $70,000 or more annually have a positive impact on purchases of 1% flavored milk. Like this study, Schmit and Kaiser (2004) showed that household income had a positive influence on fluid milk purchases. This finding is important in that it gives retailers some insight on the type of fluid milk they should supply based on the average household income of the neighborhoods.

Closing Remarks

Many studies have reported estimates of demand elasticities for fluid milk products, but they have generally identified only a few product categories. In this study, the retail purchases of nine different fluid milk products: whole milk, 1% milk, 2% milk, skim milk, whole flavored milk, 1% flavored milk, 2% flavored milk, skim flavored milk, and a category of all other fluid milk products, are analyzed. The Nielsen Homescan data used for the analysis included many zero purchases, which present a complicated statistical problem in estimating the demand system. A censored demand system procedure is used to address this issue and to obtain statistically consistent estimates for demand parameters and elasticities.

Both uncompensated and compensated demand elasticity estimates are derived. Demographic variables are statistically significant and are found to affect demands for the nine fluid milk products. Findings also suggest notable differences between empirical estimates from the compensated and uncompensated demand specifications for the skim milk own-price elasticity. Our own-price elasticity estimates for whole milk and 2% milk are similar to those reported by Boehm and Babb (1975), but larger than those reported by Gould (1996). Uncompensated elasticity estimates suggest a mixture of both gross substitutions and complements, while the compensated elasticity estimates suggest that net substitutions are the more obvious pattern among the milk products.

Why do cross-price elasticities matter? If these estimates just remain on the pages of this article, they do not matter at all. Retail store managers would care about cross-price elasticities because changes in the price of one product may have implications for the demands, or quantities of the other products they are selling. If the retailer store managers under estimate supplies they need to move through their dairy cases, it will cost them extra to procure needed supplies. If they over estimate, then they will have to return unsold products to their suppliers, which would result in lost revenues. Policymakers would also have an interest in these cross-price elasticities. The substitutability of the differentiated fluid milk products allows a low fat fluid milk product to be exchanged for a fluid milk product that has a relatively higher fat content. Researchers or modelers will use these cross-price elasticities to analyze policy changes for the policymaker or forecast future market demands and conditions.

A disaggregated list of fluid milk price and expenditure elasticities can help retailers, dairy industry analysts, and policymakers understand how consumer purchases of individual product might change if product prices are contemplated. It assists them by providing a multiple product analysis, which allows one to examine the correlation or relationship between different products. For example, the disaggregated fluid milk elasticities from this study can inform retailers and dairy producers how consumers will likely respond if there is a change in the own-price of any one or more of the fluid milk products. If there is a 1-percent increase in the price of whole milk (for example), retail and dairy managers can expect the purchase quantity to decline by 1.48% (based on the uncompensated results) and the demand for 1% milk, 2% milk, skim milk, whole flavored milk, 2% flavored milk, and skim flavored milk to increase by 0.20%, 0.05%, 0.64%, 0.50%, 0.30%, and 0.33%, respectively.

The demand elasticities for the milk products are derived from the comparisons among prices and quantities purchased of the identified fluid milk products. Whole milk may be more elastic relative to the others since there are now several perceived substitutes to it that deliver the attributes consumers' desires. The own-price elasticities for whole milk have changed overtime. For a business selling all the products—decisions to raise or lower the prices of not just the elastic product but all the substitutes may be made with more of an eye toward how sales in total would be affected and thus the overall revenues to the seller. Raising the price of an elastic product is likely to have a greater effect on total milk sales than would a change in a less elastic product (since quantities of the less elastic would not change as much). Milk is desirable for most children and the elderly population because it provides calcium, a nutrient essential to proper health and development. However, whole milk and products made with whole milk have declined overtime partly due to the support of healthy diets and the push for low fat dairy products

through programs like Women, Infants, and Children (WIC) and "3-Every-Day". A left shift in the demand curve for whole milk will cause both price and demand to fall, assuming all other things remain constant.

Assuming increases in consumers' food expenditures transfer into greater fluid milk expenditures, and given the estimated expenditure elasticities, it is expected that total fluid milk purchases also will rise. In particular, dairy producers and retailers may use these expenditure elasticities to estimate the impact increases or decreases in household expenditures may have on milk sales and dairy firm viability. A 1-percent increase in consumers' total milk expenditures will increase the purchase of 2% milk, skim milk, whole flavored milk, 1% flavored milk, 2% flavored milk, and skim flavored milk by more than 1-percent. All the expenditure elasticities suggest a positive effect on income in milk purchases. This study's expenditure elasticities for whole milk, 2% milk and 1% milk are similar to those reported in the literature (e.g., Gould, 1996).

Agricultural (dairy) product processors, manufacturers, and marketers or food retailers may use demographic information from studies to boost sales through advertisement of specific fluid milk products. For example, retail and dairy managers can use findings about the positive influence of factors such as children in the home, household size, female head of household with high school diploma, households earning less than $20,000 annually, and those earning $35,000 – $49,999 to help increase total sales of whole milk. It may be useful for retail and dairy managers to know that most fluid milk sales are positively influenced by teenagers, children ages 6 to 12, people residing in the Central region of the United States and large households. An increase in the Central region population will increase the demand for fluid milk. Over the next year, if there is an increase in household size, number of teenagers, or children ages 6 to 12 in America, we can expect the demand for fluid milk to increase also.

Selected household income categories have also had a positive influence on fluid milk consumption, particularly skim milk and 1% flavored and non-flavored milks. This information can be used by retail and dairy managers to increase sales through specific advertisements that target selected demographic group identified in this study. For example, the industry program "3-Every-Day", which is designed to encourage people to drink more low-fat milk, in addition to consuming more low-fat cheese and yogurt, developed several marketing programs directed toward children (National Dairy Council, 2011).

It has been suggested (Carman and Sexton, 2005) that fluid milk markets are vertically integrated from processors to retailers when the perspective is product costs but that at the retail level, estimates of demand relationships for fluid milk products are derived from a horizontally differentiated market. The information provided in this study can be useful to managers of both retail and dairy processing operations, but in different ways.

For the retailer, both demographic and economic information for specific locations is readily available from census and other sources. By analyzing this information to derive demand relationships such as price and demographic elasticities, retail managers can design specific pricing and promotional programs based on the demographic of the specific geographic locations of their stores. Since fluid milk generally has a short shelf-life product, the information provided in this study will also help retailers manage the dairy cases in their stores given the demographics of that store location.

The processors providing fluid milk products to determine retail customers can use information on how demand for those products relates to price or demographic factor changes to how much of each product might be made available. Milk is made up of fat, protein, and other solids in fixed proportions. As processors produce alternative final products, changing demands may force processors to find alternative markets for milk components. For example, if demand for lower fat fluid products grows, processors must find a use for the surplus fat in raw milk. This balancing of milk components may result in a fluid milk processor expanding his plant to include products such as ice cream, other cream products, and/or butter production.

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Determinants of the Use of Information: An Empirical Study of German Pig Farmers

Ludwig Arens[ⓓ a], Cord-Herwig Plumeyer[b] and Ludwig Theuvsen[c]

[a]*Ph.D., Department für Agrarökonomie und Rurale Entwicklung, Universität Göttingen, Platz der Göttinger Sieben 5, Göttingen, Niedersachsen, 37075, Germany.*

[b]*Ph.D., Department für Agrarökonomie und Rurale Entwicklung, Universität Göttingen, Platz der Göttinger Sieben 5, Göttingen, Niedersachsen, 37073, Germany.*

[c]*Professor, Department für Agrarökonomie und Rurale Entwicklung, Universität Göttingen, Platz der Göttinger Sieben 5, Göttingen, Niedersachsen, 370735, Germany.*

Abstract

Due to growing expectations for quality and safety of food products and an increasing demand for more transparent food supply chains, pork production faces new challenges. In the course of this development, chain-wide communication has gained importance in agribusiness. Nonetheless, existing approaches focus primarily on information supply, whereas the use of information for managerial decision-making has only rarely been highlighted. This research gap is addressed in this paper on the basis of a large-scale empirical study of animal health management on German pig farms. By applying factor and multinomial logistic regression analyses, this study identifies determinants of the use of information as well as ways to improve information use on farms. It shows that factors like intrinsic motivation and farmer's competence have a significant influence on information use.

Keywords: Chain-wide communication, information use, animal health management, pork production

ⓓCorresponding author: Tel: + 49. 551399442
Email: larens@uni-goettingen.de
C-H. Plumeyer: cplumey@gwdg.de
L. Theuvsen: theuvsen@uni-goettingen.de

Problem Definition and Goals

Various food crises have laid bare certain deficits in the quality control of food production and have resulted in a considerable loss of trust among consumers. Since the mid-1990s, a political reaction has resulted in the legislation and administration of new food production legislation which encompasses the entire supply chain "from the farm to the fork", from the pre-production areas of agriculture on through the production, manufacture, and distribution of the products (Fritz and Fischer 2007; Härtel 2007). Industry in turn has responded by implementing various quality control systems, the central element of which similarly aims to oversee all or at least the most important stages in the food production process (Hatanaka, Bain, and Busch 2005; Jahn 2006; Peupert and Theuvsen 2007).

Due to the many efforts of legislators and agribusiness firms to assure the improved quality of food products, the continuous exchange of information among all supply chain partners has become extremely important. Therefore, various efforts have been made to improve communication between supply chain partners. Examples of this development are new legislation concerning the exchange of information on salmonella monitoring in pork production, Regulation (EC) 853/2004 as part of the so-called "hygiene legislation package" regarding food supply chain information, and the requirements established by certification systems to pass on information to supply chain partners (Ziggers and Trienekens 1999; Schulze Althoff, Ellebrecht, and Petersen 2005; Deimel, Plumeyer, and Theuvsen 2008a). So far the exchange of information in agribusiness, particularly in the meat industry, has been hindered by considerable organizational and structural barriers. The transfer of information is difficult due to complex supply chain structures, resulting in numerous organizational interfaces along supply chains, each of which acts as a hurdle the information flow has to overcome (Deimel, Frentrup, and Theuvsen 2008). In the meat supply chain, the interface between agribusiness firms like slaughterhouses and farmers seems to be the most difficult relationship due to structural and organizational disparities (Deimel, Plumeyer, and Theuvsen 2009). Therefore, in recent years great efforts have been made to take advantage of modern information technologies that allow a multitude of information on food quality derived from the findings at slaughterhouses (e.g., results of salmonella testing and other animal health issues) to be systematically gathered and made more available to farmers in order to enable them to improve their animal health (AH) management (Plumeyer, Theuvsen, and Bahlmann 2009).

In order to ensure the effective use of information, it must not only be guaranteed that the information can flow unhindered along food supply chains, it is also important that the recipients use the information provided in their managerial decision-making processes (O'Reilly 1982; Amponsah 1995). The adequate use of information in order to create knowledge can be seen as a "[…] growing individual and collective optimization problem […]" (Stock et al. 1998). Its solution plays an important role in agribusiness firms' ability to gain and sustain competitiveness (Carneiro 2000). The exchange and use of chain-wide information are of particular importance for hog farmers due to the high prevalence of subclinical infections such as salmonella which result from inadequate hygiene management during piglet and fattening stages, but are in most cases only detected during slaughter (Mack et al. 2005). Blaha (2004) refers to this as the problem of "pre-harvest food safety", and so far it has received only limited attention.

Considering the need to assure a continuous flow and use of information among the organizational interfaces between farmers and slaughterhouses, it is surprising that so little scientific research has been devoted to this topic. The literature mostly focuses on the use of information systems instead of use of information distributed through such systems (Davis 1989; Morris 1991; Venkatesh et al. 2003; Bahlmann and Spiller 2009). In agribusiness, the literature addresses only the technical design of information delivery systems or the use of information providers (Amponsah 1995). Thus, the absence of research about information use is especially obvious in this field. Therefore, the goal of this paper is to analyze hog farmers' use of information provided by processors and to derive recommendations that contribute to the improvement of communication among all supply chain partners. The contribution this makes to previous studies on the exchange of information lies in the identification of relevant practice-oriented determinants of use of chain-wide information by hog farmers. This allows the development and implementation of more advanced technical approaches which also take into account human information behaviour. The latter is seen as an important influence regarding the use of information systems (Gershon and Slade 1984; Alvarez and Nuthall 2006). In doing so, we first give an overview of the German pig sector. Then we describe the conceptual framework, methodology and sample of our research and present the results of the univariate analyses of our empirical data. Factor and multinomial logistic regression analyses are used to test the theoretical framework underlying the study. The paper closes with a discussion of results, some conclusions and suggestions for further research.

German Pig Sector

Germany is the world's third largest pork producer with an output of 5.4 mio. tons in 2010. In the European Union, Germany is the largest pork producer, followed by Spain, France, Denmark and Poland. After German reunification, German pork production declined due to the privatization process in Eastern Germany and the reduction of production capacities in the new German states. As a result, herd size decreased from 34.2 million pigs in 1990 to 26.5 million pigs in 1996 (Spiller et al. 2005). Since then, production has slowly recovered; in 2010, 32,900 pig farmers kept 26.9 mill. pigs. Due to growing imports of slaughter pigs, pork production reached an all-time high in 2010. In 2006, for the first time in history, Germany was a net exporter of pork (Burchardi et al. 2007).

The major pig producing area is located in North-Western Germany close to the Dutch border where 17,000 farmers keep about 14.7 mill. pigs, or about 55% of the German pig herd. A second important production area is Southern Germany (Bavaria: 3.6 mill. pigs on 7,600 farms; Baden-Wuerttemberg: 2.08 mill. pigs on 3,600 farms). Farm size is much larger in Northern Germany; average herd size is 864.7 pigs in the North-West compared to only 473.7 pigs in Bavaria (Destatis 2010a, 2010b).

The requirements for conventional husbandry apply to over 99% of the hogs in Germany. Less than 1 percent are produced according to the standards for organic farming (Burchardi et al. 2007). Sows were held alone in pens with their piglets and hogs for fattening in heated stables with perforated flooring for the discharge of liquid excrement (98%) according to EU Regulations (2001/88/EG) (Hoy 2002).

In Germany, farmers are confronted with a growing concentration ratio at the processor level, but, with 226 slaughterhouses, there are still enough alternative buyers of slaughter pigs. The leading companies (ISN 2011), Tönnies (24.4% share of total slaughters), Vion (18.4%), and the cooperative Westfleisch (11.3%), follow different sourcing strategies: Tönnies and Vion work with private livestock dealers and pig marketing cooperatives and only rarely with individual farmers. Transportation of slaughter pigs is also provided by these traders. In contrast, Westfleisch introduced marketing contracts with 70% of its farmers in 2001 and owns a logistics centre. However, Westfleisch marketing contracts do not go very far. Farmers are allowed to choose from several breeds, which only have to be evaluated positively in a test program; the same applies to the feed. Thus, the intent of these contracts is only to ensure a certain percentage of the quantities required. Vion, Tönnies and most of the remaining German slaughterhouses do not apply contracts, nor are they vertically integrated—except for some smaller farmer associations that operate their own slaughterhouses (Schulze, Spiller, and Theuvsen 2007).

Conceptual Framework

Exchange and Use of Information as Success Factors

Research conducted in various industry subsectors and regions has indicated that communication plays a decisive role in firm performance (Narver and Slater 1990; Deshpande, Farley, and Webster 1993; Bigne and Blesa 2003). Fawcett and Magnan (2001) state that "[…] information is the 'life blood' of effective supply chain management". In a survey of firm managers, Baker and Sinkula (1999) were able to show that not only firm performance but also innovativeness correlates significantly with the exchange of information. Moreover, the exchange of information among partners is an essential determinant of the successful strategic positioning of firm networks (Jarillo 1988). Other network theories also consider the continuous exchange of information an essential success factor (Miles and Snow 1984; Granovetter 1985).

Empirical studies have repeatedly confirmed the importance of a continuous exchange of information in food supply chains (Hill and Scudder 2002; Reiner 2005; Schulze, Spiller, and Theuvsen 2006b). Caswell and Mojduszka (1996) and Theuvsen, Plumeyer and Gawron (2007) particularly emphasize the high relevance of information exchange for food quality and safety. Lazzarini, Chaddad and Cook (2001) as well as Windhorst (2004) see the unhindered flow of information between supply chains partners as an essential precondition for the integration of supply chains and networks in the agribusiness sector. Whereas Hollmann-Hespos (2008) analyses determinants of investments in tracking and tracing systems that aim at the improvement of information flows relevant for traceability of food and feed products, Peupert and Theuvsen (2007) discuss how the exchange of quality information in agribusiness can be supported by the use of quality techniques such as quality function deployment.

In addition to the availability and supply of information, its use is also a key success factor (Moorman, Zaltman, and Deshpande 1992). The use of information constitutes a cognitive process that encompasses the acquisition, processing and storage of information, as well as the effect (e.g., the actions of the information user) (O'Reilly 1982). Choo (1996), Weißenberger (1997) and Thong (1999) consider the use of information as the primary goal of the information exchange.

The analysis of information use is difficult since it can neither be observed directly nor described or explained in its entirety. Previous studies, therefore, were confined to an indirect observation of the use of information and could only cover selected aspects. One of the first scientific studies on the use of information was done by Simon et al. (1954) and focused on how information is used in the context of controlling. With regard to agriculture and the food industry, various studies on the acceptance and use of new informational technologies have been published (Davis 1989; Goodhue and Thompson 1995; Venkatesh et al. 2003; Vennemann and Theuvsen 2004). Information use in farmers' decision-making processes was analyzed by Öhlmér et al. (1997), whereas Hannus (2008) took a more technical approach to its analysis in the context of quality assurance processes in the agribusiness sector.

The Exchange and Use of Information in Pork Production

A broad spectrum of information is transferred along pork supply chains, concerning matters as diverse as prices, costs, product quality, expected supply and demand, orders and delivery dates (Deimel, Plumeyer, and Theuvsen 2008a). Drivers of information exchange along pork production chains are legal requirements, certification systems and the need to coordinate business operations between supply chain partners (Plumeyer, Deimel, and Theuvsen 2008). The diverse content of communication, complex business relationships and the danger of information asymmetries pose special challenges for the management of communication relationships in pork production chains (Deimel, Plumeyer, and Theuvsen 2009).

The continuous flow of information along pork production chains with regard to such matters as data gathered at slaughterhouses is hindered by the highly differentiated organizational structure of these supply chains. This is due to an intensive vertical and horizontal division of labour, which results in a complex value-added network in pork production (Bijman et al. 2006; Schulze Althoff 2006). This network is characterized by an extreme inhomogeneity (Horváth 2004; Spiller et al. 2005). A large number of comparatively small farms are confronted with a much smaller number of slaughterhouses operating nationally or even internationally. The complexity of supply chains strongly contributes to the complexity of information flows (Gampl 2006; Theuvsen, Plumeyer, and Gawron 2007).

Despite these problems, the continuous flow of information is considered essential for successful pork production (Den Ouden et al. 1996; Windhorst 2004). Petersen (2003) and Doluschitz (2007) emphasize that the efficiency of businesses processes, animal health and food safety can be improved through more effective communication. Furthermore, the exchange of information between hog farmers and slaughterhouses has been analysed with regard to its effect on the transparency of supply chains (Deimel, Frentrup, and Theuvsen 2008; Deimel, Plumeyer, and Theuvsen 2008a; Frentrup 2008). Other authors have highlighted the relationship between information exchange and the quality of animal health management at the farm level (Schulze Althoff 2006) as well as the influence of alternative forms of vertical coordination of pork production chains on information exchange (Schulze, Spiller, and Theuvsen 2006b).

The use of animal health (AH) information throughout the supply chain is considered essential to the improvement of food quality (Doluschitz 2007; Theuvsen and Plumeyer 2007). Thus, slaughterhouses are continually demanding stricter quality control measures on farms (Petersen et al.

2007) because shortcomings at the farm level (e.g., salmonella infections) often lead to hard-to-tackle problems in downstream industries (Mack 2007). Recent legislation has supported these demands. Hog farmers are now legally required to continuously use available salmonella testing results. However, it is often suspected that hog farmers do not make optimal use of the available information in their animal health management (Morris 1991; Blaha 2007a; Vallan 2007). In fact, empirical studies indicate a very heterogeneous use of the results of salmonella tests (Plumeyer, Deimel, and Theuvsen 2009).

Factors Influencing the Use of Animal Health Information

On the basis of previous studies, this investigation began by outlining the factors influencing the actual use of AH information at all levels of the pork production chain and summarizing them in an exploratory and explanatory model (Figure 1). To this end, a one-step model design was intentionally used in order to obtain basic theoretical understanding of the determinants of use of chain-wide AH information.

The endogenous variable was a direct question concerning the frequency of information use. This question referred to specific information regarding AH management. The exogenous variables were derived from the existing literature in the areas of communications and information research, as well as agribusiness. The model is an ad hoc design developed specifically to address the information needs in the pork production sector.

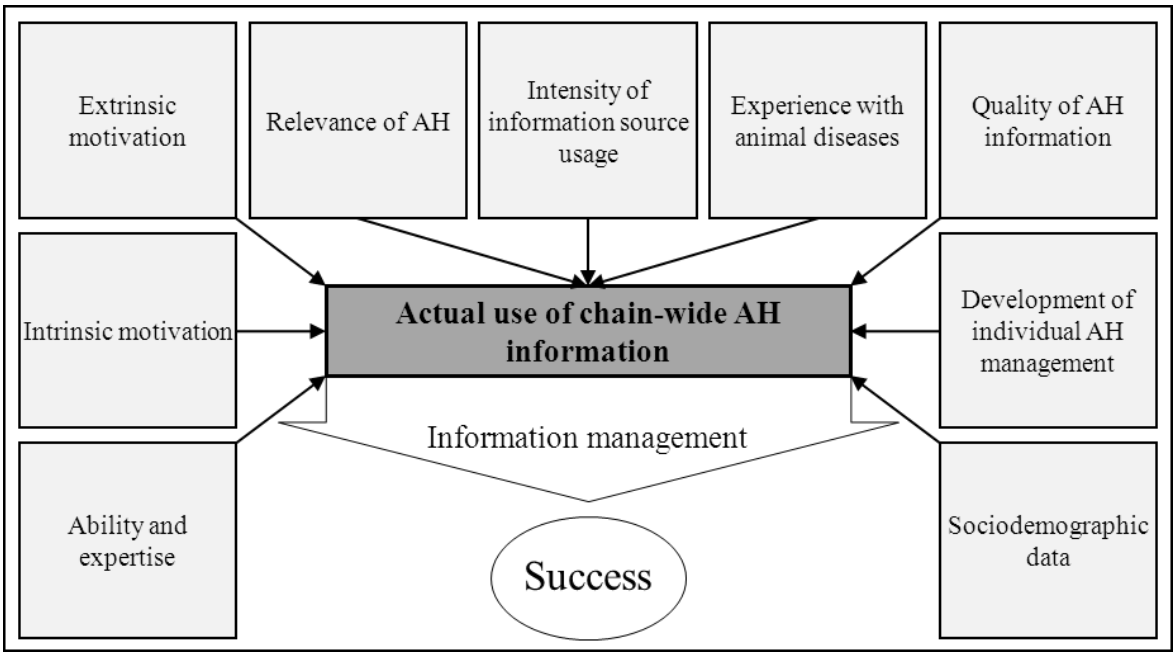

Figure 1. Theoretical Framework

Knierim and Sieber (2005) found that farmers' **ability and expertise** as well as their motivation influence farmers' actions. Fernandez-Cornejo and McBride (2002) also determined a relationship between farm managers' abilities and their decision-making behavior. Regarding the management of salmonella in hog fattening, Blaha (2007a), Bode (2007) and Vallan (2007) assume a

diverse use of information due to vast differences in the skills and motivation of farmers. With regard to farmers' motivation, motivation theory suggests distinguishing between **intrinsic and extrinsic motivation** (Frey 1993). The former reflects one's personal goals and the motivation potential of task themselves, such as fattening healthy animals, whereas the latter reflects external pressures, such as the threat of receiving a reduced price from slaughterhouses for infected hogs.

Besides expertise and motivation, Öhlmér, Olson, and Brehmer (1997) identify other factors, for example, the **relevance of a problem** (e.g., health status of hogs) and its operationalization (e.g., with regard to financial outcomes) as determinants of information use. With regard to animal health, both factors are influenced by legal as well as private standards.

An appropriate **intensity of information source usage** is an essential precondition for the use of information (Kuß and Tomczak 2002; Meffert, Burmann, and Kirchgeorg 2008). Mohr and Sohi (1995) also describe the usage of different information sources as an important determinant of chain-wide communication. Current efforts seek to increase the usage of different sources within the pork industry through the implementation of IT-based communication systems (Deimel, Plumeyer, and Theuvsen 2008a).

We also assume that farmers' personal **experience**, for instance, with the outbreak of an animal disease, affects their information use (Öhlmér, Olson, and Brehmer 1997). Jahn, Peupert, and Spiller (2003) were able to identify a change in attitudes towards certification systems among farmers who had experienced quality- and safety-related incidents.

A further determinant is the perceived **quality of AH information**. Zahay and Griffin (2003) hypothesize that the information use depends on the quality of the information provided. The empirical study of McKinnon and Bruns (1992) also indicates that the use of—in this case—controlling information was highly dependent on the quality of information. Similarly, Schulze (2008) and Wocken (2008) found correlations between the perceived quality of information and the intensity of communication in the agribusiness sector.

According to Dippold (2005), the management of information must always be viewed in the context of the problem to be solved. Thus, the **development of a farms' individual AH management** can be identified as another key determinant. Blaha (2007b) states that a certain development level of the AH management as well as a basic understanding of animal health issues are prerequisites for improvement in this area. Finally, **sociodemographic data**, such as farm size and farmers' age, has repeatedly been identified as an influential factor on decision-making processes in agriculture and the food industry (Nayga 1996; Rosskopf and Wagner 2003; Wocken 2008).

Methodology

In order to determine the use of information for animal health management in the pork industry, 3,024 hog farmers from all across Germany were surveyed between April and May 2008. The test persons were approached using a quota from each state. In this manner it was ensured that the regions with a high density of hog fattening were adequately represented. However, despite

this measure it is not possible to guarantee the representative status of the study. The response rate was approximately 29% (sample size: N=873). Due to sporadic missing values, sample size varies slightly among the individual analyses. The survey of hog farmers included three thematic blocks. Besides asking questions as to sociodemographic background, data was collected on farmers' use of information and their use of computers and the internet with relation to pork production. The special research question served as a basis for an ad hoc operationalization of the constructs introduced above in statement batteries. Data on information use processes was obtained by asking farmers to agree or disagree with these statements on five-point Likert scales. To this end, the scales traditionally used in social research were applied (Roßteutscher 2004; Spiller and Schulze 2008; Gehring and Weins 2009). The data set was analyzed by univariate as well as multivariate tests, including means comparison, factor analysis and a multinomial logistic regression. The data regarding information use behavior was analyzed using a multinomial logistic regression model. Multinomial logistic regression models enable one to calculate probabilities and identify the influencing factors that determine them (Backhaus et al. 2008) using the maximum likelihood estimation (MLE). With the MLE, the parameters of the logistic regression model can be set so as to maximize the likelihood of preserving the observed data. Since, in order to maximize the occurrence probability for all observable cases at the same time, the probability statement for independent events (information use) should be applied, the likelihood function is maximized through the use of the Newton-Raphson method in an iterative process. Since there is no linear relationship between the independent variables and the occurrence probabilities determined by the logical function, it is difficult to interpret the meaning of the regression coefficient; only the tendency of the influence is recognizable. The odds of obtaining a given event rather than its complement are mirrored in the relationship between the occurrence probability and its complement (Backhaus et al. 2008). Statements concerning the effect of the influence strengths on the occurrence probability can be made by way of so-called effect coefficients (odds ratios), which indicate how the odds change when the value of the independent variable increases by one (Menard 2002; O'Connell 2006). These analyses were completed using SPSS 19 software.

Results

Sample Characteristics

Although respondents from all over Germany participated in the survey, farms from intensive production regions (the Weser-Ems region and North Rhine–Westphalia) are strongly represented in the sample. Respondents are on average 45.4 years old (German average = 44.3 years), and 95% (Germany: Agriculture = 68%) of them were male. The vast majority of respondents (95%) were either owner-managers or successors. The farmers usually worked full-time on the farm (85.8%), and the majority of the farms (69%; Germany = 75%) focused on hog fattening (see Table 1). For the most part (75%), the farms were family farms with an average size of 211 ha. This large average farm size—compared to the overall German average—resulted from the relatively high percentage of large farms from Eastern Germany in the sample. On average, the farms surveyed have room for fattening 1,342 (Germany = 880) hogs; 24% of them plan to extend their capacity by an average by 766 hogs. Table 1 shows technical, economic and structural data regarding the hog production. Taking into account the high standard deviations in the descriptive results, we are facing a partly heterogeneous sample. By looking at the cost of medica-

tion and the average loss rate, the high standard deviation clarifies the remarkable differences in success among the farmers surveyed. This could raise the question whether the farmers' information management is related to the success of their farms. This hypothesis, which is also posed in the conceptual framework, is analyzed in Table 4.

Table 1. Technical and economic performance indicators

Question	Mean	SD
What is your average cost of medication (€) per hog?	4.13	13.31
What is the average weight of your piglets when they begin the fattening process?	28.97	3.93
What is the average number of days that your hogs are fattened?	119.68	14.02
What is the average loss of your pig herd (%)?	2.67	1.13
How many hog fattening pens do you have?	1342.24	2056.46
How many hectares do you farm?	211.12	565.91
I have been active in hog fattening for roughly ____ years.	20.63	10.83
	Modal	**%**
What is your operational emphasis? (Please check only one.)	fattening	50.6
Is your farm your main or an additional source of income?	main income	85.8
In which production system are you fattening your hogs?	solely hog fattening	68.9

Determinants of Information Use

In order to more thoroughly analyze the determinants of farmers' use of animal health information, a group of 28 statements on information use were subjected to factor analysis. The quality of the data for factor analysis was tested with the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett-Test for sphericity. The KMO coefficient shows whether sufficient correlations are present to justify a factor analysis. The KMO value of 0.754 can be considered "pretty good" (Backhaus et al. 2008). The Bartlett test checks the null hypothesis that all correlations are equal to zero (sig.= 0.000). The test statistics are Chi-square distributed and account for 3743.827 with 300 degrees of freedom; the correlations, therefore, significantly deviate from zero (sig.= 0.000). The results of both tests show that the variables used in the factor analysis are appropriate. The factor analysis reached acceptable results with 54.89% of the total variance explained. A total of seven factors were extracted (Table 2): extrinsic motivation, relevance of AH, intrinsic motivation, farmer's competence, intensity of information source usage, farm's individual AH management development and quality of AH information. Three factors have only limited reliability since their Cronbach's Alpha values are above 0.614 but below 0.65 (Nunnaly 1978). However, the constructs are not excluded from further analyses since they are consistent both internally and with others' results (Pedhazur and Pedhazur Schmelkin 1991).

A multinomial logistic regression analysis was used to determine which of the identified factors and additional variables determine the actual use of AH information (see conceptual model in Figure 1). In this case, the dependent variable is a single variable indicating the time spent using information about AH management. The variable has three expressions: little time, average amount of time and much time spent in information use.

Table 2. Determinants of information use: Factor analysis

Parameter	Mean	Standard deviation	Factor load
Extrinsic motivation, Cronbach's Alpha = 0.808			
It's a waste of time to go over the salmonella reports.[1]	-1.07	0.832	0.877
I personally can't do anything with the salmonella reports.[1]	-0.87	0.895	0.788
As long as I am not threatened by penalties, I have no interest in/ignore the salmonella reports.[1]	-1.26	0.764	0.785
Relevance of AH, Cronbach's Alpha = 0.614			
I have enormous competitive advantages when my hogs have above-average health.[1]	1.42	0.696	0.840
I can avoid a great reduction in market price when my hogs are in good health.[1]	1.18	0.729	0.735
Intrinsic motivation, Cronbach's Alpha = 0.665			
I feel morally responsible for keeping my hogs in good health.[1]	1.48	0.599	0.718
I take great joy in seeing healthy hogs in the pen.[1]	1.71	0.474	0.640
As a farmer I am responsible for ensuring that the consumers do not get salmonella poisoning.[1]	1.13	0.942	0.617
I'm filled with pride when my farm has a good salmonella status.[1]	1.2	0.785	0.558
When it comes to maintaining the health of my hogs, I go to great trouble.[1]	0.95	0.683	0.555
Farmer's competence, Cronbach's Alpha = 0.657			
When it comes to knowing about diseases affecting hogs, I am an expert.[1]	0.48	0.666	0.707
I always know exactly what to do when my hogs are not healthy.[1]	0.32	0.64	0.729
I receive sufficient information about the health of my hogs.[1]	0.66	0.695	0.698
I pay particular attention to the results of hog health testing.[1]	0.99	0.663	0.503
Intensity of information source usage, Cronbach's Alpha = 0.639			
How often do you use this information in daily operations to improve/optimize hog health?			
Consultant recommendations[3]	0.382	0.931	0.718
Veterinarian recommendations[3]	0.399	0.778	0.711
Salmonella test results[3]	0.846	0.926	0.625
Organ test results[3]	0.818	0.928	0.630
Farm's individual AH management development, Cronbach's Alpha = 0.704			
I frequently check on hog health status because the businesses I sell to require it.[1]	0.38	0.974	0.815
I frequently check on the salmonella status because it is a government requirement.[1]	0.48	0.926	0.811
Quality of AH information, Cronbach's Alpha = 0.628			
How informative do you consider the following resources to be regarding hog health?			
branch-oriented publications[2]	0.73	0.667	0.686
lecture events/informational talks[2]	0.68	0.671	0.643
representatives of the feed or pharmaceutical industry[2]	0.17	0.707	0.622
information on the Internet[2]	0.56	0.758	0.617
other farmers/people in the business[2]	0.356	0.75	0.554

KMO = 0.754; Total variance = 54.89 %; [1] = Scale ranges from 2 = completely agree to -2 = totally disagree; [2] = scale from -2 = completely useless to 2 = very useful; [3] = scale from 2 = very frequently to -2 = never

The information about the model adjustment was acquired through the likelihood ratio test (Backhaus et al. 2008). At 209.158, the chi-square value is highly significant; thus, the model distinguishes reliably between the groups. The quality of the adaptation was evaluated using a classification matrix. The model's hit rate (56.6 %) was not only greater than the proportional probability (29.8 %), but also greater than the maximal coincidence probability (42.1 %); thus, its hit rate can be characterized as good. As a whole, however, the quality of the model is average. This is because the pseudo R-square statistics that quantify the manifested variations of the logistic regression model lie between 0.2 and 0.4 (Backhaus et al. 2008). Both the Cox & Snell R2 (0.264) and the Nagelkerke R2 (0.318) are in that "good" zone; only the conservative McFadden R2 (0.172) lies outside it.

Table 3. Results of the Multinomial Logistic Regression Analysis

	Little time vs. average amount of time[1]	**Much time vs. average amount of time[1]**
	B (Exp (B))	**B (Exp (B))**
Extrinsic motivation	0.174 (1.190)	0.03 (1.003)
Intrinsic motivation	-0.329** (0.720)	0.498*** (1.646)
Quality of AH information	-0.620*** (0.538)	0.387*** (1.473)
Intensity of information source usage	-0.532*** (0.588)	0.489*** (1.631)
Farmer´s competence	-0.715*** (0.489)	0.744*** (2.105)
Farm´s individual AH management development	-0.231 (0.794)	-0.166 (0.847)
Relevance of AH	-0.037 (0.964)	0.078 (1.081)
Hog fattening capacity[2]	0.000 (1.00)	0.000 (1.00)
Experience with gastro-intestinal disease[2]	-0.170 (0.844)	0.184 (1.202)

[1]Reference group; [2]Single variable; B = regression coefficient; Exp(B) = effect coefficient; ***p ≤ 0.001, **p ≤ 0.01, *p ≤ 0.05; likelihood ratio test: chi-square value = 209.158; significance = 0.000; Hit rate of the model = 66.3%; proportional coincidence probability = 47.7%; maximal coincidence probability = 63.4%; Cox & Snell pseudo R^2 = 0.264; McFadden pseudo R^2 = 0.172; Nagelkerke pseudo R^2 = 0.318

As the results shown in Table 3 clearly indicate, the factors identified above influence the use of information. Contrary to the assumption of the conceptual framework, sociodemographic data has little impact on information use; therefore, only the farm's "hog fattening capacity" was taken into account. A second variable represented the farmer´s experience with animal diseases (Did your hogs show evidence of the following diseases over the past two years?; scale from 2 = very frequently to -2 = never). In the social sciences, the rating scale used to measure the variables can be characterized as quasi-metric as long as there are at least five choices (Bagozzi 1981). Based on statistics literature, this justifies its use in this analysis (Jaccard and Wan 1996; Bortz 1999).

The likelihood ratio test, which represents a quality judgment on the variable level and indicates the explanatory power of independent variables (Backhaus et al. 2008), identifies the factors, or variables, 'intrinsic motivation', 'quality of AH information', intensity of information source usage' and 'farmers competence' as significant influencing factors in distinguishing between the groups. It is not surprising that a high 'quality of AH information' increases the likelihood that a farmer will devote more time to information use. The same is true for the increased use of information sources; this also has a positive effect on the extent of information use. Furthermore, both

greater farming competence and stronger intrinsic motivation raise the probability that more information will be used.

Information Management and Success in Animal Health Management

In order to integrate the success of animal health management into the analysis, the farmers surveyed were grouped into three groups with regard to their perceived success in animal health management: less successful farms (N=30), those with average success (N=500), and more successful farms (N=229). A comparison of the mean values reveals that the prerequisites for the use of AH information, as well as the varying degree of information management, significantly varies among the three groups (Table 4). In addition to the great significance determined, which may have been due to the influence of the larger sample size, the results reveal the tendency that more successful farms have a better information management. The comparison thus provided interesting clues to the positive influence information management exerts on the success of hog farming.

Table 4. Information management among hog farmers: comparison of mean values

Please compare your success with hog health with that of other farms.	Less successful farms	Farms with average success	More successful farms
[a]I learned in my training about the importance of hog health. ***	0.8 (σ=0.96)	0.91 (σ=0.69)	1.11 (σ=0.72)
[a]I receive adequate information about the health of my hogs. ***	0.35 (σ=0.77)	0.58 (σ=0.68)	0.82 (σ=0.66)
[a]I carefully evaluate the data regarding the health of my hogs. ***	0.47 (σ=0.73)	0.09 (σ=0.65)	1.19 (σ=0.61)
[b]How much time do you spend learning about ways to improve the health of hogs? ***	2.93 (σ=0.78)	3.02 (σ=0.64)	3.35 (σ=0.69)

[a]Scale: 2=totally agree to -2=totally disagree; [b]Scale: 5=a lot of time to 1=very little time;
**** = p < 0.001, ** = p < 0.01; * = p <0.05; σ = standard deviation*

According to the empirical results, the farmers who experience average success and those with above-average success learned more about the importance of animal health during their training, feel that they receive more information on animal health, more carefully analyze animal health information and spend more time on acquiring information about animal health.

Discussion and Conclusions

Various researchers have advocated intensifying information exchange in order to promote continuous improvement of quality management in the pork industry (Doluschitz 2007; Petersen et al. 2007; Deimel, Plumeyer, and Theuvsen 2008a). Thus, in addition to a request for adequate availability of information, there should be a stronger focus on its use. Initial efforts in this direction can be seen in both public and private regulations concerning salmonella in pork; these regulations have established mandatory information exchange between farmers, veterinarians and consultants for farms in the worst salmonella category.

Four factors extracted in the factor analysis show a significant influence on the time spent in information usage. It is interesting to note that the use of information does not depend on sociodemographic factors. Instead, it is influenced by manifest factors such as "Intensity of information source usage" as well as latent parameters such as intrinsic motivation. The negligible influence of sociodemographic factors has already been shown in other studies, for instance on the willingness of dairy farmers to change their dairy company (Wocken and Spiller 2009). Main influences of the information use are the quality of AH information, intrinsic motivation, intensity of information source usage and farmers competence. Knierim and Siebert (2005) have already emphasized the great significance the expertise of the farmers has when it comes to the effectiveness of handling their affairs. Greater expertise has a positive effect on the use of information (Fernandez-Cornejo and McBride 2002). The present study confirms this finding in the case of animal health management.

It is not surprising that the intrinsic motivation of farmers exerts a positive influence on the use of information. Extrinsic motivation stemming from external forces such as sanctions has no significant influence. This indicates that external pressure alone is not sufficient to bring about improvement. Rather, additional efforts to improve farmers' intrinsic motivation are important. Measures that could be taken along this line within the meat industry might include a reliance on role models (for instance, successful, widely known farmers) as well as educational activities (Theuvsen 2003).

A high-functioning exchange of information has repeatedly been identified as a success factor (Narver and Slater 1990; Deshpande, Farley, and Webster 1993; Bigne and Blesa 2003). The means comparison in this study also revealed significant differences between more successful and less successful farms with regard to animal health management. This indicates a positive correlation between information management and successful animal health management. The fact that successful farmers had learned more about the importance of animal health management in their training presents a starting point for influencing the attitude of farmers towards animal health management. In addition, the correlation between the use of animal health information and business success is significant. The valence theory shows that positively valued outcomes—in this case, greater business success—motivate individuals to improve animal health management on their farms in order to attainment these goals (Vroom 1964).

The implementation of IT-based communication systems is currently a widespread trend in the meat sector (Bahlmann, Spiller, and Plumeyer 2009). According to the results of our study, the success of such systems is not solely dependent on their technical capabilities; it also depends on the behaviour of the farmers using those systems and the information provided by these systems (Theuvsen and Plumeyer 2007) as well as farmers' attitudes towards animal health management. Therefore, although IT-based systems are an important component of communication along food chains, their implementation has to be supplemented by additional measures that address the determinants of information use.

Further research might provide a more in-depth analysis of the determinants of the use of animal health information in order to develop longer-term strategies for the successful implementation of IT-based information systems. According to the insights gained by the foregoing explorative models, a multi-layer conceptual model should be developed (for instance, Structural Equation

Model). This would enable determination of interdependencies between the constructions. Possible cause-and-effect relationships could be analysed via a causal analysis. It is conceivable that moderating variables such as technical or economic performance indicators and various methods of production could highlight differences between various groups. In terms of different hog production structures in Germany, a multiple-group comparison should be implemented for the north-western, southern and eastern German region.

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Comparative Economic and Gender, Labor Analysis of Conservation Agriculture Practices in Tribal Villages in India

Cynthia Lai[a], Catherine Chan[Φb], Jacqueline Halbrendt[c], Linsey Shariq[d], Pravat Roul[e], Travis Idol[f], Chittanrajan Ray[g], and Carl Evensen[h]

[a, c, d]*Graduate Students, Natural Resource and Environmental Management, 1910 East West Road, Sherman Lab101, University of Hawaii, Honolulu, Hawaii, 96822, U.S.A*

[b]*Professor, Natural Resource and Environmental Management, 1910 East West Road, Sherman Lab 101, University of Hawaii, Honolulu, Hawaii, 96822, U.S.A*

[e]*Associate Professor, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India*

[f]*Associate Professor, Water Resources Research Center,1910 East West Road, Sherman Lab 101, University of Hawaii, Honolulu, Hawaii, 96822, U.S.A*

[g]*Professor, Water Resources Research Center,1910 East West Road, Sherman Lab 101, University of Hawaii, Honolulu, Hawaii, 96822, U.S.A*

[h]*Professor, Natural Resource and Environmental Management, POST 204H, University of Hawaii, Honolulu, Hawaii, 96822, U.S.A*

Abstract

The tribal villages within the district of Kendujhar, Odisha State, India struggle with farming on marginal lands with an increasing detrimental effect on agricultural productivity. Research has been focused on the implementation of conservation agriculture (CA) practices, specifically: minimum tillage and intercropping in such villages. Results provide a comparative economic and gender labor analyses of selected CA practices, future implications, and insight for agribusinesses, farmers and policymakers.

Keywords: India, conservation agriculture, gender, labor, maize, cowpea

[Φ]Corresponding author: Tel: + 1 808.956.7530
Email: chanhalb@hawaii.edu

Introduction

Kendujhar is one of the poorest tribal districts in the state of Odisha, India. Located in the agro-climatic zone of Odisha's North Central Plateau (Figure 1), it is characterized by multiple small villages of 30-100 households. Each household is engaged in low-input subsistence agriculture, with farm sizes generally less than 2 hectares. More than 40% of farmers earn less than 100 Indian Rupees (INR) per month (2 USD/mo/capita).

Farmers grow a variety of crops, focusing mainly on staple crops such as rice and maize. Yields throughout Odisha are lower than the national average, with approximately 1.5 tons per hectare for rice and 2.2 ton per hectare for maize (Government of Odisha 2010). However, these yields generally apply to modern, high-yielding crop varieties, which dominate much of the commercial production in the state. In the tribal villages of Kendujhar, household income is mainly through the selling of agricultural outputs where farmers predominantly use traditional low-yielding varieties of maize and rice, irrigation is uncommon, and fertilization consists primarily of farmyard manure application with occasional supplements of inorganic N and P additions.

In developing countries, agriculture can play a significant role in regards to economic development; specifically, to tribal subsistence farmers who rely on their land for food and income. Given the propensity for low agricultural outputs and land degradation from such conventional farming systems, there exists much opportunity for the introduction of improved farm management and cultivation practices. While introducing standard agricultural "Green Revolution" technologies into these villages can increase crop yields (Dr. P.K. Roul (OUAT), personal communication, 2010), farmers with small landholdings, low income, poor access to credit, and limited technical capacity simply cannot take full advantage of interventions that are more suitable for large, mechanized farms. Moreover, output growth is not only determined by technological innovations but also by the efficiency with which available technologies are used. As such, more appropriate for these farmers are conservation agriculture (CA) practices, which aim to conserve natural resources while enhancing food and livelihood securities. For this study, CA practices refer to a general set of practices including the concepts of minimum tillage and intercropping (FAO 2000). Not only do these CA practices offer environmental benefits such as improved soil and water conservation, as highlighted in this study, there can also be significant savings of agricultural labor through reduced demands of tillage and weeding (Bishop-Sambrook 2003), which can then be directed towards agricultural diversification, farm improvements, or off-farm work to supplement agricultural income, and impacts to household income and yields depending on the CA practice selected.

To date, there has been little published on the potential benefits or tradeoffs of various integrated CA practices, particularly on resource-poor smallholders in tribal villages, such as those in Kendujhar. Nevertheless, evidence suggests that combining these practices (minimum tillage and intercropping) can have positive implications for input use, yield, income, and gender equity, while promoting long-term environmental sustainability.

To ensure selection and implementation of appropriate CA practices in Kendujhar, current farming practices must first be understood within the context of their economic and social impacts. This study's location lies in the northern part of Odisha in Eastern India, which epitomizes the

challenges facing the sustainability of smallholder, rain-fed agriculture in southern Asia as well as the cumulative impacts of environmental conflicts within the food production system (Figure 1). Given that agriculture in Odisha represents approximately 30% of the state's economy, improvements to the local farming systems have the potential to improve the sustainability and security of numerous households within the state and across the nation of India (Pattanayak 2004).

Objectives

The goal of this research is to evaluate the food security and economic livelihood of the tribal farm families in Kendujhar, in Odisha State through the introduction of sustainable conservation agriculture practices of minimum tillage and intercropping. The specific objectives of this study are to:

1. Estimate the yield, labor and profitability differences between the CA practices of minimum tillage and intercropping and the use of conventional tillage on representative maize-based farms.
2. Evaluate the gender implications of implementing selected CA practices as they relate to labor use.
3. Discuss the implications of introduced CA practices for policy-makers, local entrepreneurs and agribusinesses, and smallholder farmers.

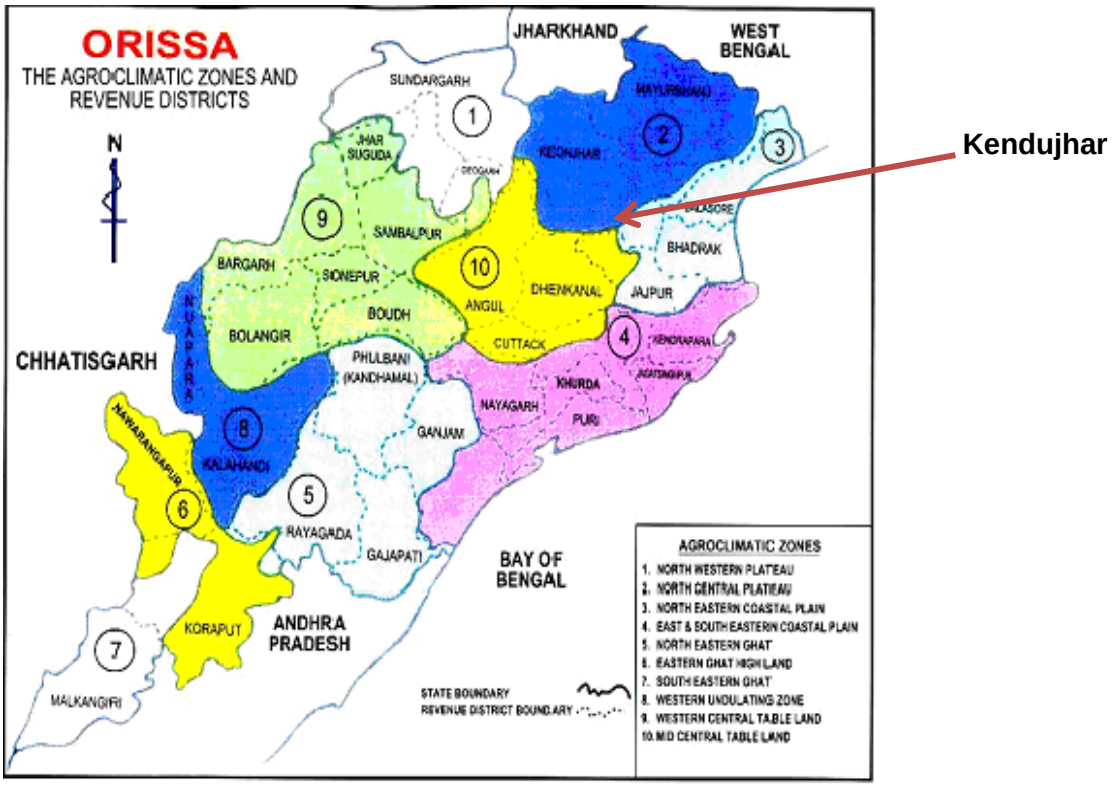

Figure 1. Location map of Kendujhar district, Odisha State, India with agro-climatic zones.

Literature Review

The following literature review provides comparative yield statistics of different CA practices, offering insight into the influence of changing yields on farm profitability and rural farm labor. Based on a review of past studies regarding maize-based production systems, CA practices including conservation tillage, residue retention and intercropping with legumes have all been shown to increase yields. The results of several studies analyzing the effectiveness of CA practices revealed that the highest yield increases resulted from intercropping with legumes, improving total yields by 15-40% over conventional practices. Adopting some form of conservation tillage without intercropping practices resulted in slightly lower yield improvement of 13% (Table 1).

Table 1. Yield Effects of CA Practices in Maize-Based Production Systems.

Region/Country	CA Practices	Yield effect in kg ha^{-1} (% change)	Reference
Kisii / Kenya	Conventional tillage Residue retention Intercrop: Maize-Common beans	+550 (20%)	Nzabi et al. (2000)
North East India	Conservation tillage No residue Intercrop: Maize-Pea	+130 (15%)	Ghosh et al. (2010)
Ethiopia	Conservation tillage Residue retention Maize-alone	+170 (13%)	Rockström et al. (2009)
South Africa	Conventional tillage Residue retention Intercrop: Maize-cowpea and Relay Crop (RC)	+2450 (40%) RC: +1200 (20%)	Bloem et al. (2009)

As new farming practices become more prominent, a shift in farm labor time allocation can occur. For example, with the introduction of a new cotton variety in rural India, increased yields showed a direct increase in labor during harvest yet experienced decreased labor for pest management. This offset of labor can be considered as a net neutral outcome; however, since harvesting is a predominantly female activity, whereas pest management is a typically male activity, a shift in time commitment and distinction of labor division between genders is created (Subramanian 2009).

When labor time is reduced as opposed to shifted, the household income effect depends on how the newly available time can be used. This is often determined by the availability of opportunities for off-farm income. In India, several income generating off-farm activities are available for male farmers, including: construction, mining, small-scale manufacturing, retail trade, private and transportation services including driving tractors and auto-rickshaws (Subramanian 2009). Within the district of Kendujhar, mining represents the predominant off-farm employment. The

contrast in opportunities for off-farm employment is apparent in Tamil Nadu, India, where the decreased labor requirements of growing Jatropha has led to an increase in male participation in off-farm seasonal migration while women have fewer alternative employment opportunities and take on increased household responsibilities when the men migrate for work (Ariza-Montobbio 2010; Kochar 1999). Therefore, even when farm labor requirements decrease, the potential for females to earn supplemental income is limited.

Methodology

Three villages in Kendujhar were selected for this study. These villages were chosen based on their agricultural and demographic characteristics; their proximity to the local extension office of Orissa University of Agriculture and Technology (OUAT); past and current working relationships between the villages and the university; and the presence of tribal populations practicing subsistence agriculture on small farms within the village.

The methodological framework of this study consists of seven steps:

1. Develop farm household surveys to collect baseline economic farm data
2. Collect data through face-to-face interviews of randomly selected farmers
3. Validate data through comparison with relevant literature
4. Construct baseline representative maize-only and maize/cowpea farm budgets from survey data
5. Calculate yield and production cost specifically for labor changes from selected CA practices on experimental farm plots
6. Estimate potential economic returns in terms of changes in farm profitability with or without labor opportunity costs using data collected from step five above
7. Report results and provide recommendations to farmers, agribusinesses and policymakers.

Survey Design and Data Administration

Surveys were designed to collect both qualitative and quantitative data. The questionnaire consisted of 6 sections (family profile, assets, land and input use, labor use, agricultural output and grain transaction descriptions). Specifically, the following data pertaining to this study were collected: size of farm plots by crop, land use and cropping patterns, cost of production, input and output data, crop yields, market transactions and prices.

Data was collected from a random sample of 145 households from three villages (Tentuli, Saharpur, and Gopinathpur), located approximately 15-30 km from the town of Kendujhar. During the time period of June to December 2010, 35 households were interviewed, representing approximately 24% of the sample interviewed.

Descriptive Statistics of Farm Household

Key socio-demographic characteristics of the villages are shown in Table 2.

Table 2. Selected socio-economic characteristics of three tribal villages in the study district of Kendujhar, India.

Village Number of Households	Farm Annual Income (INR)	Household Size	Highest level of Education	Farm Size (ha)	Major Staple Crops	Maize Yield (ton/ha)
Tentuli (56)	18,130 (410 USD)	7	None	1.4	Rice, Maize	0.25
Saharpur (64)	19,140 (433 USD)	7	None	1.2	Rice, Maize	0.3
Gopinathpur (25)	47,588 (1,076 USD)	7	Primary	2.1	Rice, Maize	0.3

Source. Household survey data 2010. Values represented are averages and modes.

The majority of the study population in the three villages is tribal, largely dependent on traditional agriculture and forest resources for daily sustenance, and practice smallholder, subsistence, rain-fed agriculture.

The average household family size is seven members, with 2-3 generations per household. Average farm size is between 1.2 to 2.1 hectares. Major staple crops grown are rice and maize. Maize yield is relatively low, averaging 0.25 to 0.3 ton/ha. Average farm household annual incomes range from about 400 to 1000 USD per household. According to the survey data, farm incomes are higher for families with additional off-farm employment. As mining is the major industry present in the Kendujhar District, families with more than one son over the age of 18 typically earn additional income (9 USD/day). However, villages such as Tentuli, with low literacy rates and the majority of the population under age 10, must rely on the farm for income (Table 2).

The survey also revealed that each of the three villages were major producers of maize. In 2009, 47% of the surveyed population produced maize solely for household consumption and livestock feed, the other 53% of the population sold on average 55% of their maize output. The low proportion of households selling their yields and the limited amount of crop available to be marketed indicates the population's vulnerability to food security in the region. Due to World Bank funded extension efforts meant to address these food security issues, some farms began to incorporate cowpea intercropping to improve soil nitrogen content and corresponding crop yields. According to market surveys, cowpea has a seasonal market price of USD$.30 -.45/Kg, nearly double the price of maize, making it one of the more profitable crops for sale. For this study, cowpea was considered an introduced crop, as over 80% of the survey population did not previously produce cowpea.

Research Design

Selected Conservation Agriculture Practices Scenarios

For this study, a representative maize-based production system using conventional tillage was compared with three potential CA practices to be introduced to the tribal villages (Table 3).

The three conservation agriculture practices include one or more of the following:

1. Minimum tillage (MT): Land was tilled once prior to sowing vs. conventional tillage (CT) where land is tilled twice.
2. Intercropping (M-CP): Cowpea (*Vigna unguiculata*) was planted between rows of maize (*Zea mays*). The inter-row spacing for maize was standard for a maize monocrop treatment (M), with no reduction of maize plants in the intercropped treatment.

Table 3. Conservation Agriculture (CA) treatments implemented in Kendujhar, Odisha State, India, 2010.

Treatments	CA Practices (Abbreviations)
Farmer Practice: Maize Plow	CONTROL
Maize Minimum Tillage[1]	MT/M
Maize/Cowpea Intercrop Plow[2]	CT/M-CP
Maize/Cowpea Intercrop Minimum Tillage[2]	MT/M-CP

Source. Household Survey Data 2010

[1]For maize only plot size 0.005 ha

[2]For maize/cowpea intercrop plot size is 0.0025 ha for maize and 0.0025 ha for cowpea (original plot size, 0.005 ha, divided in half)

The above CA practice interventions and associated abbreviations will be referred to throughout the following tables and discussions.

The CA experimental trial was conducted at the Orissa University of Agriculture and Technology (OUAT) experiment station in Kendujhar to evaluate the benefits and costs of each intervention.

For this study, the effect of both minimum tillage and intercropping were assessed individually, in combination, and compared with conventional maize monocrop plow production systems. Experimental data were collected on the quantity and cost of seeds planted and fertilizer applied; amount and cost of agricultural labor by gender required to plant, maintain, and harvest crops; and the quantity and market value of maize and cowpea seed yields.

The Representative Maize Only Production Budget

A representative maize-only production budget was constructed from the survey data to reflect the costs from that system for 2009. Using the budget, which included price and cost of production for maize and cowpea, the data was assessed to identify changes to input and output costs (Table 5). The data was further assessed to determine the differences of households with and without the opportunity for off-farm employment, where the experimental plot farm wage rate of USD$.26/hr (Dr. P.K. Roul (OUAT), personal communication, 2010) was used as the opportunity cost. According to the farm household survey, there were no commercial agricultural input costs for the production of maize and cowpea. Seed used is typically retained seed from the pre-

vious year or government subsidized, while fertilizer is often farmyard manure. As such, the remaining cost is for labor. The on-farm labor is from household members. Gender impact was evaluated using current labor requirements for the representative farm to determine potential gender implications from the new labor requirements associated with adopting selected CA practices.

Results and Discussion

Performance indicators focusing on farm profitability, labor use and gender impact were evaluated. Although non-market benefits would be desirable for inclusion in a more comprehensive assessment, emphasizing the immediate profitability impacts is essential for promoting the adoption of CA practices. The evaluation of gender equity in terms of labor changes has further implications to household well-being and thus is also important to evaluate.

CAPS Intervention Strategies: Comparing Returns from the CA Practices

Data collected from the experimental plots in Kendujhar was compared based on a percent change between no CA (Control) and the selected CA practices in terms of maize yield and labor for the cropping practices. Subsequently, profitability accounting for opportunity costs is evaluated based on the collected data, as well as current market prices and labor wages.

Yield Impacts

As previously mentioned, cowpea would be an introduced crop to these farming systems; therefore, all yields would result in a 100% increase. Yields for cowpea on the intercropped experimental plots averaged 998 Kg/ha with conventional tillage and 747 Kg/ha with minimum tillage. On the other hand, all CA practices resulted in a decrease in maize yield from the current farming practice of conventional tillage (Control). Conventional tillage (Control) produced a maize yield of 570.8 Kg/ha, while CA practices of MT/M produced a maize yield of 393.28 Kg/ha (a decrease of 31%), CT/M-CP produced a yield of 476.96 Kg/ha (a decrease of 16%) and MT/M-CP produced a yield of 405.89 Kg/ha (a decrease of 29%). The effect of yield differences for maize and cowpea is further discussed in the section titled "Profitability: Economic Analysis of Opportunity Costs", Table 5.

CT/M-CP represents the least reduction in yield of maize (-16.44%) of the three CA practices while benefiting the additional cowpea yield. This treatment may be the most beneficial and most easily adoptable technically for tribal villages, as they are familiar with intercropping and are currently practicing conventional tillage. As such, seed suppliers should work in collaboration with agricultural researchers to determine other beneficial crops (focus on enhanced economic income and environmental benefits) for intercropping in Kendujhar, such as cowpea with maize, and with policy makers to subsequently promote and provide subsidies for those crops' seeds.

If yield is the only factor to be considered, farmers should not consider implementing MT/M, as this practice produces a decrease in maize yield in the short term and has no supplemental cowpea yield to compensate for this loss.

Labor Impacts

For the purposes of this study, labor was measured in hours. The percent change in labor for each CA practice compared to the control (No CA) is as follows:

Table 4. Labor hours for production activities, incorporating gender division and percent changes indicated in ( ) for each CA practice compared to the control.

Labor	Land Preparation		Sowing Cowpea		Sowing Maize		Fertilization		Weeding		Harvest	
	M	F	M	F	M	F	M	F	M	F	M	F
Control	13.50	-			4.5	4.5	4.5	13.5	-	31.5	9	9
MT/M	9.64 (-28.6%)	-			4.5 (0%)	4.5 (0%)	4.5 (0%)	13.5 (0%)	-	31.5 (0%)	9 (0%)	9 (0%)
CT/M-CP	20.73 (+53.6%)	-	2.37 (+100%)	2.37 (+100%)	4.5 (0%)	4.5 (0%)	4.5 (0%)	13.5 (0%)	-	44.1 (+40%)	17.4 (93%)	17.4 (93%)
MT/M-CP	9.64 (-28.6%)	-	2.37 (+100%)	2.37 (+100%)	4.5 (0%)	4.5 (0%)	4.5 (0%)	13.5 (0%)	-	44.1 (+40%)	17.4 (93%)	17.4 (93%)

Source. Household survey data 2010. Percent changes indicated in parentheses () were taken from KVK experimental plot data, 2010

Note. Shaded squares represent that no labor activity occurred as the practice solely includes maize; dashes represent that the gender does not participate in this labor activity.

Labor is a major determinant for adoption of new farming practices for these farmers, as the current subsistence farming provides little or no opportunity costs. Furthermore, gender represents a distinct division of labor for agricultural activities. Women are typically involved with activities such as weeding and fertilization, while men typically manage tasks such as plowing for land preparation. Thus, labor requirements must be considered for each of the CA practices and are outlined based on gender in Table 4 and further discussed in this section.

At present, farmers in the villages of the Kendujhar district practice conventional tillage through plowing. In theory, the transfer of minimum tillage from conventional tillage has the greatest impact on the land preparation activities of agricultural production. Both MT/M and MT/M-CP practices include minimum tillage; as such, these practices reduce the amount of labor required for land preparation activities. Minimum tillage reduces labor hours by 28.6%, as land preparation for the field is only plowed once as opposed to two times for conventional tillage. Therefore, the reduction in labor hours for land preparation of MT/M and MT/M-CP will influence the seasonal activities of male farmers as they will have more time for other activities (Table 4). On the other hand, it will have the opposite effect on labor hours for CT/M-CP, where there is an expected increase of 53.6%, due to an additional plowing for the intercrop field.

MT/M-CP and CT/M-CP introduce cowpea to the farmers' fields for the CA intercrop system. Intercropping has the greatest impact on weeding activities, with labor hours increasing by 40% due to the additional precision required for weeding as opposed to maize-only fields. For women, the increase in labor hours noted for weeding intercropped fields will take away from time available for non-farm activities (Table 4). As such, extension researchers should consider technologies and/or tools that may help to reduce weeding hours for women.

These intercrop CA practices (MT/M-CP and CT/M-CP) will both have an increase in sowing labor (100%) and increase in harvest labor (93.33%) due to the introduction of cowpea that results in an overall increase in yield. Increases in labor hours are equal for both genders as they contribute equally to these activities.

There is no increase in overall labor for fertilization as the farm plots are the same in size and use the same amount of inputs as the conventional plow system. However, there is a distinct contrast in labor hours contributed to fertilization between the genders, as females contribute three times more labor hours (+200%) than their male counterparts. Based on these results, future research should consider the variable off-farm opportunities that exist for farmers (male and female) as a result of either an increase or decrease in labor saving hours, the following section introduces this topic.

Profitability: Economic Analysis of Opportunity Costs

Opportunity costs (OC) represent the potential income that farmers would forego by not engaging their labor elsewhere. An analysis of the opportunity costs reveals the profitability trade-offs incurred as a result of adopting various CA practices (Table 5).

Table 5. Percent change in profitability from CA implementation with and without opportunity costs

	Yield, Maize	Cowpea, Yield	Total Labor (Hrs)	Total Input Costs[1] (INR)	Profit[2], INR (w/ OC)	Profit, INR (w/o OC)
CONTROL	50 kg		90	1,012.50	-592.5	420
MT/M	-31.10%		-8.11%	-8.11%	3.41%	-31.11%
CT/M-CP	-16.44%	100%	46.69%	49.69%	-46.98%	62.92%
MT/M-CP	-28.89%	100%	26.37%	26.37%	-25.54%	30.39%

[1]Total Input Costs (Labor only, seeds are assumed to be saved from the previous season)
[2]Profit (Y) = TR – OC
Total Revenue (TR) = Yield (kg) x Price (INR/kg)
Price of maize: 8.4 INR/kg, Price of cowpea: 15 INR/kg (Household survey data, 2010)
Opportunity cost (OC) = Total labor hours x Wage Rate per hour (11.25 INR/hour)

This analysis shows the potential profitability of farming with off-farm opportunities (at 11.25 INR/hour) as negative. In general, if there are off-farm opportunities available, farmers would have greater earning potential working off-farm. Yet, if there are no outside opportunities for farmers, the farm profitability compared with the profitability from current conventional tillage farming would increase through the implementation of CA practices which include intercropping. By implementing intercropping alone (CT/M-CP), farmer profitability increases by 69.92%, while increasing by 30.39% when implementing minimal tillage plus intercropping (MT/M-CP) (Table 5). Since the availability of off-farm opportunities differs between genders, ages, and through seasons, women and older aged farmers often find it difficult to attain alternative employment, whereas young men do not. For this reason, women and older farmers would likely experience the no opportunity cost scenarios, gaining the greatest profitability through the

adoption of CA practices with intercropping. Men, however, are subject to seasonal fluctuations in employment opportunities and sometimes experience the lack of jobs that women and the elderly do. As mentioned previously, future research should consider these specific employment opportunities (i.e. for young men, seasonal employment opportunities, and other alternative employment options for farmers) and their effects on farmers' decision-making and practices.

The analysis also shows that minimum tillage with a single maize crop reduces labor hours, which in turn increases the time available to work at a second job. For this reason, farmers could increase their income when off-farm opportunities are available if they practice minimal tillage. When there is no available outside employment, the profitability of a minimal tillage practice decreases by 31.11% due to yield decreases and labor hours saved with no off-farm opportunities for income generation. As women have limited off-farm opportunities, this practice would not be as beneficial as it would be to men, who have greater opportunities to generate secondary income.

Based on the results, the short run economic incentives are what have caused farmers to continue their current and unsustainable practices. As the aim is to promote and enhance farmer households' food security and livelihood, policy makers should work in collaboration with extension research, agricultural managers, seed suppliers and farmers to promote CA practices with a focus on the long-term economic and environmental benefits. To be specific, policy makers should provide subsidies to young farmers so that they can focus on the farm rather then look for off-farm employment, extension researchers should not only focus on the innovative technologies themselves but also incorporate workshops and other learning opportunities in which they can explain the long term benefits of CA practices and subsequent food security. In addition, seed suppliers and agricultural managers can work together in determining other crops that may work well in these environmental conditions and that incorporate intercropping to further emphasize the significance of the long term benefits of CA practices.

Conclusion

From the data presented in Table 5 and the overall analysis of this study, three optimal scenarios have been determined based on the comparison of the three conservation agriculture treatments to conventional farming practices:

1. When taking opportunity costs of labor into account, labor is more effectively used for off-farm employment. If one must farm, the best scenario is to incorporate minimum tillage with maize, as it requires the least on-farm labor and the saved labor can be used for off-farm employment.
2. When opportunity costs of labor are not considered, as in the cases where heads of household are either elder or female with limited options for off-farm employment, farmers would optimize earnings through the adoption of intercropping.
3. Although incorporating minimum tillage generates short-term decreases in maize yields, it should nevertheless be integrated into farming systems due to the potential for long-term gains. Evidence has shown that minimum tillage has the potential to contribute to higher yields over time. Continuous practice of minimum tillage has been estimated to increase maize yields by at least 12% and between 8-25% when intercropped with a leguminous crop (Jeranyama et al. 2000).

Part of the objective of this research was to provide solutions to enhance the food security and livelihoods of tribal farm families in Kendujhar, Odisha State. As such, this study focused on ways to increase farmers' yield through introducing the sustainable conservation agriculture practices of minimum tillage and intercropping cowpea with maize. At present, the district of Kendujhar produces only one-fifth of the average national maize yield, representing a significant obstacle for subsistence farmers attempting to earn a living. Yields are currently too low for Kendujhar farmers to sustain their families' livelihood and food security. Therefore, it is apparent that a major policy recommendation should be to increase yields through more advanced technologies, including the use of improved seed varieties, more effective fertilizers and modified farming practices. Seed companies and extension services can each play a role in enhancing the rural knowledge of improved agriculture technology and seed varieties.

The results show that the net profits of adopting some conservation agriculture practices are positive while adopting minimum tillage either has negative or lower returns due to decreased yields. Since CA practices have shown that benefits such as yield and soil improvement take a longer period to reflect positive results, policy-makers should provide farmers with immediate incentives for adopting CA practices. Currently, only a limited number of households (5%) surveyed produced cowpea. Given that cowpea represents one of the more profitable crops sold in the market, introducing cowpea for intercropping would be a profitable enterprise. The role of policy-makers in providing subsidized seeds, other inputs and technical advice would be crucial for promoting the successful adoption of cowpea by farmers without imposing any further input costs to current farming systems (Table 6).

Table 6. Role of stakeholders in enhancing the livelihood and food security of smallholder farmers in the District of Kendujhar, Odisha State, India.

Stakeholder	Roles
Policymakers/Government	▪ Strengthen extension services to rural farming areas ▪ Subsidize seeds, fertilizers and other inputs for the initial stages of implementing conservation agriculture (CA) practices ▪ Provide low cost loans and insurance
Seed suppliers	▪ Provide training on benefits and use of commercial seed varieties ▪ Work with agricultural managers and extension to focus on seeds that utilize intercropping
Extension	▪ Disseminate the benefits/costs of CA practices ▪ Provide long-term demonstration plots comparing yield and soil effects for conventional and CA practices

At present, the state of Odisha supports 30 KVKs (agriculture technology transfer stations) and 8 regional research stations across the state. Therefore, although this specific study is supported by a local agricultural university (OUAT) in collaboration with a KVK station, the numerous tech-

nology transfer and research stations reflect the potential for replication of CA practices in villages across the state. However, due to the prevalence of low yields and food insecurity amongst these smallholder populations, the lack of effectiveness in extension by these research stations for capacity building and information dissemination highlights a disconnect between extension workers and communities. With the pressing need for improved food security and livelihoods for these farmers, policy-makers should enhance the quality of extension services with regards to agriculture technology and knowledge transfer.

Without sustainable high returns from farming, the lure of off-farm employment will only serve to further threaten the food security of these tribal farm families. Additionally, there are potential implications for the distribution of labor within the household with the implementation of CA practices. Although results from this study showed changes in labor hours for minimum tillage in land preparation, a typically male activity, and weeding, a typically female activity, as well as increases in time spent sowing and harvesting, a shared activity, the resulting labor shift negatively impacted females only.

This study presents the short-term economic benefits and gender impacts of implementing specific conservation agriculture practices. The long-term benefits of sustained higher yields and environmental improvements are expected to result from future studies with similar villages.

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Consumers' Perceptions and Attitudes of Organic Food Products in Northern Thailand

Parichard Sangkumchaliang[a] and Wen-Chi Huang[Φb]

[a] *Doctoral Student, Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology (NPUST), 1 Shuefu Rd., Neipu, Pingtung, Taiwan 912*

[b] *Graduate Institute of Agribusiness Management, National Pingtung University of Science and Technology (NPUST), 1 Shuefu Rd., Neipu, Pingtung, Taiwan 912*

Abstract

The adoption of organic production and processing is highly determined by market demand. Therefore, this is reflected in consumers' perceptions and attitudes towards organic food products. This research draws on a survey of 390 respondents. Results indicated that the main reasons for purchasing organic food products are an expectation of a healthier and environmentally friendly means of production. Organic buyers tend to be older and higher educated than those who do not buy them. In addition, consumers' trust in the authenticity of the goods and price are also issues. However, the main barrier to increase the market share of organic food products is consumer information.

Keywords: organic food, consumer behavior, food labels, consumer awareness

[Φ]Corresponding author: Tel: + 886. 8.7703202 Ext. 7824
Email: wenchi@mail.npust.edu.tw
P. Sanghkumchaliang: poy_pari@hotmail.com

Introduction

Food consumption patterns are changing as a result of health and environmental issues. Interest in organically produced food is increasing throughout the world. Global demand for organic products remains robust, with sales increasing by over five billion US dollars a year (Willer, Yussefi-Menzler, and Sorensen 2009). In Thailand, rapid socio-economic development has been accompanied by modernization and industrialization of agricultural food production. In the past, subsistence agriculture in Chiang Mai province, which has the second capital city and the largest city in Northern Thailand, was part of a traditional system in which farmers produced foods mainly for family consumption and exchanged the surplus with neighbors. Since the implementation of the National Economic and Social Development Plan in 1961, the Thai government has promoted an industrial and export-oriented agriculture. In order to maximize yields, farmers started to use chemical fertilizers, insecticides and pesticides in large quantities (UNDP 2007). Pesticide imports to Thailand have increased rapidly over the past decade; total tonnage has more than doubled between 1987 and 1996 (Thapinta and Hudak 2000). This has led to increasing problems related to economics, health hazards, and environmental issues. Investigations have shown that dangerous levels of pesticides are used in food production in Northern Thailand (IPMDANIDA 2004). Based on this information, government agencies and NGOs in Chiang Mai province have focused their attention on organic agriculture. In 1997, the Ministry committed to provide funds to conduct the Pilot Project on Sustainable Agriculture Development for small farmers, which by 1999 was administrated by local organizations in 34 provinces, including Chiang Mai province (Pattanapant and Shivakoti 2009). Organic agriculture is one of the sustainable agriculture approaches that are being promoted and practiced extensively in the province. Thai organic agriculture is still at an early stage, the organic production area being less than 0.02% of total agricultural land. In the 1998 about 1,005 hectares of cropland was farmed organically and this increased to 21,701 hectares by 2006, while market value increased by 3.4% between 2005 to 2006 (Panyakul 2008; Willer, Yussefi-Menzler, and Sorensen 2009; Eischen, Prasertsri, and Sirikeratikul 2006). Even though organic production increased between 1998 and 2006 it declined in 2007 due mainly to higher prices and production levels for conventionally produced products. An additional factor was that farmers were not convinced that there was a secure market channel for organic products.

Certification informs the consumer of the undesirable and unobserved pesticides that may or may not have been used in the production of food. Thailand has multiple forms of organic regulations and certifying bodies. A standard and certification by the national government has issued only one label, called "Organic Thailand", by the Department of Agriculture (DOA), when the government set up standards for organic crop production in 2000 and developed a certification body for organic food products. The major certification body accredited by IFOAM is called "Organic Agriculture Certification Thailand" or ACT. This private organization was founded in 1995 and the members are NGOs, producer groups and other private organizations. The leading producer of organic food is Green Net Cooperatives. Both ACT and Green Net are supported by the Earth Net Foundation, which is playing a leading role in promoting organic farming in Thailand. There were about 4,000 hectares of certified organic production in Thailand in 2003 (IPMDANIDA 2003; Roitner-Schobesberger et al. 2008). In the Northern region, the Northern Organic Standards Association (NOSA) certifies all of the product markets through the Institute of Sustainable Agricultural Cooperatives (ISAC) and its affiliates. NOSA regulations were established by a coa-

lition of farmers, consumer advocates, and NGOs (Wyatt 2009). "NOSA" is a locally registered body, and the products it certifies are sold mainly in Chiang Mai province and other provinces in the northern region of Thailand. In 2007, the data show that about 726 hectares of organic farm land or 0.34% of total farm land, in Chiang Mai province were used for certified crops (Pattanapant and Shivakoti 2009).

However, a specific feature of local Thai food markets is the coexistence of different environmentally friendly, healthy or hygienic labels. Therefore governmental institutions started different certification systems for different safe food products (Eischen, Prasertsri, and Sirikeratikul 2006). Safe Food labels were therefore introduced by the Thai Government. They are based on standards that have been agreed upon by both The Ministry of Public Health and The Ministry of Agriculture and Cooperatives. The standards for safe food are not as strict as for organic food; farmers are allowed to use chemical fertilizers and pesticides, but tests are carried out to make sure that residues do not exceed a maximum level. Certificates are issued to the farmers and food suppliers whose products pass the tests (IPMDANIDA 2003). The first safe food label is "Hygienic Fresh Fruit and Vegetable". With this label the use of agro-chemicals is regulated and controlled and the residues on the products have to be below a specific level that is safe for consumers. The second label is "Pesticide-Safe Vegetable" which is assigned to retailers of agricultural products who conduct tests for toxic substances before selling the products. These products are from production systems using agro-chemicals, but the residues have to be within the defined levels. The third label is "Food Safety", the products are tested for residues and if they are below the maximum residue level farmers and producers can use this certificate (Wyatt 2009).

Organic farming is a growing sector in Thailand, which is encouraged by the government and many private initiatives. Therefore, production is expected to rise to meet the growing demand in the domestic market for organic foods. The increased range of healthy foods and the establishment of certificates for pesticide controlled vegetables indicate that there is a potential market. Consumers everywhere know very little about the production process, as there is no identification with the product and its producer. This might be true for Thailand as well, and therefore leads to low levels of confidence in organic production, which would indicate that there is not enough information on the consumers' side about organic production. So it has to be explored how much knowledge of organic farming consumers already have, and how they would like to be more informed. Studies concerning consumer demand for organic food products are still under-developed in the Northern Thai region. Therefore, the present paper aims to understand the perceptions and attitudes towards organic food products in this region, to collect detailed information of the demographic characteristics and to identify the reasons affecting consumers' behavior towards organic food products.

Literature Review

It is a worldwide phenomenon that people have become more and more separated from the origins of their food. Worried about their health, consumers seek out certified products to protect themselves from toxins and carcinogens. With an increasing awareness of the domestic problems regarding pesticide poisoning and diseases from fresh food products, the Thai government overhauled its approach to food safety (Srithamma, Vithayarungruangsri, and Posayanonda 2005). The increasing consumer demand for higher quality produce and food safety makes organic food

an interesting option. There have been a considerable number of studies on organic consumers in many countries, especially in Europe and other western countries (Onyango, Hallman, and Bellows 2007; Gracia and Magistris 2007; Gracia and Magistris 2008; Magistris and Gracia 2008; Makatouni 2002; Squires, Juric, and Cornwell 2001; Briz and Ward 2009; Essoussi and Zahaf 2008; Storstad and Bjorkhaug 2003; Shepherd, Magnusson, and Sjoden 2005; Batte et al. 2007). Many studies have found a variety of factors that can potentially influence organic food consumption. Concern for health, environmental protection, concern for the chemical residues in conventional food products, pesticides, nutritional concern, as well as improved taste and flavour in organic food products are some of the factors identified (Storstad and Bjorkhaug 2003; Voon, Ngui, and Agrawal 2011; Sangkumchaliang and Huang 2010). According to Tsakiridou et al. (2008) a study of Greek consumers seems to show that they are informed about environmental and health issues. Consumers' attitudes, in particular towards the health attributes and towards the environment, are the most important factors that explain consumers' decision-making processes for organic food products (Tsakiridou et al. 2008; Lea and Worsley 2005; Roitner-Schobesberger et al. 2008; Magistris and Gracia 2008). Moreover, it has been found that more information about the organic food market, which increases consumers' organic food knowledge, is important because it positively influences consumers' attitudes towards organic food products (Briz and Ward 2009; Gil and Soler 2006).

In any case, the importance of individual factors appears to be country specific and/or time specific. Even in cases where similar attitudes between different countries were depicted, cultural differences lead consumers to seek different values when making purchasing decisions on organic food products. Consumer behavior involves a complex and sophisticated pattern that requires marketing research in order to understand the process. The basic idea behind consumer research is the questioning of consumers about their reasons for buying, however researchers have to go deeper and also ask people how and in which circumstances they purchase and consume. Consumer behavior consists of ideas, feelings, experiences and actions, along with additional environmental factors like advertisements and price (Krystallis and Chryssohoidis 2005; Tsakiridou et al. 2008; Fotopoulos and Krystallis 2002). The premium price accruing to organic food products directly impacts the consumption levels (Aryal et al. 2009). Instead the demand for organic products must be seen in relative proportion of income that is usually spent on food consumption (Tsakiridou et al. 2008). Furthermore, consumer behavior is a dynamic process because of continuous changes in ideas, perceptions and activities of the consumers. Attitude is shaped selectively to compromise consumers needs. Learning is gained by experience and it affects consumers' behavior. Scientific evidence suggests that almost all behaviors are learnt. Learning differentiates between stimuli and a response, and consumer behaviors translated as learnt attitude, along with how it is learnt and experienced, is very important for marketers (Padel and Foster 2005).

Additionally, demography is especially of interest to marketers as it is important to see how population is changing in number and distribution of gender, age and other demographic characteristics and variables. Family structure, marriage and divorce rates of individual counties also have effects on consumption habits; for example, couples with children have many more health concerns when buying food than singles. The presence of children in the household has been regarded as a significant factor, which positively influences consumers' organic food attitudes as well as buying behavior (Essoussi and Zahaf 2008). Moreover, children have effects on changing the buying decisions of the parents when they are shopping in a supermarket. Children's age can be

considered as a key factor, meaning that the higher the age of children in the household, the lower the propensity to buy organic food (Roitner-Schobesberger et al. 2008; Lea and Worsley 2005). Education has also been reported as a significant factor affecting consumer attitudes towards organic food products. People with higher education are more likely to express positive attitudes towards organic products (Gracia and Magistris 2007). Higher income households are also more likely to form positive attitudes and to purchase more organic food (Aryal et al. 2009; Haghiri, Hobbs, and McNamara 2009).

In general, the intention to purchase organic decreases with a limitation of knowledge and awareness towards those products, with many factors effecting consumers' perceptions and attitudes. In consumer behavior theory, consumers make their own decisions based on an individual's intention to perform a behavior, which is influenced by attitudes (Ajzen 1991). In this research the simple framework was developed from Aryal et al. (2009) and used to analyze consumers' perceptions and attitudes towards organic foods. Consumers decide whether to buy or not based on three main aspects: knowledge, attitude, and intention (Aryal et al. 2009). Consumers' knowledge is a construct that effects how and what consumers decide to buy. People's knowledge is affected by the type and quality of information made available to consumers. Advertisements, processing, awareness of certifications and labels, all play a pivotal role in knowledge enrichment. Thus, knowledge and awareness are critical in the consumers' behavior. In addition, demographic characteristics are also important factors for purchasing behavior, which can explain the purchase of organic products. Individual socio-demographics include economic characteristics (i.e. personal or household income) and are commonly included as determinants of choice. If an individual cannot clearly differentiate between organic food and conventional food products, a price premium on the organic food product can confuse and affect the individual's purchasing decision. Consumers' age, education, family size, marital status, and children in household, along with product attributes, affects their attitude and preference to buy the products.

Methodology

The survey was undertaken in two stages. First, a face-to-face survey was made in December 2009 with visitors to "the 6th Northern Agricultural Fair" held at the Faculty of Agriculture at Chiang Mai University. Collaborative organizations came from both governmental and private sectors. The cooperation from all sectors involved included, in part, the Institutions in Agricultural, which has played an important part in the role of knowledge and innovation in agriculture. The survey was performed with a systematic sampling of fair visitors. No claims can be made that the sample group represents the general populations. However, the fact that the fair visitors are interested in family farm products, and possibly in organic foods, suggests that survey respondents provide an interesting study group for this issue.

The second part of the survey was carried out during December 2009 and January 2010 at three different markets: the community market of The Multiple Cropping Centre (MCC market), the Royal Project shop (Doi Kum) and Tops supermarkets. The Multiple Cropping Center (MCC) was established in 1969 with an aim to promote and increase the productivity of irrigated rice-based cropping systems in northern Thailand through multi-disciplinary research activities. They have community market projects to let the farmers and consumers meet each other dirctly. Every

Wednesday and Saturday, they have a community market, called MCC market, for pesticide safe products certified with the "Food Safety" label. Also, 1969 marked the establishment of the Royal Project in the North of Thailand as originated from His Majesty the King's private study. This Royal Project has pursued its mission in collaboration with the Royal Thai government, foreign governments, universities, public and private agencies and volunteers. This project has a health food shop called "Doi Kum". Finally, Tops supermarket is a grocery chain in Thailand. Tops supermarket offers a wide assortment of food, products and vegetables. Tops supermarket sells safety, GAP, and organic products. Consumers were approached during their food shopping in outlets at three different areas. Three markets and one trade fair, which carry organic food or a range of fruits and vegetables displaying the major safe food labels, were selected for the interviews. Finally, six Thai students were trained to administer the questionnaire personally; we collected 390 respondents from four different areas.

The questionnaire was designed to analyze consumers' organic knowledge, attitudes and purchase behavior. Respondents were questioned on three different aspects. The first section was related to their organic food knowledge, i.e. organic food labels and organically produced food. The second section of the questionnaire was comprised of questions related to organic food consumption (frequency of purchase and perceived quality). Finally, several questions on the reasons of purchase, or not, were included. The questionnaire also contained questions on socio-demographic characteristics (i.e. gender, age, household size, education, personal income, and marital status). The first phase of the questionnaire was drafted in English. The issues raised were based on results from the literature research. These finding were discussed to see whether the questionnaire was relevant for the Thai situation. Before finalizing the questionnaire, the Thai version was translated back into English to ensure that the questionnaire retained its original meaning.

The data was summarized using descriptive statistics (frequency and cross tabulation). To analyze differences between consumer types, the respondents were divided into three groups: those who had never heard of organic produce (39 respondents, 10%); those who had heard of organic produce, but never purchased any (organic non-buyers: 82 respondents, 21%); those who had heard of and bought organic produce (the organic buyers: 269 respondents, i.e. 69%). The significant differences between groups were established using cross-tabulation tables and a Chi-square test (at a 5% level of significance). The statistical analysis was run with SPSS 17.0 package for Windows.

Results

The sample comprised of 63% female and 37% male, something that is expected since females are the main food purchase decision-makers in households. The age of the respondents varied from 18 to 70 years. More than half of them had a university education (53%), about 27% had finished high school and 19% of the respondents had completed only primary school. About 51% of the respondents received a monthly income less than 10,000 Baht, and 19% were above 20,000 Baht. More than half of the respondents (55%) lived in families with more than four members, more than a quarter (38%) had two-three family members, about 5% lived alone, and 39% of the respondents, were married.

In the demographic variables, three of five variables indicated significant differences between the three groups (Table 1). Consumers with a lower income (74%) and a lower level of education (40%) were least likely to have heard of organic agriculture. Conversely, those who had a higher income and held academic degrees seemed more likely to have bought organic foods in the past.

Table 1. Demographic Characteristics of respondents

Variable	Number of interviewees	Unaware of organic term	Organic non-buyers	Organic buyers	Statistical p-value
Average age (in year)	390	36.0	30.20	36.10	0.001*
Gender					0.157ns
Female	246	8.5%	19.1%	72.4%	
Male	144	12.5%	24.3%	63.2%	
Children in the household [a]					0.038*
Yes	164	6.1%	18.9%	75.0%	
No	225	12.9%	22.7%	64.4%	
Highest education level [a]					0.001*
Primary school	75	20.0%	9.3%	70.7%	
High school	107	11.2%	23.4%	65.4%	
Bachelor	181	5.5%	26.5%	68.0%	
Master or above	24	4.2%	8.3%	87.5%	
Family income per month [a,b]					0.067
< 10,000	199	14.1%	23.1%	62.8%	
10,001-20,000	114	5.3%	21.9%	72.8%	
20,001-30,000	56	5.4%	16.1%	78.6%	
>30,000	17	5.9%	11.8%	82.4%	

[a] Some information was missing on some questionnaire, thus not all categories add up to 390 respondents.
[b] The National Statistical Office of Thailand reports that the average monthly income per household in Thailand was approximately 21,135 Thai Baht (35 Baht ≈ 1$US).
*Statistically: p<0.05 (Chi-square test); Significance of the difference between groups.

Although the organic buyers were more likely to have higher income, the relationship was not significant. Of the organic buyers 22% had a higher income (more than 20,000 Baht per month), compared to 13% of non-buyers and 11% of the unaware group. Truly, most of the organic buyers group (54%) held a Bachelor or higher academic degree. Organic buyers tended to be older, compared with the non-buyers group. Regarding organic buyers, about 49% were over 35 years of age and only 28% were under 25 years old. Organic buyers were more likely to be female: 66% of female respondents said that they had purchased organic foods in the past; compared with 34% of males. There was no statistical difference in the personal income level ($x^2 = 3.369, p = 0.338$) and education level ($x^2 = 4.377, p = 0.227$) between the interviewed females and males. The organic buyers were more likely to have children living in their household, that relationship was significant ($x^2 = 6.536, p = 0.038$). Of the organic buyer group, 46% reported having a child or children (72% were less than 18 years old) living in their household. The significant effect of children in the household variable shows that children had an effect on changing the buying decisions of the parents when they were shopping in a market.

The respondents were presented with seven labels found on food products. More than 30% of the respondents recognized the "Food Safety", "Hygienic Fresh Fruit and Vegetable", and "Organic

Thailand (DOA)" labels, respectively. All other labels were not well known, with about 19% knowledgeable of the "pesticide-safe" label and less than 10% recognizing the two organic labels (ACT and NOSA). Of those respondents who stated that they knew one of the seven labels, more than 70% were organic buyers (Table 2). It thus seems that organic buyers are more aware of food labels than the other two groups. When asked to distinguish between organic food labels and other food labels, some respondents were still confused between organic labels and safe food labels.

Table 2. Level of safe food labels knowledge by type of organic food consumers (n=390)

Label	**Number of respondents (n)**	**Percentage of the respondents knowing the label by group**		
		Never heard	*Non-buyers*	*Buyers*
Food safety	145	4.8	15.9	79.3
Hygienic fresh fruit and vegetable	127	2.4	16.5	81.1
Organic Thailand (DOA)	122	4.1	9.0	86.9
Pesticide-safe vegetable	74	4.1	4.1	91.9
IFOAM	39	2.6	5.1	92.3
Organic Agriculture Certification Thailand (ACT)	35	.0	11.4	88.6
The Northern Organic Standards Association (NOSA)	25	.0	4.0	96.0

The result shows 44% of respondents stating that they know the NOSA label, but that this label was not for organic food, and almost half of the respondents who had awareness of labels stated that safe food labels are the same as organic food labels. Thus, even if the respondents state that they know, it does not necessarily mean that they have correct the information regarding the label. This might explain why 13% of respondents said that they knew the "organic Thailand" label, although they had never heard of the term organic. This lack of discernment might be related to the fact that although most markets have distinct sections for organic food, safety food and hygienic food, they tend not to distinguish between them. The respondents themselves were aware of their limited knowledge regarding organic agriculture. The results show that 71% of those who had heard of the term organic said they had little knowledge about it, and 20% were not sure what it meant. Even among those who purchase organic foods, about 74% of organic buyers said they only know a little about the meaning of organic, while 12% said they know a lot. Nonetheless, the organic buyers feel better informed than the organic non-buyers. Of the 246 respondents who said that they know just a little about the meaning of organic, 79% were organic buyers and 21% were organic non-buyers. Of the 33 respondents who said they know a lot about organic, 97% were organic buyers.

The respondents, who had heard of the term organic, were presented with 7 statements and asked whether they agreed or disagreed or whether they did not know (Table 3). The survey shows that respondents are convinced that organic farming is good for the environment and that organic foods do not carry pesticide residues. Although 62% and 61% of respondents agreed with the statement regarding the production and processing of organic food, that it is strictly controlled and all products coming from organic agriculture are certified, respectively, 41% agreed with the

Table 3. Assessment of statements about organic farming by the respondents who have bought of organic in percent (n=269)

Statement	Agree	Disagree	Don't know
ınic farming is good for the environment	93.7%	2.0%	4.3%
ınic food products do not carry pesticide residues	80.3%	12.3%	7.4%
ınic farming does not use chemical pesticides or chemical fertilizer	74.9%	14.2%	10.8%
production and processing of organic food is strictly controlled	62.1%	14.8%	23.1%
›roducts coming from organic agriculture are certified	61.3%	16.5%	22.2%
ınic is just a marketing promotion	41.3%	38.2%	20.5%
lifference between organic products and safety products	26.8%	49.8%	23.4%

statement that organic is just a marketing promotion. Asked directly about the difference between organic products and safety products, 27% said there was no difference. Those respondents who had purchased organic food in the past (269 respondents) were asked about their motives. The most important motive was the expected positive health effects (a reason for 97% of the organic buyers). These expected positive health effects may be related to their being pesticide-free, as 90% of organic buyers said that they purchase organic food because they do not contain pesticide residues and 88% mentioned that organic foods have a high safety level of guarantee and control. About 94% of organic buyers purchased organic food because they are environmentally-friendly and support local farmers. Further reasons to purchase organic food were because they are fresher (64%) and have better taste (50%) when compared with conventional ones, or they think organic foods are fashionable (30%). Regarding the information available, 91% of consumers said they need more information about organic foods from the media. The respondents who have purchased organic foods were asked about the availability of organic foods and how often they purchase organic foods. The majority (88%) of organic buyers were satisfied with the range of organic foods available at markets. However 72% said they would like to buy more organic foods if they had more income. Regarding their purchasing habits, 31% of the organic buyers stated that they purchase organic foods weekly, 23% said once per month and 47% said they are purchase organic foods less than monthly.

According to the price tag in supermarkets in April 2010, the price difference between organic and conventional vegetables in Chiang Mai province varied between 50% for French beans and 414% for red oak and green oak, with most organic vegetables (e.g. baby carrots, shake eggplant, Chinese celery, spring onions, carrots, green lettuce, and pointed cabbage) having a price premium of 60-227% above conventional products. Despite the price difference, about 56% of organic buyers said that the price of organic foods was not a problem. Over 50% of organic buyers distrust the authenticity of organic food products in that they are not sure that they are genuinely organic. This pinpoints the level of trust they have towards who is deciding whether a product can be considered as organic or not, and following what procedure. Trusting the certification process is important for consumers as they note the rapid growth of big distribution channels in the organic foods market. Therefore, without the supporting demand for organically grown products, the potential for this sector of agriculture clearly has limitations. The organic non-buyers,

those who have not previously bought organic foods (82 respondents, i.e. 23% of those who had heard the organic term) were asked why they do not purchase organic foods. The main reason was that they think hygienic and safety food products are enough (76%) and that organic foods are difficult to get in the market (76%). Further reasons were that they do not trust the organic label (31%) and some stated that organic foods have nothing special (29%).

The data reveals that the respondents in the agriculture fair and three markets had the same proportions of the sample. Each location of Agricultural fair and three markets was comprised of 195 respondents. In the comparison of respondents' perceptions and attitudes of organic food between the Agricultural Fair and Health Food Markets, Chi-square analysis showed that there were differences in consumer buying behavior with respect to different locations. We found that respondents in the markets tended more to purchase organic foods than respondents who visited the agriculture fair ($x^2 = 6.763, p = 0.034$). The findings regarding awareness of food labels shows that respondents in agriculture fairs are more likely to be aware of organic food labels than respondents in markets, with statistically significant differences on the three organic food labels: 74% of respondents in the agriculture fair said that they had seen an ACT label ($x^2 = 9.071, p =0.002$), 76% had seen NOSA ($x^2 = 7.223, p = 0.006$), and 64% had seen IFOAM ($x^2 = 3.447, p =0.045$), respectively. It could be assumed that visitors to the "6th Northern Agricultural Fair" are more interested in labels than consumers in markets since it was announced in the media that organic precuts would be presented at the fair. Regarding the 7 statements and asked whether they agreed or disagreed or whether they did not know, and their reasons to buy or not buy organic foods. The comparison shows that even though the respondents had visited different places, they had similar attitudes about organic foods and had no significant difference, i.e. 49% of respondents in the fair and 51% of respondents in markets were convinced that organic farming is good for the environment and that organic foods do not carry pesticide residues. For those who do not buy organic foods, the main reason they gave was that hygienic and safety food products were enough (50% for fair and 40% for market).

Discussion

The consumers of organic foods products in Chiang Mai province tend to be older (average age of organic buyers about 36 years old) and hold academic degrees than those not purchasing organic foods. Older consumers (over 35 years old) seem to be more willing to purchase organic food products despite their premium price. Young consumers (less than 25 years old) are not willing to pay for organic food products usually as result of their lower-financial status. This profile is similar to results in other counties (Engel 2008; Radman 2005; Tsakiridou et al. 2008). A study in Bangkok found that typical organic buyers also held an academic degree and had higher income. Although Chiang Mai organic consumers' age tended to be older than non-buyers, they were younger than consumers in Bangkok (average age of organic buyers being about 42 years old) (Roitner-Schobesberger et al., 2008). Similarly to reports in the literature (Aguirre 2007; Lea and Worsley 2005), females in Chiang Mai seem to be more likely to purchase organic food than males, though this is contrary with the study in Bangkok (Roitner-Schobesberger et al. 2008). Many of the organic buyers have children less than 18 years old living in the household. As a result, children have a large effect on the buying and decisions-making of their parents when they are buying food. This study is therefore similar to the literature (Lea and Worsley

2005; Roitner-Schobesberger et al. 2008). This could be identified as a link to increased levels of concern about food safety and health issues identified in these consumer groups.

There are several main motives for purchasing organic foods in Chiang Mai province: the expected health and environmental benefits, the support of local or small farmers, the attraction of fashionable products, and the search for fresher and tastier products. Health and environmental benefits have been reported as a main motive for purchasing organic foods by most studies (Ahmad and Juhdi 2010; Magistris and Gracia 2008; Tsakiridou et al. 2008). In Thailand, as this study and the study in Bangkok (Roitner-Schobesberger et al. 2008) confirm, the health and environmental aspect is associated with the pesticides used in agriculture. Even though organic foods do not completely lack pesticide residue because of the pollution in the air and environment, they are safer than conventional foods that get pesticides directly (Dangour et al. 2009). The second important motive to purchase organic foods is that the consumers were considering that purchasing organic food products can support local and small farmers. Local and small farmers are important for organic farming in Northern Thailand, and although there is large scale farming for export, we expected small and local farmers to take up organic farming in Chiang Mai province, and as expected, most of this kind of farming is done by local and family farms. The third motive to purchase organic food is the consumers' search for new trends of healthy food products. The fourth motive is related to organic attributes including fresher and tastier food (i.e. vegetables). This is similar to other studies (Ghorbani and Hamraz 2009; Krystallis and Chryssohoidis 2005).

The share of respondents, in Chiang Mai province, who report having purchased organic foods in the past (69%) is higher, almost double, with 39% of respondents in Bangkok who state that they had purchased organic foods in the past (Roitner-Schobesberger et al. 2008). The market for organic food is thus potentially large. However, to be able to tap this potential customer base, it may be necessary to clearly difference between organic and conventional foods price. Indeed the perception of price is important for consumers to purchasing organic foods, which the result shows that more than half of organic buyers said the price of organic foods was not a problem and their purchasing proportion is higher compared with Bangkok. In Chiang Mai province, organic food labels do not have a clear profile for consumers. The main barrier to purchasing organic foods is that the information consumers have between organic, safety and hygienic foods is not clear. From the results it is observed that there is a lack of advertising of organic foods, 90 % of the consumers have confirmed a need to improve organic food advertising in Chiang Mai. Government and NGOs have attempted to enforce organic food promotion; however, the information is isolated to specific small groups. However, to be able to tap this potential consumer base, it may be necessary to clearly state the position that organic food as distinct from others. This lack of awareness of the organic standard includes organic agricultural methods, and it is not only in Thailand (Ndungu 2006; Batte, Beaverson, and Hooker 2003) that the organic labels are not really recognized by consumers. However, awareness of food labels can increase the probability that consumers would purchase organic food, even if it costs more than conventional food (Ndungu 2006; Krystallis and Chryssohoidis 2005). Another factor mentioned that limits the market share of organic food is price, especially the price difference between organic and conventional food products (Aryal et al. 2009; Batte et al. 2007). The current price premium for organic vegetables in Chiang Mai province is approximately 50% above the price of conventional vegetables. This is higher than the usual premium of 5-50% that consumers are prepared to

pay for organic food (Aryal et al. 2009). However in Northern Thailand as elsewhere, it is unclear to what extent price is really a key factor in the choice between organic and conventional products. The study has shown that of the organic buyers, 44% see price as a limiting factor, and 51% of organic non-buyers mention it as a reason for not buying organic food products. Thus, the price of organic foods in Chiang Mai province is likely to be a key issue limiting sales. This study shows that more than 50% of consumers do not purchase organic food products regularly, even though organic foods are healthy and do not contain pesticide residue. However, the awareness of organic labels and price still becomes an obstacle for consumers when making their decision for buying. Because consumers are still confused with many safe food labels, some consumers do not understand the price premium of organic food products.

The survey of potential and actual organic food consumption in Chiang Mai province provides some evidence for recommendations at the policy and industry level for improving strategies in order to increase the market share of organic foods. At the government policy level it would seem advisable to promote and make advertisements to reduce consumer confusion between the multitudes of safe food labels. Regulate of safe food labels also mean that it would allow organic labels to be more clearly positioned and indicate more restrictive standards. Organic could be communicated as indicating that due to production methods, residues are not allowed, it offers additional health benefits, particularly the environmental impact and small or local farmer benefit. These approaches could help the private sector to increase the market share of organic foods, such as increasing the purchasing frequency of organic buyers and encouraging the organic non-buyers to try organic food products.

Conclusions

Organic food consumption is increasing because of concerns over environmental and health issues associated with food production. The increase in consumers' interest in organic food products has been attributed among other issues to the growing demand for food free from pesticides and chemical residues. With the present study an attempt is made to describe the existing situation regarding Northern Thai consumers' perceptions about organic foods. The main motives to purchase organic food products are health and environmental benefits, plus support for local or small farmers. In addition, an important factor that was revealed as a barrier to the development of organic foods is consumer information. Increased consumer awareness of organic labeling and their trust in organic labels as well as increasing the availability and range of organic food products, may be the most effective way of increasing their market share. The organic buyers in Chiang Mai province tend to be older, higher educated and more likely to have children in their household than those not purchasing organic food products. The study found that the groups of buyers and non-buyers have significant differences in demographic characteristics. However, age, household size, children in household, and education level seemed to have an effect on the perceptions of consumers. The main barrier of organic foods market share is the information available and consumer awareness. Results from this paper are of great importance because they provide valuable information on consumers in Chiang Mai province that can be used by policy makers in organic farming at the national and regional level.

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A Methodological Framework to Design and Assess Food Traceability Systems

Mhamed Bendaoud[a], Catherine Lecomte[b], and Bernard Yannou[Φc]

[a]*Quality Engineer, VIF, 10, Rue de Bretagne , 44244 La Chapelle sur Erdre Cedex, France*

[b]*Assistant-Professor, UFR CEPAL Département SESG, AgroParisTech, 1 Avenue des Olympiades 91744 Massy Cedex France , Laboratoire PESOR Faculté Jean Monet, 54 Boulevard Desgranges, 92331 Sceaux Cedex France*

[c]*Professor, Laboratoire Genie Industriel, Ecole Centrale Paris, Grande Voie des Vignes, 92290 Chatenay-Malabry, France*

Abstract

A methodological framework to design, assess and manage food traceability systems (TS) is proposed. The services delivered for the multiple beneficiaries of the TS are listed and featured by a series of high-level performance criteria. We also propose a library of modular technical solutions to guide designers in choosing appropriate traceability solutions. Again, at this technical level, practical performance criteria are provided for daily traceability control. This performance system may be used in a design methodology as well as for auditing a TS. Based on this model, we develop an Information System that we apply to a poultry processing company.

Keywords: traceability, food tracing, food safety, performance system, information system

[Φ]Corresponding author: Tel: + 33.141.13.15.21
Email: bernard.yannou@ecp.fr
M. Bendaoud: mhamed.bendaoud@graduates.centraliens.net
C. Lecomte: catherine.lecomte@agroparistech.fr

Introduction

Various food security crises, like *mad cow disease*, have shaken the agri-food sector during recent years have resulted in tightened regulations and standards on food safety. For instance, according to the EC Regulation 178/2002, food companies must set up means enabling them to trace and track their products. A traceability system (noted herein TS) can be defined as a *system structured in such a way that it allows to totally or partially reconstruct the lifecycle of a given set of physical products* (Bendaoud et al. 2007). In practical terms, it provides users with a set of relevant information related to origin, composition, location and other characteristics of the product under consideration. This information can be used for different purposes. That which is most often highlighted is the ability to locate a non-conforming foodstuff and retrieve it from the market in order to protect public health. A more comprehensive view of the added value of a TS is provided in literature, especially in (Bendaoud 2008) and (Töyrylä 1999). In addition to regulation texts, food operators must comply with other requirements, particularly food safety standards such as ISO 22000, IFS (International Food Standard), BRC (British Retail Consortium) and SQF (Safe Quality Food). As many authors point out (Moe 1998; Töyrylä 1999; Viruega 2005) we noticed that the few references scrupulously dealing with the issue of food traceability still remain incomplete and unsatisfactory. In fact, most of the existing literature is written by practitioners and is not based on more systematic industrial engineering approaches.

So, on the one side there are food operators who need to be provided with methodological tools to comply with traceability requirements and, on the other, we notice the incomplete and unsatisfactory character of existing references and traceability frameworks. Starting from this situation, we have been conducting an action-research project since 2005. This project aims at proposing a set of conceptual and methodological tools to design, assess and manage a food traceability system (Bendaoud 2008). The present paper's purpose is to show some findings of this project. More precisely, it is about a functional analysis through which we define and characterize a certain number of technical functions to be fulfilled by a food TS in order to satisfy the needs of its beneficiaries.

Our research project can be understood as the study of food TS from three complementary points of view. The first one is **functional** since it focuses only on what TS are expected to do, this is also the domain of expected performances. The way they do it must not be dealt with here. This stage has resulted in three deliverables: identifying the beneficiaries of a food TS, defining the services provided by this system and building quantifiable criteria to assess these services (Bendaoud et al. 2007). The second point of view, which constitutes the subject of the present paper, is **technical** in the sense that it is dealing with lower-level functions and with processes which constitute the structural solution of a TS. As can be seen hereafter, most of these (technical) functions apply to the information used to *totally or partially reconstruct the lifecycle of* traced products. In order to have a precise idea of this information, the third perspective of our research, described as **informational**, aims at building a generic traceability data model. Its purpose is to accurately define and characterize the different data to be taken into account within the framework of a food TS. A computer platform based on this model has been developed and implemented within a French food processing company.

The research issue and the followed approach are further detailed in Section 2 and the results are presented in Section 3. We illustrate our findings in Section 4 through a practical case study within a poultry processing company. Finally, the last section (5) is devoted to a conclusion of our proposals.

Research Issue and Approach

Like other European food companies, our industrial partner (Arrivé S.A., one of France's leading poultry processing companies) has been confronted with recent traceability demands (Bendaoud et al. 2007) and had no choice but to improve its TS in order to fulfill them. In this context, we were firstly asked to carry out an audit aimed at highlighting how well the firm traces its products. Despite an in depth analysis of the literature, we failed to find rigorous and quantifiable criteria to be used to assess the strengths and weaknesses of the system. In fact, certain performance criteria are sometimes mentioned such as *breadth* (Golan et al. 2004), *effectiveness* (Bertolini et al. 2006) and *timeliness* (Töyrylä 1999), but their authors do not explain the protocols for quantifying these in detail. Our approach thus starts with a *need functional analysis* that consists of circumscribing the TS in its environment and studying various interactions that it may have with other surrounding systems. These interactions are expressed in terms of *primary functions* and *adaptation* (or *secondary*) functions. The first aims at satisfying the user's needs while the second *reflects reactions, resistance or adaptations to elements found in the outside environment* (Prudhomme et al. 2003). As represented schematically in Figure 1, eight *surrounding environments* are identified. Five of them (underlined) constitute the *beneficiaries* whose needs are satisfied through the primary functions of the TS.

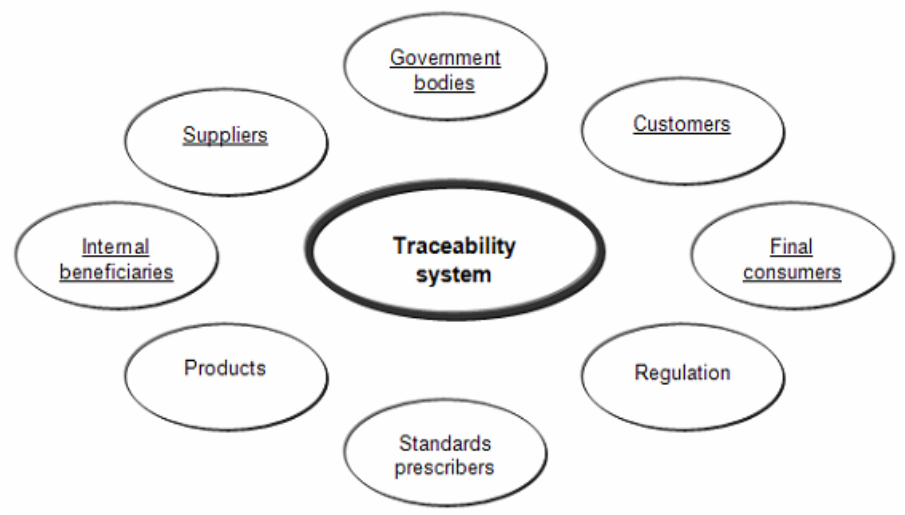

Figure 1. The TS and its Surrounding Environments

- Government bodies: Public institutions which play a role in terms of protecting consumers' health and ensuring fair competition (*e.g.* FDA in the USA and DGAL in France).
- Customers: The parties to which the products are supplied, such as supermarkets or other manufacturers.

- Final consumers: Physical persons who receive and use the product (food or feed) for non-professional purposes.
- Regulation: Laws or administrative rules that deal with food traceability (*e.g.* the *EC Regulation 178/2002* in Europe and *Bioterrorism Preparedness and Response Act* in the USA).
- Standards prescribers: Organizations which define the standards totally or partially dealing with food traceability (*e.g.* IFS and BRC).
- Products: The substances that can be used to prepare or package the foodstuff.
- Internal beneficiaries: Physical or moral entities inside the company which own the traceability system (*e.g.* quality department, supply chain department).
- Suppliers: Organizations which supply the substances used to prepare or package the foodstuff.

This approach made it possible to define a dozen of primary functions and characterize them with a set of assessment criteria (Bendaoud 2008; Bendaoud et al. 2007). These functions can be summarized in what we call a *generic primary function* (GPF):

GPF: To provide { Government Bodies, Customers, Final consumers, Internal beneficiaries, Suppliers } with data on { upstream, internal, downstream } Traceability of products

The three dimensions of traceability mentioned above correspond to different categories of information that a TS is expected to provide in different contexts and for different purposes. According to a given entity (link) in a supply chain:

- upstream traceability consists of identifying the origin of input products,
- internal traceability consists of reconstructing the history of a given product within a company or location which is under consideration and
- downstream traceability consists of identifying the destination(s) of output products.

This generic function may, then, be simply expressed as follows:

GPF: To provide the beneficiaries of the TS with data on product traceability.

Therefore, to the question "***WHAT*** *is expected from a (good) traceability system?"* we have tried to answer by defining and characterizing the service functions (*i.e.* primary and adaptation functions) carried out by this system. In this functional perspective, the TS is viewed as a *black box* since its internal behavior is completely omitted. The subsequent question, resulting from the first, is about the how a TS works internally in order to provide what is expected from it. This is precisely the subject of the present paper in which we deal with the following research questions:

*Technically, **HOW** should a traceability system work? Which are the technical functions to do so? And, according to which criteria can the pertinence of the chosen solutions be assessed?*

These questions denote a twofold ambition. The first consists of proposing a *modular design* method that provides guidelines to choose the appropriate solution for accomplishing each functionality of the TS. The second is to define a set of quantifiable performance criteria to assess the various solutions.

A literature review reveals few attempts to define how a TS should work by identifying various "technical" functions. However, these proposals are incomplete and seem intuitive since their authors do not explain the approaches they followed (Regattieri et al. 2007; Steele 1995; Verdenius 2006). For instance, Steele identifies four elements which '*define the full scope of lot traceability*': ensuring physical lot integrity (*e.g.* to prevent losing traces of a part of a lot), collecting data, maintaining links between a lot and its manufacturing process and retrieving data from the system. In the same perspective, Verdenius describes a TS as a combination of three functions: product identification, data recording and data processing. As it can be noticed, this representation is too general for practical purposes. As a last example, Regattieri defines four elements that constitute the backbone of a TS. These relate to identifying the product, tracing its characteristics, tracing its manufacturing process and choosing appropriate tools (*e.g.* and identification system that is compatible with the nature of the product).

In an attempt to answer the previous research questions, we have adopted a *conceptual design* approach that aims, according to Pahl and Beitz, to identify principles of solutions. In subsequent steps of the process, these principles can be translated into physical solutions and implementable tools. So the purpose here is to define and characterize the *technical functions* and their relationships (simultaneity, exclusion, precedence…) that fulfill the service functions of a food traceability system. According to Prudhomme, a technical function refers to *the action of a constituent part or an action between the constituent parts of the product designed to provide the service functions required*.

Starting from the *generic primary function* defined above, we opted for the FAST (*Function Analysis System Technique*) method to identify the appropriate technical functions. Developed in 1963 by Charles W. Bytheway, (see Bytheway 2005; Kaufman 2003; Wixon 1999; Yannou 1998), FAST allows a designer progressively and explicitly to visualize links between goal-functions (*i.e.* a primary function) and means-functions (*i.e.* a technical function) (Yannou 1998). In the next section, further details will be provided about the FAST method.

A Framework to Design and Assess a Food Traceability System

Defining Technical Functions of the Traceability System

As shown in Figure 2, the generic primary function (GPF) constitutes the starting point of our approach. According to the FAST method, it is considered as an upper-level function. The principle consists, very briefly, of starting with this function and asking HOW it is performed. Each answer to this question allows us to define a lower-level function that is submitted, in turn, to another question HOW, etc. The process is stopped each time the HOW- question leads directly to a technical elementary solution (i.e. an equipment or a basic organizational process).

The diagram must also be read and covered from right to left by asking WHY a given function is performed. This way of scanning the FAST diagram is useful for validating the pertinence of lower-level functions. As for the vertical dimension (WHEN), it describes temporal and causal constraints between functions. For example, a given function A cannot be accomplished prior to another function B. This process of scanning from left to right and from right to left must be performed until no new technical function can be envisaged and no other cause-mean relation can be set. We have applied this process exhaustively to a traceability system. In the following, we detail the progressive building of the FAST model leading to the set of technical functions of the TS. It partly serves as a proof of exhaustiveness and relevance of the result.

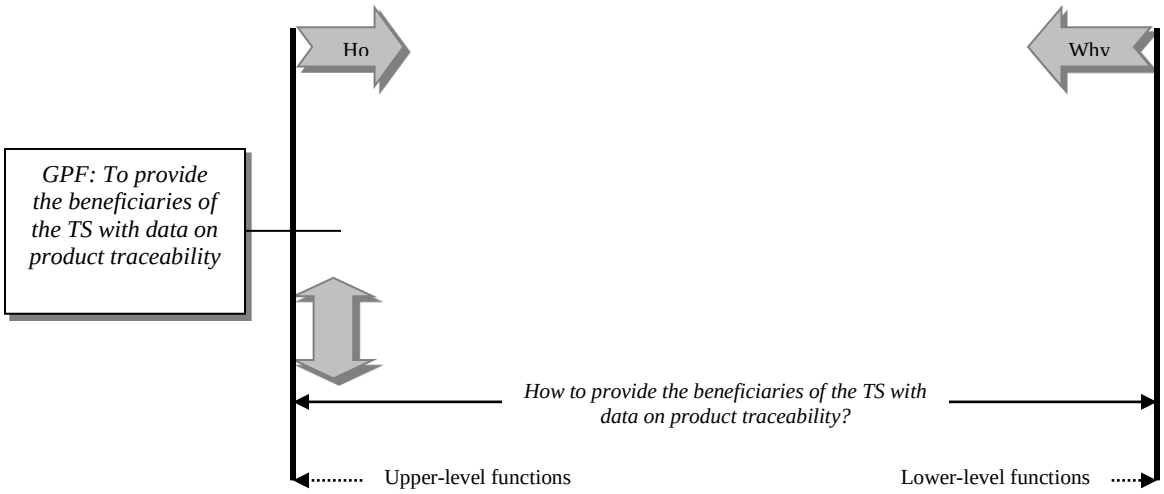

Figure 2. The Structure of FAST Diagram

Traceability data are supposed to pre-exist on a given support (paper, database, etc). So, logically, the first step consists of **restoring** them from the corresponding support. This action can be expressed through our first technical function as shown in Figure 3.

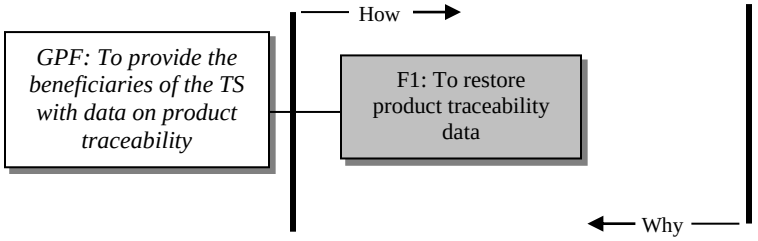

Figure 3. Identification of Function F1: *To restore product traceability data*

An internal beneficiary (a quality manager for example) who needs traceability information can ask the system directly and get what he or she wants via function F1. However in case of an external beneficiary (a customer for example), there is generally no direct access to traceability data. That is why an additional function is required to **communicate** these data to concerned beneficiaries. In Figure 4, function F2 is linked to the generic primary function (GPF) by a dotted line to emphasize its optional character.

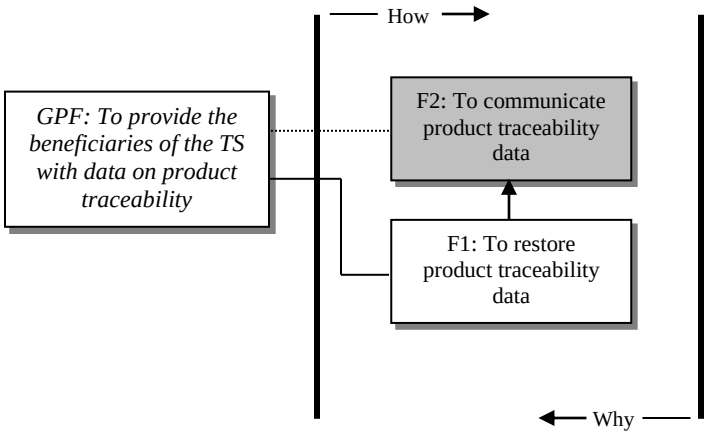

Figure 4. Identification of Function F2: *To communicate product traceability data*

This portion of the FAST diagram is read as follows: Providing the beneficiaries with traceability data can be achieved either by direct consultation of the TS (F1), which supposes that the beneficiary is a direct user, or by using communication channels (F2). In the first case, the given user is referred to as an *internal beneficiary* (See Figure 1).

Restoring traceability data (F3) assumes that these have previously been stored or memorized, which is the role of our next function (F3) (See Figure 5). Here one can clearly see that the vertical oriented arrow means as well a task correlation (meanwhile another required task is…) as a task precedence.

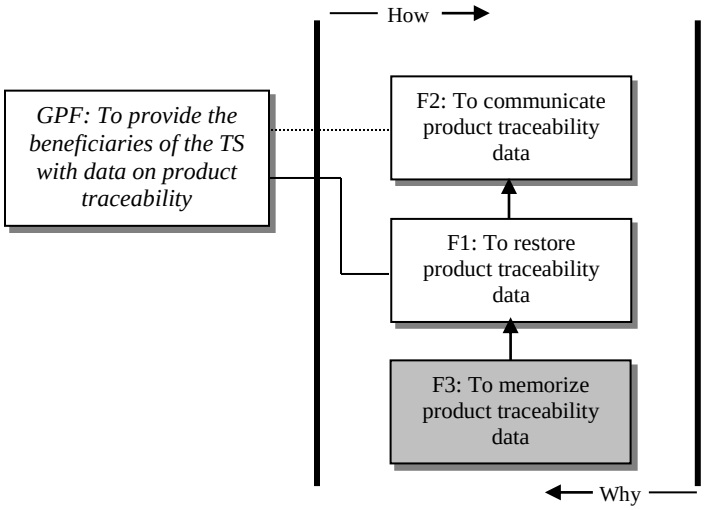

Figure 5. Identification of Function F3: *To memorize product traceability fata*

To memorize product's traceability data in a food production environment, two methods can be used (See Figure 6). The first consists of associating them directly to the product or its packaging (*e.g.* through the labels used to product identification). The other is to record these data in an external support (*e.g*. paper-based records, IT, etc).

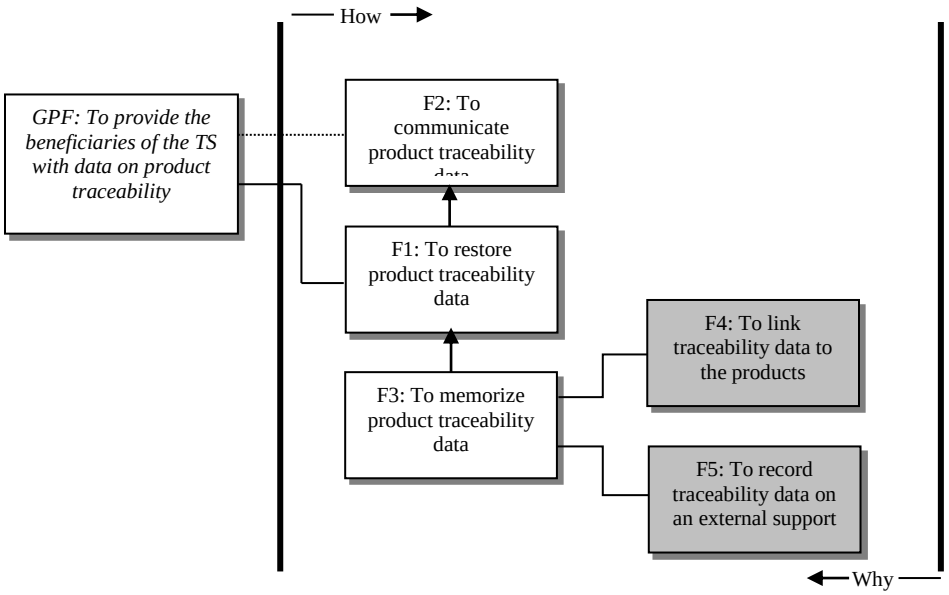

Figure 6. Identification of Function F4 and Function F5

This new part of our FAST diagram is read as follows: to memorize them, products traceability data can be either linked to the product itself **or** recorded on an external support. The disjunction "OR" is here an inclusive one since F4 and F5 can be used simultaneously.

Prior accomplishing F4 or F5, memorized traceability data must be available and known. That means the data must be acquired or obtained from a given source as represented in Figure 7 through function F6.

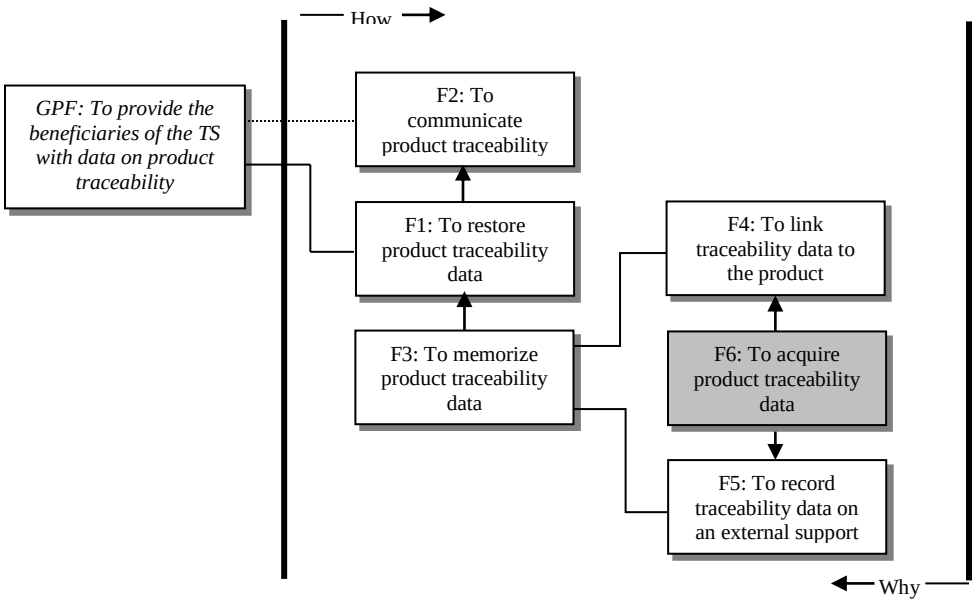

Figure 7. Identification of Function F6: *To acquire product traceability data*

Function F6 is considered as a necessary condition for accomplishing functions F4 and F5 but it does not constitute a means to carry out these functions. In other words, F6 does not provide an answer to the *HOW-question* associated either to F4 or F5.

Now, let us continue our FAST process by asking how to collect product traceability data. Two answers can be found depending on whether these data already exist or not. The first case reflects situations where traceability data are available somewhere and only need to be collected. For example, when certain raw materials are delivered to a plant, some traceability data can be collected from invoices or from delivery slips. In the second case, traceability data must be generated since they do not yet have any physical existence. For instance, in a dairy product plant, pasteurization temperature is crucial information that is first generated (created) using a thermometer and then acquired (recorded) as traceability data (F6). So, as indicated in Figure 8 two new functions are added to the FAST diagram to collect and to generate traceability data.

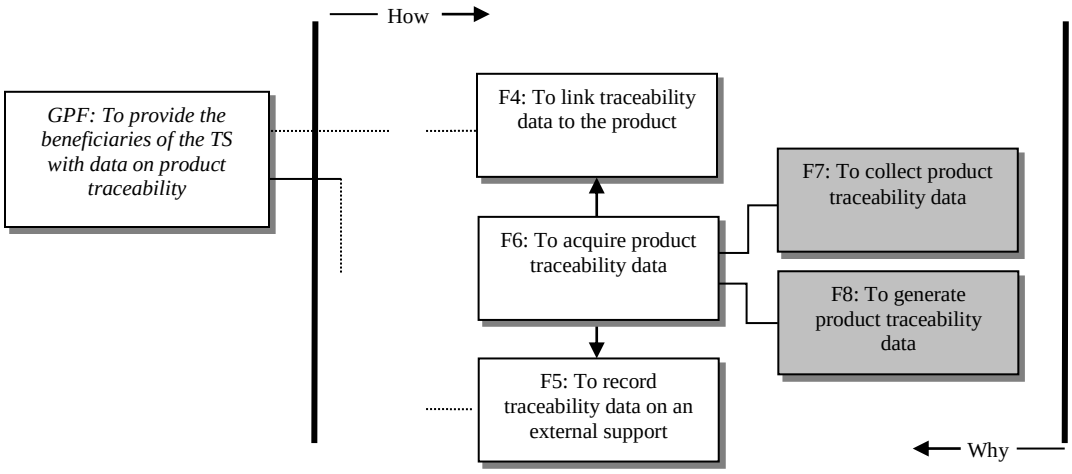

Figure 8. Identification of Functions F7 and F8: *To collect and to generate product traceability data*

In the food industry, products are often managed through the notion of lot (or batch). According to European Council Directive 91/238, a lot can be defined as "*a batch of sales units of foodstuff produced, manufactured or packaged under the same conditions*". In the traceability field this is a key concept. For example, in case of a food crisis affecting a given product, instead of recalling all the instances of that product, a traceability system makes it possible to target only the batch that is actually concerned. To achieve this, each lot must be given a unique identity. This task is assigned to function F9 that must be completed prior to F7 and F8 (See Figure 9) since collecting or generating traceability data necessarily refers to a given lot of products.

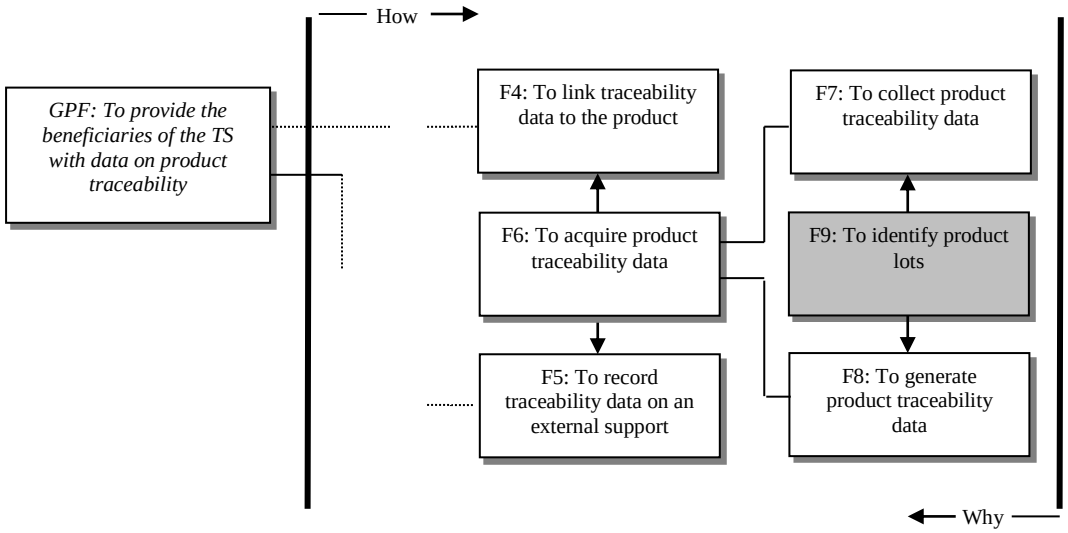

Figure 9. Identification of function F9: *To identify product lots*

Identification aims at distinguishing between different instances (lots) of the same product. In practical terms, it consists of firstly creating the identifier (F10), and then associating it to the appropriate lot (F11). These new functions are added to our FAST diagram as shown in Figure 10.

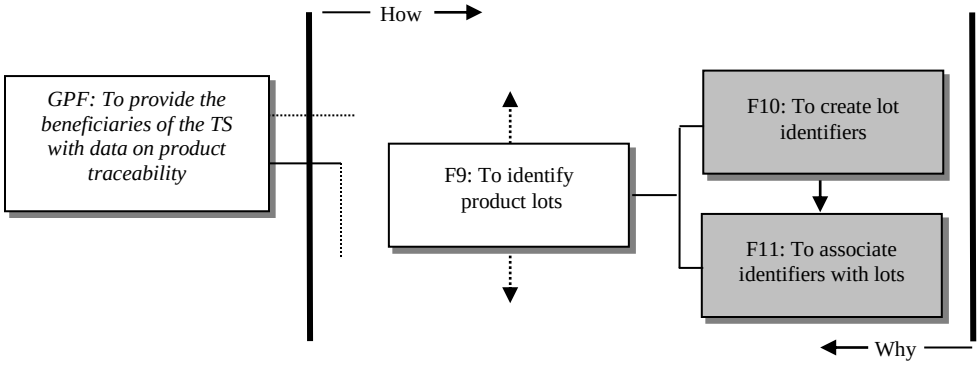

Figure 10. Identification of functions F10 and F11: *To create and to associate lot identifiers*

On the basis of our industrial experience and several literature references (Garrido Campos and Hardwick 2006;Jansen-Vullers et al. 2003;Pinto et al. 2006; and Rönkkö et al. 2007) the lot number is the identifier most used. Generally, a lot number takes a form of alphabetic, digital or alphanumeric code and can be either automatically (by IT) or manually generated. There are different ways to associate an identifier with the corresponding lot depending on the kind of considered product and on the technology adopted. For example, we can print (mark) the identifier directly onto the product (e.g. eggs, canned foods, cow tattoo, etc.), use barcodes or RFID tags. Finally, to physically associate an identifier with a lot, we can use direct marking (F12) or indirect marking (F13) as shown in Figure 11.

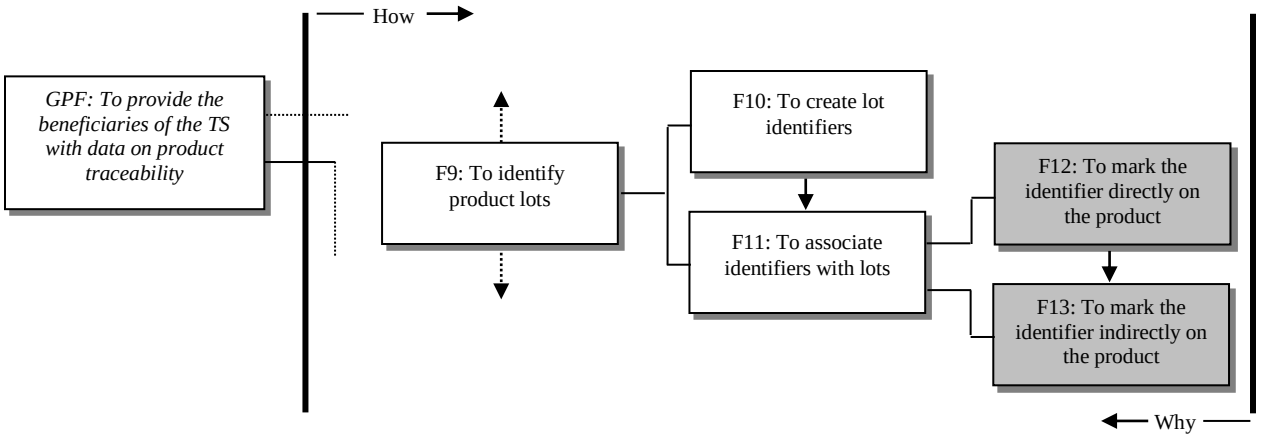

Figure 11. Identification of functions F12 and F13: *To mark the identifier directly/indirectly on the product*

As we can see in Figure 11, functions F12 and F13 can be used simultaneously to ensure a link between a product and its identifier. For example, for a lot of canned fish, the lot number can be printed on each can (F12) and also marked on a barcode stamped on a trade unit (box or pallet). Such a redundancy may guarantee a better reliability for a low extra cost. In both scientific and technical literature, all solutions that can be used to perform function F13 are grouped under the generic expression *identification carriers.* Hence, to the question *"how can we mark the identifier indirectly on the product?"* we can answer *"by using identification carriers".*

In practice, an identification carrier is generally used both to identify the product and to carry a set of (traceability) data describing this product (See F4). An RFID tag, for instance, contains the lot number of the product and other data such as manufacturing date, manufacturer's address, etc. Therefore, we can enhance the FAST diagram with a new function (F14: To use identification carriers).

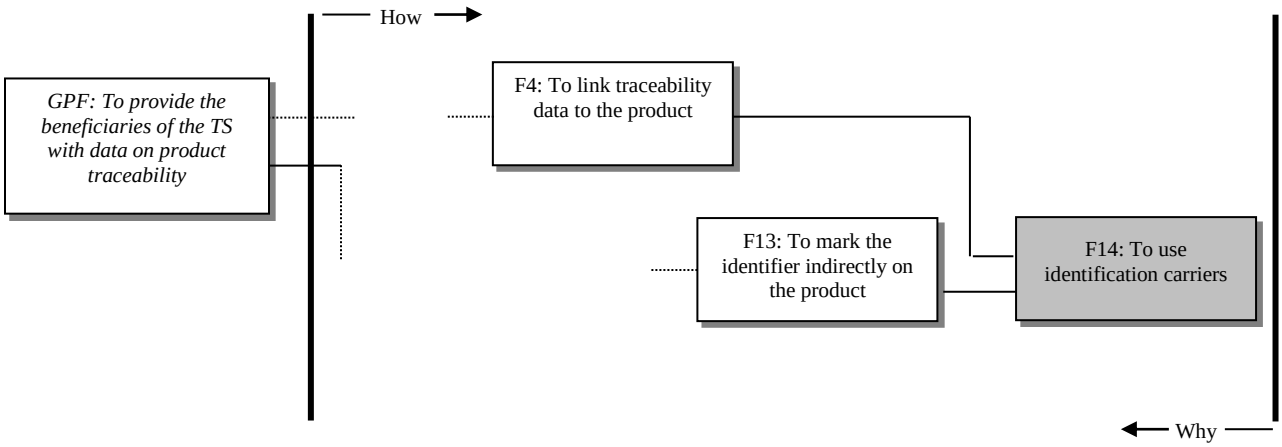

Figure 12. Identification of function F14: *To use identification carriers*

Through the previous paragraphs, we have presented the typical functions that must be performed by a food traceability system in order to satisfy its beneficiaries. But, as some of these

functions relate to product lots, it would be interesting to define a last function (F15) that deals with creating lots (See Figure 13). In a production or manufacturing process, a lot is created when a homogeneous group of products is considered and identified as a unique entity. For example, all the chickens bred in the same conditions (place, feed, etc.) can be considered as a unique lot. As can be noticed in Figure 13, function F15 necessarily takes place before function F11. However, it is quite possible to create a lot identifier prior to creating the given lot and *vice versa*.

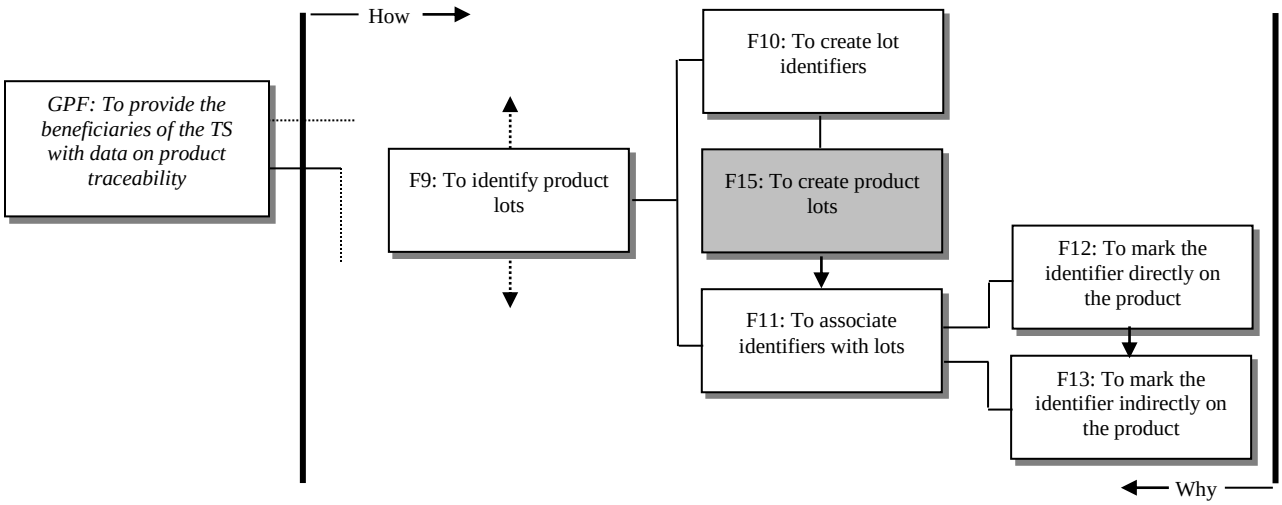

Figure 13. Identification of function F15: *To create product lots*

After identifying the fifteen technical functions of a traceability system and explaining their logical links, let us put them together to construct our complete FAST diagram (See Figure 14 in Appendix A).

Synthesis of the Technical Functions

Our ultimate objective is to propose a library of technological solutions associated to the technical functions in order to be used during the design of traceability systems. In practice, the design process of a TS now amounts to a two-step process: a first composition of technical functions respecting the logic of the FAST (successive choices with inclusive disjunctions), and a second choice of technological solutions (physical or IT equipment, organizational principles or working principles, processes) for each of the existing technical functions. In our case, the first design process leads at best to the nine functions located at the right hand side of the FAST diagram. These functions are henceforth called the **technical functions** (TF) of the traceability system. They are listed in Table 1 in chronological order.

The intermediate functions presented in the FAST diagram (such as F6, F9 and F13) are considered as the goals to be achieved through the nine technical functions listed above. Therefore, they do not appear in Table 1.

Table 1. The Nine Technical Functions of a Traceability System

Carrying out order	Function code	Designation
1	TF1	To create product lots
1	TF2	To create lot identifiers
2	TF 3	To mark the identifier directly on the product
2	TF 4	To use identification carriers
3	TF 5	To collect product traceability data
3	TF 6	To generate product traceability data
4	TF 7	To record traceability data in an external support
5	TF 8	To restore product traceability data
6	TF 9	To communicate product traceability data

Note. If function TF4 is used exclusively to carry traceability data (F4), it is achieved in the forth position, between TF6 and TF8. In practice, this case is quite rare since an identification carrier serves mainly to physically associate an identifier with the corresponding product.

To summarize this section, we started by identifying the highest finality (series of service functions) expected from a traceability system which consists in providing the system's beneficiaries with different kinds of data. Using the FAST method, this finality is logically broken down into a series of nine technical functions that a traceability system must partly or totally comply with. Practically speaking, this model has been set up as a two-step design process of a TS and a library of TS technological solutions that a designer may use to automate and document the detailed design of a TS. The choice of a technological solution depends essentially on the expected performance level of a given function. In the next section, we propose a set of criteria that can be used to assess the (internal) performance of a traceability system.

Performance Assessment of Traceability Systems

In this section we propose a series of 20 performance criteria that can be used to characterize and assess the completion of the nine technical functions previously identified. We call them ***technical criteria*** (TC). In Bendaoud (2008) we have provided a detailed description of each criterion in describing its quantification procedure and measurement protocol. Some of the criteria presented in Table 2 (found in Appendix B) are illustrated in the next section through a case study.

As can be noticed, none of the criteria listed above refers to the cost of data storage. In fact, due to the continuous decrease in cost of storage materials (Morris and Truskowski 2003) this criterion seems less crucial. However, data acquisition cost is frequently mentioned in literature. Unfortunately, we did not find any reference explaining how to assess this criterion in a concrete way. In an attempt to fill in this gap, we propose (Bendaoud 2008) a calculation method to estimate unit cost of traceability data acquisition.

In this section we have briefly presented a set of 20 criteria to use for assessing the technical functions of a traceability system. Further details about their quantification procedure and measurement protocol are provided in Bendaoud (2008). These criteria can serve either to evaluate the performance of an existing system or to choose appropriate solutions for a future one. In the next section, we present a case study through which some of the performance criteria described above will be illustrated.

A Case Study from a Poultry Processing Company

This case study aims at illustrating some concepts and propositions presented in the previous sections. It is carried out within a poultry processing company equipped with a traceability system in order to comply both with regulations and its customers' demands. This company slaughter several tens of thousands head per day on more or less automated lines. Nevertheless, as mentioned in Section 5, our model is generic enough to be applied regardless of the size and equipments of the company. To describe its traceability system, we focus on a single product: Roasted Chicken Thighs. The process starts with marinating the thighs in a sauce prepared with water, salt, paprika and other ingredients. After this step, the marinated thighs are roasted using an oven. The output is a set of products that are prepared in the same conditions and share the same characteristics. In other words, they belong to the same lot. So a new lot of products is created (See function TF1). The amount of products belonging to the same lot represents the size of the given lot. In our case study, an average lot weighs about 256 Kg. Given that a single trade unit (i.e. a box) used by the company weighs about 4 Kg., we obtain a lot size ratio of 64 (See TC1). This means that in case of a non-conformity affecting the process described above, the company must recall 64 boxes even if the entire lot is not actually affected.

So as to identify the given lot uniquely (See TF2), the company traceability system automatically generates the lot number 904422048886 which comprises 12 characters (See TC4) and can be considered as a meaningful identifier (See TC2). In fact, its first character refers to the year of production (9: 2009) and the following four (0442) identify the workshop where the lot is produced. The rest is made up of a sequential number. Thanks to its length and its meaningfulness, this identifier is unique forever (See TC3).

In order to physically associate the lot number to the products, the company uses barcodes as identification carriers (See TF4). According to manufacturing managers, they are robust enough (See TC6) and the marking indelibleness (See TC5) is satisfactory. However, humidity, combined with ventilation of cold rooms can weaken the link between products and their identification carriers (See TC7). The capacity of these barcodes (See TC8) is sufficient to carry some other data, especially manufacturing date and manufacturer's identity. Regarding the benefits of these identification carriers, the company does not consider their cost (a few euro cents) to be a problem (See TC9).

In addition to using a unique identifier, the traceability of our lot is ensured thanks to the acquisition of various data during its lifecycle. For example, the identifiers of its ingredients are collected (See TF5) automatically by scanning the barcode of each component. Information about quantities and cooking temperature is generated (See TF6) using weights and thermometers. Data acquisition speed (See CT10) is estimated by comparing the average duration of the process to the average time spent in acquiring traceability data. In this case, we found that about 9% of the process time is dedicated to traceability data acquisition (scanning barcodes, entering the quantities handled, etc.). The intervention of users is limited since the majority of these data is automatically acquired (e.g. barcode scanning, date recording…). This way of operating improves data acquisition reliability (See TC11). According to regulation, standards and costumers demands, we have listed a set of traceability data that must be managed by the company. The comparison of this list to the list of data that are actually acquired reveals a good data acquisition

completeness (See TC12). The total cost of acquiring each single piece of data is about 0.036 € (See TC 13).

Every night, the traceability data that are acquired in workshops are sent to an Oracle database where they are recorded (See TF7) for a period of five years, which is satisfactory according to regulations in force (See TC14). Thanks to daily backups and strict management of access rights, the security of traceability data is ensured (See TC15).

In order to restore traceability data (See TF8), the company uses a web-based software that allows users to question the database through various criteria (See Bendaoud 2008). In Bendaoud et al. 2007, we provide a detailed evaluation of the criteria associated to function TF8. In terms of exhaustiveness (See TC16), we explained that the amount of data provided is beyond what regulations demand. Between their acquisition (See TF5 and TF6) and their consultation by the user, traceability data are simply memorized in a database without any alteration so they remain authentic (See TC17). In general, a few seconds are enough to answer a given traceability request (See TC18). The precision of traceability data (See TC19) is satisfactory. For example, in case of a recall, the company is able to target the sole incriminated lot.

Traceability data are often used inside the company. However, in some cases, external actors (especially customers and Government Bodies) ask for certain information describing the origin and/or the characteristics of a given lot. The required data are generally sent (See TF9) by quality managers using email or fax so the transmission is fast enough (See TC20). In about 30% of cases, we observed that receivers are not satisfied with the content or the format of the data they receive (See TC19).

In the following table we present a summary describing the solutions adopted for each technical function in our case study.

Table 3. A Brief Summary of the Case Study

TS technical functions	The solutions adopted
TF1: To create product lots	A new lot is created after each activity resulting in a homogenous set of product (e.g. raw materials receipt, chicken roasting).
TF2: To create lot identifiers	Lots are identified with lot numbers that are automatically generated by the Computer-Aided Manufacturing System.
TF3: To mark the identifier directly on the product	Due to the nature of its products, the identifiers are not marked directly on them.
TF4: To use identification carriers	The main identification carriers used are barcodes.
TF5: To collect product traceability data	Some data are collected manually from different documents such as delivery slips. Some others are collected automatically using, for example, barcode readers.
TF6: To generate product traceability data	That concerns essentially the data describing product quantities that are generated with scales.
TF:7 To record traceability data in an external support	Traceability data are recoded inside an Oracle™ database.
TF:8 To restore product traceability data	A web-based software allows users to restore traceability data through multi-criteria requests.
TF:9 To communicate product traceability data	Traceability data are regularly communicated to third parties (customers, health authorities, etc.) using usual communication tools especially email and fax.

Today, the company is entirely satisfied with the capacity of its traceability system to fulfill regulations and customers demands. To ensure a consistent performance level, some of the criteria presented in this paper are used during traceability audits carried out internally.

Conclusion

In response to the food crisis of recent years, traceability has become an incontrovertible means of protecting consumers by locating harmful products and retrieving them from the market place. In this context, food operators have no choice but to comply with the various regulations and standards in force. In this paper, we present some findings of a broader research project in which we proposed methodological tools intended to design, assess and manage food traceability systems so as to fulfill these demands.

Using the FAST method, we have proposed a model describing the internal behavior of a traceability system. This behavior refers to the functions (or the processes) performed by the system in order to provide a good service to its beneficiaries. This model constitutes a framework for designing or setting up a food traceability system. In fact designing or setting up such systems consists of selecting appropriate solutions (i.e. tools and organizations) to perform each function. For example, to identify product lots many options are available such as using barcodes or RFID tags. The choice depends on the performance level expected for this function. We have defined a set of quantifiable criteria that can be used either to choose between possible solutions for a given function, or to assess the whole performance of the system. To illustrate our proposals, a case study is presented in the last section of the paper. It shows how the different functions are accomplished within a poultry processing company and gives an idea about the related performance criteria.

Presently, several commercial solutions propose traceability solutions (i.e. software, hardware, identification tools, etc.). However, for confidentiality reasons, it has not been possible to get the founding principles and data models used by these providers to build their traceability systems. However, no one proposes a modular functional approach like we do. In Section 2 we present four alternative approaches that are mentioned in literature Regattieri et al. 2007; Steele 1995; Verdenius 2006. In Bendaoud, (2008) we explain how existing proposals are unsatisfactory since they lack exhaustiveness and are not based on known systematic frameworks. For example, despite certain attempts to analyze and comprehend the performance of such systems, the criteria that have been previously proposed lack exhaustiveness and clear measurement protocols. In comparison with most existing approaches, our proposal aims to be more comprehensive, more rigorous and more practical. Thanks to FAST method (that is acknowledged by design communities), we progressively define technical functions of a TS and systematically link them to the ultimate finality of this system. Strictness and exhaustiveness are among FAST method strengths. As such, it allows to systematically establish all the causal connections between the service (finality) provided by the system and its components (technical functions). In terms of design, this approach guarantees a continuous causal flow between the ends and the means. It minimizes, accordingly, the risk of design errors (e.g. to forget an intermediate step in traceability process). Another practical aspect of our proposal mainly lies in providing concrete examples and in defining quantifiable assessment criteria. Furthermore, the originality of our work lies in applying a conventional method used in design to a specific food processing issue, and in partic-

ular to an immaterial system of "traceability" which is composed of procedures, computers, personnel and organizational components. The present TS model is also applicable to other contexts where traceability is crucial (e.g. pharmaceutical, aerospace, etc.) provided that the traced elements are identifiable. These elements can be either individual entities or groups (i.e. lots) of entities. Actually, we can consider an individual entity as a lot composed of one instance.

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Appendix A.

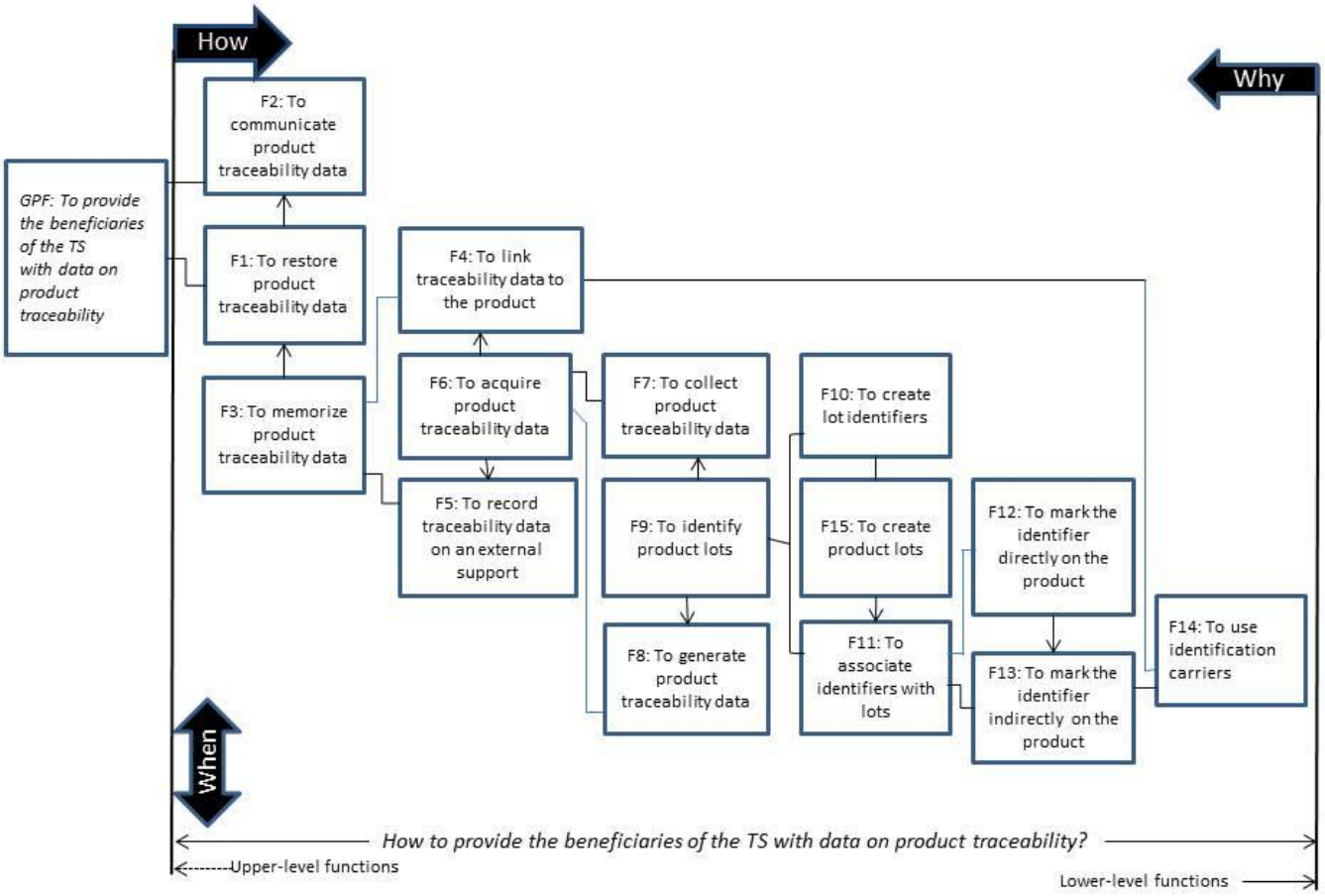

Figure 14. FAST Diagram of a Traceability System

Appendix B.

Table 2. Performance criteria of traceability systems

Technical Functions	Performance Criteria	Definitions / Comments
TF1 : To create product lots	TC1 : Lot size ratio	Many authors (Golan et al. 2004; Lecomte et al. 2006; Resende-Filho and Buhr 2007) state that traceability precision is inversely proportional to lot sizes. Our reference is trade items (bins, boxes, etc) which is a quantity of products "on which there is a need to retrieve predefined information and that may be priced or ordered or invoiced at any point in any supply chain" (after Aarnisalo et al. 2007; GS12005). Lot size ratio is obtained by dividing the average trade unit by the average lot size. The bigger this ratio, the better the traceability precision.
TF2 : To create lot identifiers	TC2 : Meaningfulness of lot identifiers	An identifier is meaningful or intelligent (according to Green 1997), if it carries a given meaning. With meaningful identifiers, some information can be obtained directly without asking the information system (e.g. a lot number made from a production date)
	TC3 : Uniqueness period of lot identifiers	The period during which a given identifier cannot be used to identify more than one lot (Dupuy 2004).
	TC4 : Lot identifiers length	The length of a lot identifier refers to the number of characters it is made up of. This criterion can have certain impacts, for example, on the size of identification carriers.
TF3: To mark the identifier directly on the product	TC5 : Marking indelibleness	The identifier marked on the product must be indelible enough to withstand its surrounding conditions (heat, dampness…). This ability depends mainly on the technology used (e.g. ink jet, laser …). To estimate this criterion, we suggest dividing marking length of life by the shelf-life of the product identified.
TF4: To use identification carriers	TC6 : Identification carrier robustness	The robustness of an identification carrier refers to its ability to withstand the surrounding conditions in which it is used. This criterion can be evaluated through the percentage of identification carriers presenting a sufficient resistance.
	TC7 : Reliability of the link between the product and its identification carrier	In addition to having robust identifications carriers, it is crucial that these remain linked to the products to ensure permanent identification. The criterion TC7 can be estimated by dividing the minimum time during which the carrier is linked to the product by product shelf-life.
	TC5 : Marking indelibleness	Criterion TC5, described above, also applies to the identifiers that are marked on the identification carriers. In the case of electronic carriers (e.g. RFID tags), marking indelibleness refers to the ability to read the content recorded inside them.
	TC8 : Identification carrier capacity	The amount of data that can that can be recorded on an identification carrier. For example, a linear barcode's capacity varies from 1 to 40 characters. With a capacity of several Ko, RFID tags can be used not only for identification purposes, but also to carry other traceability data (Tellkamp 2006).
	TC9 : Identification carrier cost	The cost of identification carriers is an important parameter to be taken into account in a traceability project. For example, due to their cost (USD $0.3-0.5), RFID tags are more suitable for identifying high value-added products.

Table 2. Performance criteria of traceability systems-Continued

Technical Functions	Performance Criteria	Definitions / Comments
TF5 : To collect product traceability data & TF6 : To generate product traceability data	TC10 : Data acquisition speed	This performance criterion is inversely proportional to the time needed to acquire the required traceability data. In practice, data acquisition takes place each time the product undergoes a given operation (processing, packaging, etc.).
	TC11 : Data acquisition reliability	This performance criterion refers to the system's ability to collect data that are free-of-error in the sense of Pipino et al. (2002). In other words, they must be correct and reflect reality. According to Sharp (1990) and Wray (2007) , when data are recorded manually, one error is produced every 300 words. The value of TC11 can be obtained by estimating statistically the percentage of data that are considered as correct.
	TC12 : Data acquisition completeness	The completeness refers to the extent to which the amount of acquired data is sufficient. According to Wang and Strong (1196), data completeness is a contextual criterion since it is strictly related to the context where data is used. In mathematical terms, if the needed data are represented by set A and the data that are actually acquired are represented by set B, TC12 can be expressed as follows: $CT12 = \frac{card(A \cap B)}{card(A)}$ (%)
	TC13 : Data acquisition cost	According to the amount of data acquired, the frequency of their acquisition and the tools used, the cost generated can be high. This cost is related to the means used in the data acquisition process, especially workforce, equipment and consumables (e.g. paper, ink, energy…).
TF7 : To record traceability data in an external support	TC14 : Traceability data's sustainability	This performance criterion refers to the length of time during which traceability data remain accessible. This duration can be defined according to the shelf-life of the product under consideration.
	TC15 : Traceability data's security	In some cases, traceability data can be subjected to different threats. In the literature, information security is generally described in terms of confidentiality, integrity and availability (Chew et al. 2008; Hoagland et al. 1998; Yialelis 1996).
TF8 : To restore product traceability data (In Bendaoud, (2007), we have described in detail how to quantify the performance criteria related to this function in practice.)	TC16 : Traceability data's exhaustiveness	The ability of traceability system to provide its beneficiaries with all the data needed.
	TC17 : Traceability data's authenticity	The ability of traceability system to restore product traceability data faithfully (i.e. without error).
	TC18 : Traceability data's speed	This assessment criterion is in inverse proportion to the time spent in answering a given request about product traceability.
	TC19 : Traceability data's precision	Precision is a criterion that is frequently quoted in the literature (Golan et al. 2004; Lecomte et al. 2006; Resende-Filho and Buhr 2007). It can be defined as the ability of a traceability system to identify, among several possibilities, the exact answer to a given request.

Table 2. Performance criteria of traceability systems-Continued

Technical Functions	**Performance Criteria**	**Definitions / Comments**
TF9 : To communicate product traceability data	TC19 : Quality of transmitting traceability data	According to communication theory, the quality of the message exchanged between an information source and a recipient is conditioned by the noise that is prone to. In Chitode (2008), the noise is defined as any unwanted signal that tends to interfere with the required signal. TC19 can be calculated as the ratio of successful communications divided by the number of total communication made during the period under consideration
	TC20 : Speed of transmitting traceability data	This criterion is inversely proportional to the time needed to transmit the message from its sender to the recipient. It depends, mainly, on the communication channel that is used (fax, mail, phone…).

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Grameen Danone Foods Limited (GDF)

Jonathan Rodrigues[a] and Gregory A. Baker[Φb]

[a]*MBA Graduate, Leavey School of Business, Santa Clara University, 500 El Camino Real Santa Clara, California, 95053-0396, USA*

[b]*Professor, Food and Agribusiness Institute , Santa Clara University, 500 El Camino Real Santa Clara, California, 95053-0396, USA*

Abstract

This case describes Grameen Danone Foods (GDF), a fresh dairy product company in Bangladesh that was founded in 2007. GDF is the result of a joint venture between Groupe Danone, a multi-national corporation, and the Grameen Bank, a Bangladeshi non-governmental organization (NGO). GDF collects milk from many small dairy farmers and produces yogurt products for distribution through both rural and urban channels. The issues, challenges and opportunities highlighted in the case are relevant for students and industry professionals. The SWOT (Strengths, Weaknesses, Opportunities, Threats) framework is ideal for analyzing the content of the case; this may then be used to create future plans, for the business as a whole and specifically in the areas of marketing and operations.

Keywords: teaching case, social entrepreneurship, Bangladesh, yogurt, dairy industry

[Φ]Corresponding author: Tel: + 1 408. 554-5172
Email: gbaker@scu.edu
J. Rodrigues: jonathan.rodrigues81@gmail.com

IFAMA Agribusiness Case 15.1

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Introduction

After a four-month hiring process and a 30-hour plane trip, Luc Jeanveaux is on a bus finishing the last leg of his journey to his new job. Having just completed his MBA, he will start work as the General Manager of Grameen Danone Foods (GDF), a Bangladeshi yogurt company that is co-owned by Groupe Danone (GD) and the Grameen Family of Enterprise (GFE).

As General Manager (GM), Luc will supervise the 100 operations, sales, and administrative staff who work in the Bogra facility. His responsibilities will include overseeing production, equipment maintenance and the collection, storage, and transportation of fresh milk from more than 100 contract dairy farmers. Luc reports directly to the Managing Director (in U.S. corporations, this is the equivalent of the Chief Executive Officer or CEO), who is based at the Dhaka headquarters. As the highest-ranking GDF official at the Bogra plant, Luc is an important link between operations in Bogra and headquarters in Dhaka. As a result, he plays several roles including:

1. Linking the supply side of the business (supply chain and operations) with the demand side (sales and marketing).
2. Ensuring that raw milk supply from internal vendors meets daily production requirements so that milk does not need to be purchased on the spot market at a higher price.
3. Identifying supply chain risks and developing extension services (veterinary, consulting, and financial services) that will help to mitigate these risks.
4. Communicating to the managing director when the cost of goods sold increases so that product and pricing adjustments may be made.

The job of GM is clearly demanding and Luc is the third person to hold the post since operations began in 2007. His predecessors and the board prepared a packet of information related to GDF's internal performance, the dairy industry, the agricultural sector, Bangladesh's macro-environment, and consumer market. After flipping through the packet, Luc knew that he would need to manage multiple issues at once and that some responsibilities would need to be prioritized over others. Knowing that there is no time like the present, Luc watched the bus pull away from Dhaka's busy terminal. He took a deep breath and reviewed the materials one last time.

Groupe Danone

GD was founded in 1919 in Barcelona, and is now the world's largest producer of fresh dairy products with more than 80,000 employees. Danone (Dannon) yogurt has long been GD's flagship product, but it also owns bottled water, baby, and medical nutrition brands. In 2009, total global sales were more than US$21 billion and it had a 15 percent profit margin (Groupe Danone 2010). In the past decade, GD has expanded aggressively into emerging markets with sales in these markets growing from 6 percent in 1999 to 42 percent in 2009. (Manners 2009). The GD CEO, Franck Riboud, promoted GDF as a mechanism for GD to expand into a new, large Asian market and to provide its nutritional fresh dairy products. In October 2005, Riboud discussed his ideas with Muhammad Yunus, the Grameen Bank chairman. Shortly thereafter, the

memorandum of understanding was signed, and GDF became GD's first investment in Bangladesh.

Grameen Group of Enterprises and Grameen Bank

The GFE began in 1976 as a project in collateral-free lending initiated by Muhammad Yunus, an Economics professor at the University of Chittagong in Bangladesh. The GFE is a diversified group of enterprises that operates in the banking, healthcare, energy, education, agribusiness, and textiles industries among others. In 1983, the Grameen Bank was formed as a government-sanctioned bank. Over the years, this micro-finance organization has disbursed more than US$10.5 billion in loans, mainly to rural women. The Grameen Bank (GB) now has 8.37 million members and more than 25,000 branches. In 2010, the total average monthly loan disbursement was about US$120 million. About 27 independent sister-concerns of the GB have been formed in industries that vary from health and energy to agribusiness to ready-made-garments. Because most of its borrowers are based in rural areas, GB has developed specialized loans and extension services to serve farmers. The Grameen Livestock Foundation (GLF), founded in 1997, is around 50 km from the Bogra factory and targets financial and extension services for dairy, poultry, and fish farmers. GDF is the GFE's first partnership with a multi-national corporation and its first investment in dairy processing (Grameen Bank 2011).

The Design Phase

With the active support of GD's CEO and the GB chairman, GDF was able to quickly move through the initial planning phase. The vision for GDF was to create up to 50 factories that provide fresh and healthy dairy products to Bangladeshis by 2020. According to Maurel (2009), GDF's four primary objectives are to:

- Provide health through nutrition at affordable prices to all Bangladeshi children.
- Improve living conditions of the poorest members of the community by involving them in all stages of the business model including supply, production, sales, job creation, and improving local competencies.
- Preserve non-renewable resources as much as possible.
- Become profitable to ensure economic sustainability.

Previously, GD produced yogurt using a centralized model in which a few large dairy farms provided milk to a centralized production facility that processed it into yogurt and distributed to retailers and wholesalers. In Bangladesh, a number of environmental factors prompted GDF to adopt a *proximity-based business model*. A proximity-based model works to bring supply, production, retail, and consumption of a product as close to one another as possible.

GDF redesigned the typical yogurt factory supply chain to serve dairy farmers with around five cows and little or no access to electricity for refrigeration. It also focused on building high sales penetration and repeat customers in the rural areas around the factory. It hires door-to-door salespeople to sell yogurt from refrigerated coolers in these areas. In addition, GDF distributes to convenience stores and supermarkets in Bangladeshi cities and towns.

The Bogra Plant

Guy Gavelle, Groupe Danone's Industrial Director for Asia-Pacific Operations, managed the design and construction of GDF's first factory in Bogra (Exhibit 1, see Appendix). The Bogra facility, which was quite different than the typical GD factory in terms of location, size, and workforce, presented several unique design challenges for Gavelle: (Yunus 2010a).

- Product – the factory needed to maintain GD's high food safety standards throughout the production of the Shokti Doi brand of yogurt (Exhibit 2, see Appendix).
- Durability – the equipment needed to be durable and dependable enough to be operated and maintained in remote locations that have limited access to replacement parts.
- Lower Capacity – the factory would produce a fraction of the output of GD's other plants but maintain the same quality standards.
- Different Labor Usage – production processes should be both labor intensive and simple enough to be performed by a low-skilled workforce.
- Distribution and Sales – the plant must include a cold storage distribution center and office space for regional sales and administration staff.
- Environmentally Friendly - the Bogra facility needed to include equipment and processes for wastewater treatment, recycling, rainwater harvesting, solar water heaters, and a biogas generator.

GD broke ground on July 14, 2006 and equipped the plant with yogurt processing and refrigeration equipment imported from China and India and stainless steel tanks and pipes that were locally fabricated. Construction took about six months to complete; commercial production began in January 2007. While other Danone factories can be more than 75,000 square feet with an annual capacity of more than 100,000 tons, the Bogra factory is about 7,500 square feet with an annual capacity of 3,200 tons, or about 8,000 liters per day. The total cost of the plant was about US$1 million – US$50,000 for land and US$950,000 for the facility (Jeanveaux 2010).

Sales Performance 2007 to 2010

During the first half of 2007, the Bogra plant ran smoothly, and product feedback was generally positive. However, after the initial push, sales growth began to stagnate. GDF's urban sales focused on about 100,000 households in the city of Bogra, but it was only able to distribute to 300 to 400 stores that had adequate refrigeration facilities. This limited the growth potential for GDF's urban sales channel unless it expanded to other towns and cities.

Meanwhile, the rural areas around Bogra represented huge growth opportunities with 650,000 households, spread over more than 2,500 villages (BBS 2007). The rural sales program, consisting of door-to-door salespeople, was designed to provide supplemental income to rural women and introduce the yogurt to rural consumers, similar to the Avon selling model. However, during the first half of 2007, it attracted only about 30 saleswomen and GDF's rural sales volume seemed to be stuck at 3,000 cups per day. In response, GDF hired a full time GM from Bogra who had experience working in the region. It also hired consultants to audit GDF's rural sales and identify areas for improvement. The consultants noticed that GDF's training process failed to engage the families of the saleswomen, especially their husbands. This

prompted GDF to launch a new recruitment, selection, and training program that focused on engaging the entire family and effectively communicating the potential economic benefits of being a successful salesperson. The company also responded to consumer taste tests by increasing the sweetness of the yogurt.

These adjustments worked; the rural sales force grew from 29 in September 2007 to 270 in March 2008 and it enjoyed six months of sustained sales growth (October 2007 to March 2008), primarily due to increases in rural sales. In several villages, GDF was selling to 50 percent of the households. This seemed to validate the proximity-based model. After its first year, GDF was not operationally profitable but was able to quickly address internal issues and build sales growth that placed it on a path to profitability (Yunus 2010a).

Unfortunately, this success was short-lived. By mid-2008, global food commodity and petroleum prices were at all time highs. In addition, Bangladesh faced two consecutive years of exceptionally bad monsoon floods. These factors caused milk prices to double between 2007 and 2008. By March 2008, the razor-thin margins were totally eroded and GDF was losing money on each sale. In April 2008, GDF raised the price of an 80-gram cup of yogurt from 5 to 8 taka (70 taka is equivalent to about US$1). The price increase caused sales in rural areas to decline by 80 percent and urban sales by 40 percent. GDF's rural sale force also dropped back to around 30 people.

In June 2008, GDF reacted by introducing a smaller (60 gram) package with the same nutritional value as the larger package and priced at 6 taka. It also launched promotional events and nutritional programs to rebuild the brand's image and introduced new packaging and pricing. It built its rural sales strategy around 35 committed saleswomen who were given daily sales targets of 50 cups and expected to work about seventeen days each month.

GDF also began selling its 80-gram packages to other towns and cities in the Rajshahi District and eventually as far away as Dhaka. The price point for provincial towns was 8 taka while yogurt in Dhaka was priced at 12 taka. GDF also introduced a mango-flavored yogurt and began developing a yogurt drink that did not require refrigeration. In September 2008, GDF re-branded its yogurt as Shokti+. Removing the word "doi,"which means yogurt, gave GDF the flexibility to expand into products other than yogurt. In March 2009 GDF launched a nationwide television commercial campaign that resulted in large urban sales increases (Yunus 2010a).

These adjustments put GDF back on track. In 2010, monthly sales volume was approximately 100 tons or over 800,000 cups of yogurt. It also introduced a liquid yogurt product that comes in a sachet and requires minimal refrigeration. This product was priced for the lowest income consumers at 5 taka for 50-milliliters. GDF now employs around 900 saleswomen who provide the company with about 20 percent of total sales. The remaining sales come from a network of small shops in provincial towns in the Rajshahi district and supermarkets in Bangladesh's large cities, including Dhaka, Sylhet, and Chittagong. In 2010, the Global Alliance for Improved Nutrition (GAIN) and Johns Hopkins University began a nutritional impact assessment of GDF's products. If current trends persist, the Bogra plant could be operating at capacity sometime in 2011 (Exhibits 3 and 4, see Appendix) (Yunus 2010b).

The Available Market

Bangladesh is home to over 150 million people or roughly 25 million households. The population is spread across seven divisions, which are sub-divided into 64 zilas (districts). About 70 percent of the population is concentrated in three divisions: Dhaka, Rajshahi, and Chittagong. Bangladesh's small landmass and large population make the country one of the world's most densely populated nations with almost 3,000 people per square mile. Over 50 percent of the population lives in more than 8,000 villages or impermanent settlements called chars (riverbanks and sandbars) that are adjacent to Bangladesh's many rivers (UNESAP 2008). The country's six official incorporated cities – Dhaka, Chittagong, Khulna, Rajshahi, Barisal, and Sylhet – are home to over 20 million people. More than 60 percent of these people live in Dhaka with an additional 20 percent in Chittagong. The remainder of urban Bangladeshis lives in over 200 smaller municipalities around the country (BBS 2010).

While aggregate household expenditures were greater than US$26 billion in 2005, there is great income inequality. About 94 percent of Bangladeshi households earn less than the equivalent of US$3,000 per year (BBS 2010). They participate in a market that is characterized by significant unmet needs, dependence on informal or subsistence livelihoods, and high prices for basic products and services (relative to the prices paid by upper income segments (Hammond 2007). About 45 percent of all households earn less than US$2 a day, and 80 percent live in rural areas. These households account for only 26 percent of total national expenditure (US$6.6 billion). The upper 20 percent of households account for 40 percent ($10.6 billion) of household expenditures, and the upper five percent of households represent 16 percent (US$4.2 billion) (BBS 2010). Culture, history and geography play an important role in the nature of the market (Exhibit 5, see Appendix).

Expenditures on Food

Food represents the largest expenditure for Bangladeshis and accounts for 36 percent of the expenditures of the wealthiest households and 65 percent of the poorest families. By contrast, Americans spend an average of 13 percent of total expenditures on food (BLS 2009). Over 14 million Bangladeshi households spend less than 700 taka (US$10) a week on food, over 8 million households spend less than 1000 taka (US$14.29), and the wealthiest 3 million households spend more than 1,100 taka (US$15.71) (BBS 2010). With such a high share of income committed to food, Bangladeshis are highly sensitive to price changes. For example, the drastic increase in food prices in early 2008 forced many middle class households to purchase government subsidized food. During this time, there were also nationwide demonstrations for higher wages and lower prices (Exhibit 6, see Appendix) (Dummet 2008).

The 2008 food crisis underscores systemic food insecurity challenges in the country that disproportionately affect the poorest income segment. Small farmers and laborers tend to have less income in the months leading up to the harvest season. In northwestern Bangladesh, the time before the November and March rice harvests is known as *monga* and characterized by serious reductions in food intake (Zug 2006). If a harvest is delayed or destroyed by a natural disaster, nutrition is further degraded, often forcing families to decide between migration and

starvation. This cycle has been a major contributing factor to socioeconomic underdevelopment in many parts of Bangladesh.

The Dairy Market

In 2005, Bangladesh produced about 2.27 billion liters of dairy products. Annual milk production tends to peak in the dry season (October to March) when there is more land available for grazing (Parves 2010). Liquid milk and milk equivalent products (e.g. powdered milk) represent more than 90 percent of total consumption, and products from processed liquid milk (e.g. yogurt and butter) account for an additional five percent (BBS 2010). A 2003 sample of 300 consumers from different geographic areas and economic groups found that roughly 44 percent of poor Bangladeshis had consumed milk in the prior three days compared with 69 percent of middle class consumers, and 88 percent of rich consumers. In villages, about 60 percent of the sample had consumed milk in the past three days versus 43 percent in urban slums, and 73 percent in the char (riverbank areas). When a family purchases milk, it was usually shared among all members. However, when there is a limited supply, children under five are usually given preference. Poor families spent about 3.5 percent of their daily food expenditures on milk, while middle class families spent eight percent, and rich families six percent (Halder and Barua 2003). In general, milk sales increase during the forty days of Ramadan and the two annual Eid festivals. Between 2003-04 and 2005-06, total milk production in Bangladesh grew by six percent. With a growing middle class, the trends toward increased milk consumption should continue (Exhibit 7, see Appendix) (Parvez 2010).

Milk and other dairy products are acquired through three primary channels: (Halder and Barua 2003).

- Self-production – up to 30 percent of milk-consuming households in villages and 69 percent of families living in chars (riverbank areas) produced their own milk.
- Informal market – buying from neighbors, door-to-door salespeople, and street vendors accounted for an additional 50 to 60 percent of consumption in villages, 29 percent in slums, 24 percent in char areas, and about 49 percent for middle class consumers.
- Fixed market sales – milk purchased from formal retail outlets represented less than 20 percent of village sales, over 70 percent of slum sales, and over 30 percent for upper and middle class consumers. With more supermarkets in cities around the country, middle and upper class consumers are increasingly purchasing milk through established retail outlets.

The Milk Industry

Raw Milk

Milk is typically purchased from town bazaars where 100 to 150 farmers bring one to five liters of milk to sell directly to local households or small businesses. Sales for household consumption are usually less than one liter, but sales to small businesses can exceed 50 liters per day. The price of raw milk varies greatly depending on location and season. For example, in late-2010 the price for milk in a market town in rural Rajshahi division was 25 taka (US$0.36) per kilogram versus 45 taka (US$0.64) per kilogram in a bazaar about 40 kilometers from Dhaka.

Alternatively, members of cooperatives or contract farmers will bring their milk to a collection center, which typically collects around 1000 liters of milk per day. The collection center staff tests the milk for quality and pays the farmer a fixed price of 26-30 taka (US$0.37-US$0.43) per kilogram. The milk is then placed into 40-liter containers and transported by bicycle van to a chilling facility. Chilling centers are located in areas with regular electricity with storage and cooling equipment that can handle 1,500 to 11,000 liters of liquid milk. Depending on capacity, the chilled milk is loaded into a car or tanker and taken to the processing facility. The collection and chilling center staff and drivers are either paid fixed rates or on commission (Jeanveaux 2010).

Traditional Processing

Traditionally, milk is processed into solid butter, liquid butter (ghee), yogurt, and milk-based sweets. Milk-based sweets are popular during festivals and special events such as weddings. Historically, Hindu "Ghose" families operate sweet shops that specialize in producing and selling products like sweet yogurt (mishtee doi) and other milk-based sweets. These sweets are one of the primary uses for processed milk. While the current sweet-making industry is no longer solely dominated by Ghoses, traditional sweet-making processes remain relatively unchanged. Milk-based sweets are usually produced through a process of boiling milk, curdling it into a solid form, and mixing it with additional ingredients. Small village sweet shops usually have a single boiler and oven while popular urban shops can have up to 15 boilers and sell more than 1000 units per day. Yogurt is traditionally sold in handmade clay pots, and other sweets are sold by weight and packaged in cardboard. While most sales take place in the same location as production, several factories in districts just outside Dhaka distribute to retail outlets in the city (Asia Sweetmeats 2010).

Modern Processing

Bangladesh is also home to a large and growing modern milk processing industry with the top nine processors employing over 80,000 dairy farmers, 1,200 permanent employees, 2,000 collectors and transporters, and 100 distributors (Halder and Barua 2003). Processors usually have centralized facilities located in rural areas with equipment for large-scale pasteurization, storage, processing, and packaging. While processing and packaging pasteurized milk is the primary focus of these facilities, they can also make milk powder (a milk product that does not require refrigeration), ice cream, and many of the same products as traditional processors (ghee, sweet yogurt, liquid yogurt, and other milk-based sweets). As milk consumption increases in Bangladesh, the supply of raw milk struggles to keep pace; this leads to price fluctuations and creates an environment where speculators manipulate supply and prices. Limited domestic supply has also forced Bangladesh to import milk powder from countries such as India, Australia, and New Zealand. Since 1994, the prices paid for raw milk by processors have more than doubled. Milk is packaged in ½- and 1-liter containers, while milk products like yogurt are packaged in sealed plastic tubs. Once packaged, refrigerated trucks transport products from the plant to a distribution point, where bicycle vans or smaller vehicles pick up the products for retail store delivery (Exhibits 8 and 9, see Appendix).

Competitive Landscape

The processed dairy market is dominated by two organizations – MilkVita and BRAC Aarong. Until 1994, when private competitors began entering the market, MilkVita had virtually 100 percent of the total market. MilkVita now controls about 60 percent of the market while BRAC controls 20 percent. BRAC began operating in 1998 as a way to increase incomes for dairy farmers. Approximately seven other enterprises account for the remaining 20 percent of the market. There are several government-owned farms around the country that have quality facilities and livestock, but mismanagement and corruption have plagued these facilities in recent years; they now produce a negligible share of Bangladesh's processed milk (Exhibits 10, 11, and 12, see Appendix).

GDF Supply Chain

GDF's raw milk supply chain does not differ greatly from that of the competition. Milk is collected from dairy farmers at kiosks that are located near the dairy farmers. Farmers are paid a fixed price for milk upon delivery to the collection center. Raw milk is brought to a chilling facility in the morning and evening by bicycle rickshaw and is stored at the facility until a truck picks it up and brings it to the factory. The collection and chilling centers are either owned by GDF or by milk collection partners. In addition to milk, GDF needs to source sweeteners and nutritional supplements in order to make its yogurt. Date palm molasses, which is prevalent in the Rajshahi Division, is GDF's primary sweetener and a popular sweetener for other Bangladeshi foods and beverages. The yogurt also includes iron, calcium, vitamin A, and iodine nutrients that are typically imported from Europe. The finished yogurt is then packaged in plastic cups or sachets (Exhibits 13, 14, and 15, see Appendix).

GDF Promotion

The Grameen Brand

With operations throughout the country and in multiple sectors, Grameen has become a trusted brand name for Bangladeshi consumers. When the Grameen Bank and founder Muhammad Yunus were awarded the Nobel Peace Prize Award in 2006, the brand also became a source of national pride. GDF's marketing strategy leverages the nationwide recognition and trust associated with the Grameen brand in its advertising and promotional campaigns. The current marketing strategy dates back to late 2008 when GDF decided to expand distribution to Dhaka and other cities. It executed this expansion with a series of television commercials that ran in March, May, and September of 2009. Several of these commercials featured Yunus, who highlighted the social objectives of the program and the health benefits of Shokti+ for children. Outdoor advertising in urban areas was also used to promote the brand in towns and cities. The increased sales volume that followed the commercial and advertising campaign seem to indicate the success of the campaign.

Promotional Events

To stimulate rural sales, GDF trains event teams who travel to villages and schools to promote Shokti +. Event teams usually include a man, a woman, and one of the saleswomen. The male team member dresses up as the Shokti + lion and goes around the village convincing people, especially children, to attend the event. This spectacle easily draws a crowd of 50-100 people who gather in the village center. At this point, the other team member begins discussing the health benefits of Shokti + and the objectives of the organization. After a 15-20 minute presentation and several free samples, people are directed to the saleswomen to purchase yogurt. These events help saleswomen quickly introduce Shokti + in new villages and can generate sales of 100 or more cups in a single event. In 2009, GDF hosted 1,270 events and employed 16 teams for rural promotions (Yunus 2010b).

Point-of-Sale Promotion

GDF has also introduced effective, point-of-sale marketing strategies. In early 2010, the company introduced a promotion in which each yogurt purchase came with a free sticker and purchasing multiple cups came with a free ruler. Saleswomen, supermarkets, and small retail stores all mentioned that sales volumes were higher during these promotional periods and dropped when they ended. Volume-based promotions are also used by GDF and have increased sales by up to 20 percent in some supermarkets. During visits to the Agora, G-Mart and Prince Bazaar supermarkets in Dhaka, prize and volume discount promotions were all observed.

Bad-Press & Muhammad Yunus' Retirement

While these marketing and promotional activities have successfully increased sales, bad press and political ill will threaten Grameen's brand equity. In 2006, Yunus declared his intentions to start a party and run for Prime Minister. This decision earned him some powerful enemies including the current Prime Minister, Sheikh Hasina. In late 2010, a Danish documentary exposed what it claimed were irregularities in Grameen's use of Norwegian aid dollars. While Norway's aid agency made assurances that the money was used correctly, the scandal drew a lot of attention in Bangladesh. Hasina used the bad-press to her advantage and stated that "micro-lenders [like Grameen Bank]…are sucking blood from the poor in the name of poverty alleviation…there has been no improvement in [their] lifestyle…[the poor] were just used as pawns to get more aid" (Financial Express 2010a). In May 2011, Muhammad Yunus retired as the GB chairman to diffuse the situation. It is unclear what will happen to the GFE without its dynamic and visionary founder.

GDF Distribution and Sales

GDF's decision to expand distribution within the Rajshahi Division and into Dhaka was a shift in distribution strategy that had an immediate impact on sales. The Bogra plant production volume was expected to grow from 22 percent of capacity in 2009 to 54 percent in 2010 (Yunus 2010b). Today, the cities of Dhaka, Sylhet and Chittagong account for 50 percent of sales volume, rural sales through village saleswomen represent about 20 percent of sales, and towns and cities in the Bogra area account for about 30 percent.

Rural Sales

The execution of rural distribution through door-to-door sales has evolved greatly over the years. The importance of training, family engagement, goal setting, and promotional support have proved to be critical to success. Even though rural sales require the most effort and represent the smallest share of sales volume, there is a huge market potential in this channel. A driver and GDF employee, using a three-wheel mini-taxi, deliver inventory to about four to five women per trip. Depending on sales volume, 100 to 150 cups and sachets of yogurt are delivered up to three times per week. It takes about four to five hours to deliver the yogurt to salespeople. Sales volume varies from person to person and from village to village. Daily sales volume ranged from 35 to 150 units during a field visit in November 2010. Salespeople who work directly with promotional teams and commit a large share of their time to selling typically have the highest sales volume. Saleswomen reported that the biggest barrier to increasing sales was price and that lowering the price from 5 to 3 taka would be necessary for the yogurt to be affordable to the majority of rural consumers. GDF is also exploring distribution partnerships with Unilever and the NGO CARE for the rural channel (Jeanveaux 2010).

Regional Sales

GDF sales in the greater Bogra region target about 4,000 retail stores. Retail stores are identified and contracted by a remote sales force of about 20 people based in towns and cities that are easily accessible by highway from the Bogra plant. Once there is enough demand in a town or city, GDF focuses on securing contracts with other retail stores located along the same route. This strategy enables drivers to make 40 to 50 deliveries per trip without leaving the highway. GDF then hires individual drivers or distribution companies to make these deliveries. The yogurt is collected at the factory in the morning from about 7:30 to 9:30 a.m. and transported by 3-wheel taxis with a capacity of 1500 units, small vans with a 4,000-unit capacity, and large vans with capacity of over 8,000 units. Deliveries can take anywhere from three to nine hours to complete. Using this same strategy, GDF is in the process of expanding distribution further south into the Khulna Division.

Urban Sales

Urban sales in Dhaka, Sylhet, and Chittagong have quickly become GDF's largest distribution channel. Initially, GDF is focusing on supermarkets, which target middle- and upper-class consumers. An average supermarket is over 3,000 square feet with a large refrigerated food section; more established food retailers might operate four or more stores. Depending on location and season, a supermarket can sell 100 to 400 cups of yogurt per day. Promotions have also proven very effective and can increase sales volume by up to 20 percent. Orders are communicated directly between the supermarket and GDF sales staff with deliveries to Dhaka, Sylhet, and Chittagong every two to three days in a refrigerated vehicle that has a 100,000-cup capacity. While there are a growing number of supermarkets in these cities, most consumers still purchase food in small shops located in neighborhoods or a central bazaar. If GDF can successfully expand distribution into smaller retail stores, sales growth in Dhaka, Sylhet, and Chittagong could grow even faster.

Looking Ahead

Luc's bus is reaching the outskirts of Bogra and the patchwork of fields begins to give way to concrete. Luc is apprehensive about the challenges he will face and equally unsure of what he will do. In spite of everything, he is confident in himself and his training and; he is looking forward to his first day on the job.

Some of the most pressing questions he plans to answer include:

1. What is the company's current strategy?
2. What has worked and what has not worked?
3. What are some of the risks as GDF grows?
4. In 2011, South Asia has faced inflation rates similar to 2008. How should GDF address volatile milk prices and seasonal fluctuations in supply?
5. How can GDF increase sales to low-income consumers and sustain its current sales growth to urban segments?
6. Which sales channels should GDF focus on and what strategy should it use?
7. What improvements could be made to the supply chain to reduce cost and increase efficiency?

In two weeks, the Managing Director will come to Bogra and Luc will have a chance to present his plans. He wants to make a good impression and he believes that if the Managing Director likes what he has to say, he will get to present his plan to the board next month. He knows that if the board, including GD's CEO, Franck Riboud, and the former Grameen Bank Chairman, Muhammad Yunus, is receptive to his plans, he will be given the authority and resources to implement his plan.

Assignment

- Develop a plan or recommendation for Luc to present to the GDF board.
- Support your recommendation using the appropriate data and analysis.

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Appendix

Exhibit 1. Why Bogra? (Yunus 2007)

Bogra was chosen for a number of strategic reasons:

- It is within 250 kilometers of Dhaka, Bangladesh's economic and political hub. Around 250,000 people live in the district of Bogra (solid red in map below) and about 35 million live in the Rajshahi Division, of which Bogra is a part.
- The division is strategically located in Bangladesh's northwest region and well connected with the rest of the country by rail and road transport. The Indian state of West Bengal is on Rajshahi's western border and the Rangpur, Khulna, and Dhaka divisions are the north, south, and eastern borders respectively. The Jamuna (Brahmaputra) River defines Rajshahi's eastern border and the Padma (Ganges) River creates the southern border.
- In the dry season, the banks of these river systems are ideal for dairy cow grazing. As a result, much of Bangladesh's dairy industry is based in the Division.
- Bogra is known as having some of Bangladesh's best yogurt and other milk-based sweets.
- The region also has high rates of malnutrition, providing GDF an opportunity to measure the impact of its yogurt on health.

Exhibit 2. The Product

The flagship product needed to be nutritious, affordable, and tasty. The International Centre for Diarrheal Disease Research Bangladesh (ICDDRB) helped GDF determine the ideal product characteristics for a food product for undernourished children. ICDDRB's Director, Dr. David Sack, recommended developing a product that could compete with the rice gruel traditionally fed to children. Yogurt was chosen for a number of reasons:

- It leveraged GD's global leadership in the yogurt product category.
- Yogurt is a popular and traditional Bangladeshi food product and imported packaged yogurts not affordable for the majority of Bangladeshis.
- Studies indicate that the live cultures in yogurt can decrease the duration and severity of diarrhea, which kills thousands of Bangladeshi children a year (ICDDRB).
- GDF felt that it could adjust the yogurt recipes to include the necessary nutrients without sacrificing taste.

The final product was branded as Shokti Doi, which means yogurt for power with a lion as the company mascot. The formula includes 3.5 percent milk, local date molasses sweetener, and 30 percent of a child's daily needs for essential nutrients like iron, calcium, vitamin A, and iodine. It was packaged in plastic containers and initially priced at 5 taka (7 cents) for an 80-gram cup (Yunus 2010b).

Products						
Description	Plain 60 gram	Mango 60 gram	Plain 60 gram with extra Protein	Plain 80 gram	Mango 80 gram	Pouch 40 gram
Price (in taka)	6	8	8	12	12	5
Distribution Area	Villages and NGOs in Rajshahi and Rangpur	Villages in Rajshahi	Dhaka and Chittagong	Dhaka, Chittagong and Sylhet	Dhaka Chittagong and Sylhet	Rajshahi and Rangpur

Exhibit 3. GDF Sales Performance (Yunus 2010b)

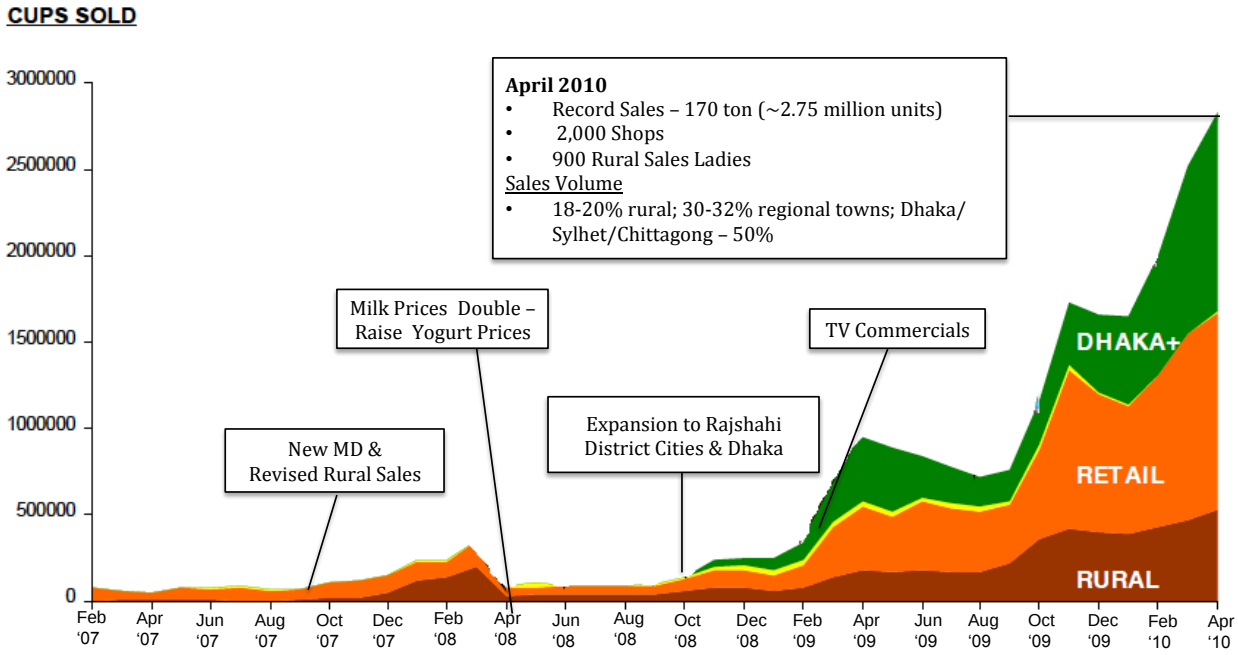


Exhibit 4. GDF Financial Performance and Projections (Yunus 2010b)

In thousands of taka, except for total volume

	Actual	**Actual**	**Budget**	**Forecast**				
	2008	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Total Volume ('000 cups)	148	696	1,727	3,200	3,200	3,200	3,200	3,200
Revenue	10,455	52,340	142,834	282,351	284,013	290,408	292,927	292,747
Raw Materials & Packaging	8,421	44,311	101,576	160,406	163,291	158,063	155,075	155,288
Gross Margin	2,034	8,029	41,258	121,945	120,722	132,345	137,852	137,459
Plant Expenses	9,183	13,058	18,210	21,462	23,873	24,865	25,757	26,620
Supply Chain Expenses	1,451	7,996	13,998	26,117	22,721	20,329	17,576	17,565
Operating Margin	(8,600)	(13,025)	9,050	74,366	74,128	87,151	94,519	93,274
Advertising & Promotion	3,568	8,196	14,069	45,176	38,058	29,041	29,293	29,275
Sales Overhead	2,282	10,176	21,730	32,024	24,703	19,589	17,417	1,477
Head Office Overhead	6,503	7,920	16,642	19,428	18,970	17,575	15,683	12,308
Net Profit	(20,953)	(39,317)	(43,391)	(22,262)	(7,603)	20,946	32,126	50,214

Exhibit 5. About Bangladesh

Geography

Bangladesh is located in the eastern part of Bengal, a linguistic and cultural region of the Indian subcontinent. The country is slightly larger than Greece with an area of about 147,000 square kilometers and primarily comprised of floodplains at the confluence of the Ganges, Brahmaputra, Meghna, hundreds of smaller rivers, and the Bay of Bengal. It shares borders with India to the north, west, and east and Burma to the southeast. Its low elevation and geographic location put the country at risk for floods and cyclones. These natural disasters cause recurrent crop and livestock losses that impoverish farmers and often lead to indebtedness, land sales, unemployment, and migration to urban areas. These same factors also contribute to the rich soil and a lush environment that make the region ideal for agri- and aquaculture.

History and Politics

The Mughals and British ruled the region until it became the eastern part of Pakistan after Partition in 1947. As part of a united Pakistani state, Bangladesh struggled to gain social equality, political representation, and commercial and infrastructural development. Eventually, these circumstances prompted Bangladesh to fight for independence in 1971. With as many as 3 million people dead, nearly 10 million refugees in India, and ongoing political unrest, independent Bangladesh has struggled to build a stable democracy. In 1974, a food shortage that followed major flooding resulted in famine that left 1.5 million people dead. This further destabilized the young democracy. In 1975, low-ranking members of the military assassinated the Prime Minister, Mujibur Rahman. Following the assassination, the military declared a state of emergency and began 15 years of military rule in the country. Since democracy was reinstated in 1991, two parties, the Bangladesh Nationalist Party (BNP) and the Awami League, have dominated the political scene. A bitter rivalry between these parties has resulted in a political stalemate that has frequently led to violence. Democratic Bangladesh has also gained an infamous notoriety as one of the most corrupt countries in the world and has seen a rise in Islamic fundamentalism. In 2006, the military declared another state of emergency to reinstate law and order, decrease corruption, and attract investment. The military handed power back to civilian rule in 2008, but the political arena is still marked by partisanship and lack of consensus. Meanwhile, climate change and rising ocean levels threaten to further stifle progress in a country that has faced major cyclones in 1970, 1991, 2007, and 2009 and floods in 1974, 1988, 1998, and 2004 (US Department of State 2010).

Economy

Bangladesh's human, economic, and infrastructural challenges have given rise to a vibrant NGO sector. Several of these organizations began as field hospitals, agricultural extension programs, primary schools, and credit programs in the years after independence. In the absence of effective government services, these organizations have innovated and grown to provide health, education,

communication, and economic development services throughout the country. The Bangladesh Rural Advancement Committee (BRAC) is the world's largest NGO with non-profit and for profit programs in health, agriculture, education, manufacturing, and finance. The Grameen Bank, a pioneer in rural credit services for low-income people, won the 2006 Nobel Peace Prize for its work with nearly 8 million members. The combined efforts of this sector have improved the quality of life of millions of people and stimulated economic growth, making Bangladesh's NGO sector an example for other developing countries around the world.

Bangladesh's gross domestic product (GDP) has grown by about 5 percent a year since 1991 to about $105 billion in 2010 (International Monetary Fund 2010). About 48 percent of the workforce (23 million) work in agriculture, forestry, and fishing and represent 18.6 percent of Bangladesh's 2009 GDP. The agri- and aquaculture sector has shrunk by about 5.5 percent since 2000. On the other hand, the manufacturing sector has grown in recent years, accounting for 18 percent of total GDP and 11 percent (5.2 million) of the labor force in 2009. Exports from Bangladesh's roughly 4,500 ready-made-garment and textiles factories have driven growth in this sector. The country's textile industry employs 3.5 million people and accounts for 80 percent of the country's total exports (Financial Express Bangladesh 2010b). Trades and retail represent the third largest share employing about 7.8 million people (16.5 percent of labor force) and contribute about 15 percent of total GDP (Bangladesh Bureau of Statistics 2010).

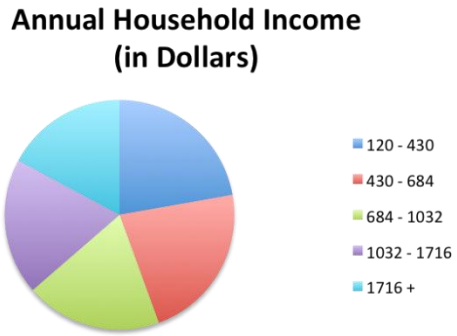
Demographic Trends

Limited rural income, underemployment, frequent natural disasters, and job opportunities in cities have resulted in large-scale urban migration. In 1950, the urban population was less than 5 percent; it was 25 percent in 2000 and expected to increase to 44 percent by 2030 (Population Division 2009). The Bangladeshi capital, Dhaka, is the world's fastest growing city and home to nearly 15 million people; it is expected to grow to over 20 million by 2025 (German and Solana 2010). Bangladesh's cities are growing at a rate of 3.2 percent per year with much of the growth-taking place in unplanned, low-income slums. This demographic shift has given rise to problems like pollution, health and sanitation issues, crime, and drug addiction.

Exhibit 6. Food Expenditure in Bangladesh (Bangladesh Bureau of Statistics 2009)

Monthly Income Range (Taka)	Monthly Income Range (Dollars)	Annualized Income in Dollars	% of Households	# of Households	Annualized Segment Expenditure (Dollars)	Share of Total Expenditure
<750 - 2499	<10 - 36	120 - 430	22%	5,722,690	2,931,680,509	11%
2500-4000	36 - 57	430 - 684	22%	5,669,159	3,721,112,947	14%
4000-5999	57 - 86	684 - 1032	19%	4,929,925	4,242,758,565	16%
6000-9999	86 - 143	1032 - 1716	19%	4,797,373	5,528,036,164	21%
10000 +	143+	1716 +	17%	4,376,774	9,641,657,345	37%
Total				25,495,920	$26,065,245,530	

All dollar figures assume an exchange rate of 70 taka/dollar.



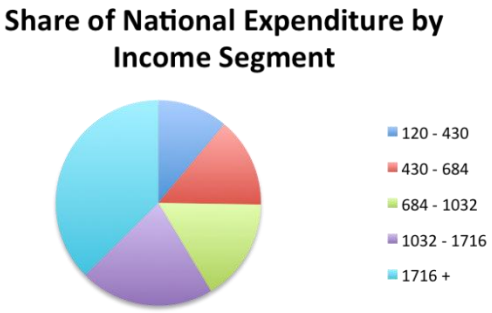


Exhibit 7. Milk Consumption (Halder and Barua 2003)

Indicator	Sample Groups					Economic Status		
	Low Vibrant Village	High Vibrant Village	Slum	Char (Riverbank)	BRAC Staff	Poor	Middle Class	Rich
Households that have consumed milk in last three days (%)	61.7	58.7	42.5	73.3	69.6	43.6	69.1	88.1
Daily Food Expenditure (Taka)	24.2	25.0	19.4	21.6	32.1	18.4	26.3	36.6
Daily Milk Expenditure (Taka)	1.2	1.2	0.6	1.61	1.5	0.6	2.2	2.3

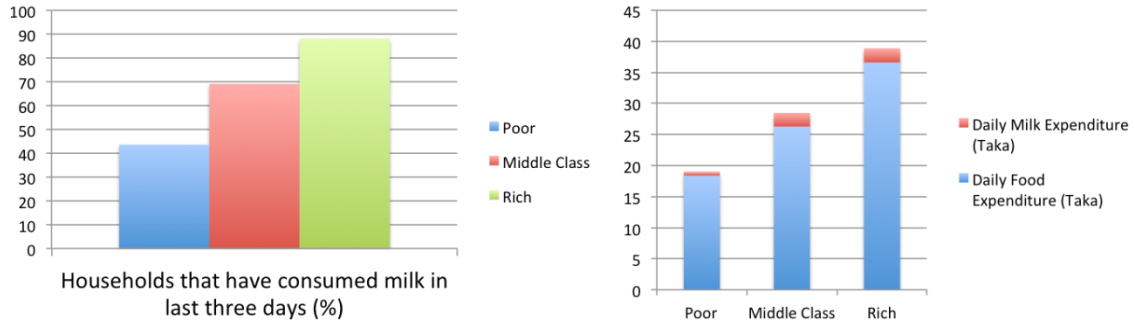


Exhibit 8. Facts About Bangladesh's Dairy Industry (Halder and Barua)[a]

- Bangladesh is home to over 24 million cattle, more than 50 percent of which are located in the Rajshahi and Dhaka divisions.
- Due to land and capital limitations, the average Bangladeshi cattle herd is only 3.5 versus about 120 in the US (McDonald et al. 2007).
- Livestock farming provides full-time employment to about 20 percent of the Bangladeshi labor force.
- Dairy farms in Bangladesh are divided into five categories:
    - Dairying for home consumption - 1-3 cows that provide enough milk for home use with a small surplus that is sold in the market.
    - Rearing for dual purpose (draft and milk) - rear 2-6 male and female cows that work in the fields during planting and harvesting and produce milk during the off season.
    - Small and medium dairy farming - Roughly 62 percent of all female cattle in Bangladesh can be found on small/medium farms with 2-25 cows.
    - Large private dairy farms – Farms with herds of more than 26 cows accounts for the smallest portion of Bangladeshi dairy farmers.
- The highest concentration of cattle rearing takes place in char areas where there is open space for grazing. Cattle are used as draft power for agriculture and as sources of meat and milk.
- While about half of all cattle are female, less than twenty percent actually provide milk.
- Indigenous and hybrid cows are the predominant cattle breeds in the country because an Australian milk cow costs $4000-6000 and an indigenous cow can cost less than $200.
- A cow's peak lactation period is 180-240 days after it gives birth, and yield varies greatly depending on breed. An indigenous cow produces 200-1000 liters during its lactation period while an Australian cow can produce about 7,000 liters per lactation period, which is about 30 liters a day.
- Yield also depends on the quality of feed that is used. Roughly 90 percent of cattle feed comes from agricultural bi-products such as rice straw; this limits milk yield but costs little or nothing to produce.
- A typical hybrid cow needs about 9 kilograms of enriched feed to produce 15-20 liters of milk a day. Enriched feed with lentils, corn, coconut, local supplements such as Atol and Teel, calcium, and salt can increase yields by up to 33 percent (Director of Livestock Research Center).
- While enriched feed could greatly increase milk yield, the added price is unaffordable for most dairy farmers unless it is subsidized.

[a]Unless otherwise noted, all information in this exhibit is from Halder and Barua (2003).

Exhibit 9. Value Chain Comparison

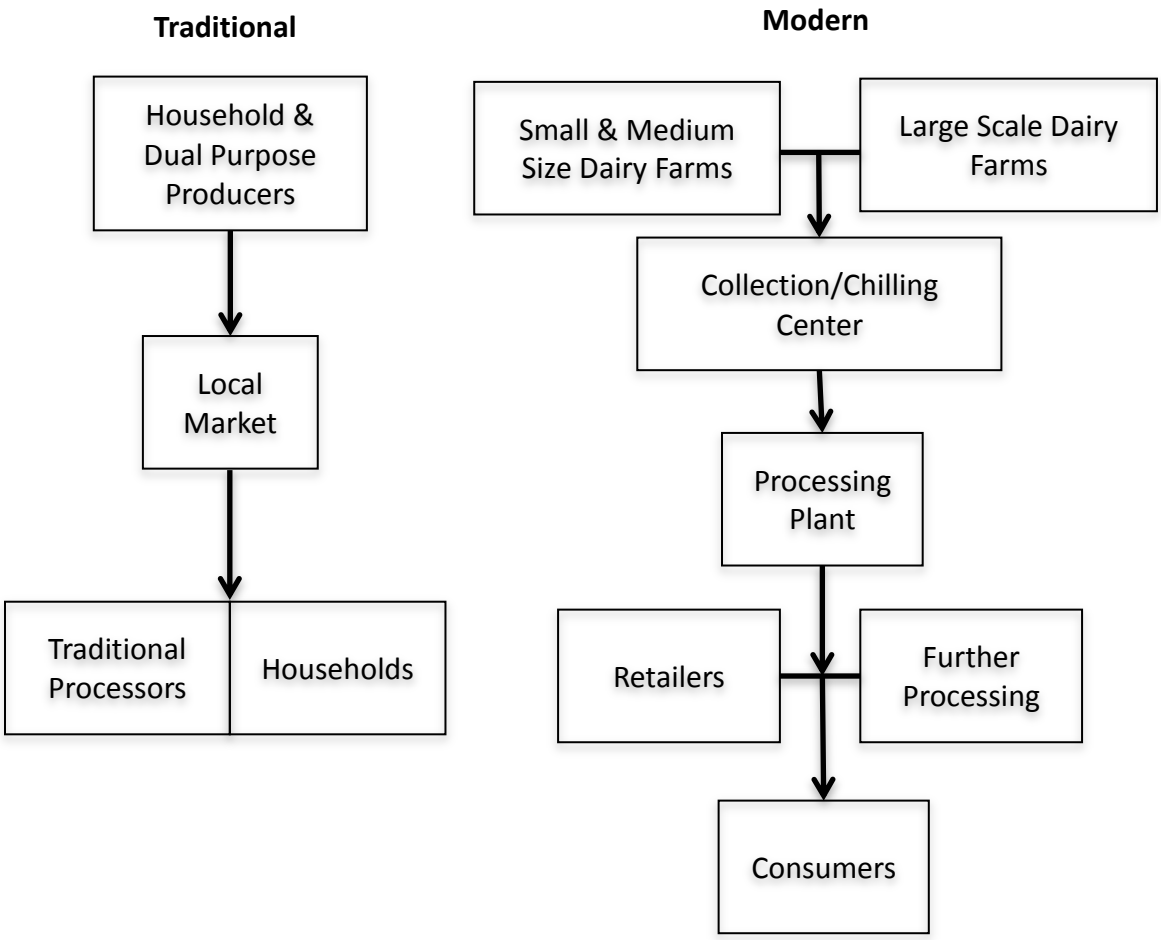


Exhibit 10. Bangladesh Milk Market

Enterprise	Number of Chilling/ Collection Centers	Operating Districts	Annual Production (liters)	Market Share
Milk Vita (Parves 2010)	26	15	650 million	30.00%
Aarong (Social Enterprises 2010)	92	25	314 million	14.00%
Pran (Yunus 2010b)	28	n/a	14.6 million	0.07%
Grameen Danone Foods	4	3	1.76 million	0.08%
Savar Dairy (Foreman, Savar Dairy 2010)	1	1	219 thousand	0.01%
All other Production[a] (BBS 2010)	n/a	n/a	1.2 billion	55.00%
Total Production			**2.2 billion**	

[a] Includes modern processors and traditional milk producers.

Exhibit 11. Milk Vita and Brac Supply and Distribution (Halder and Barua 2003)

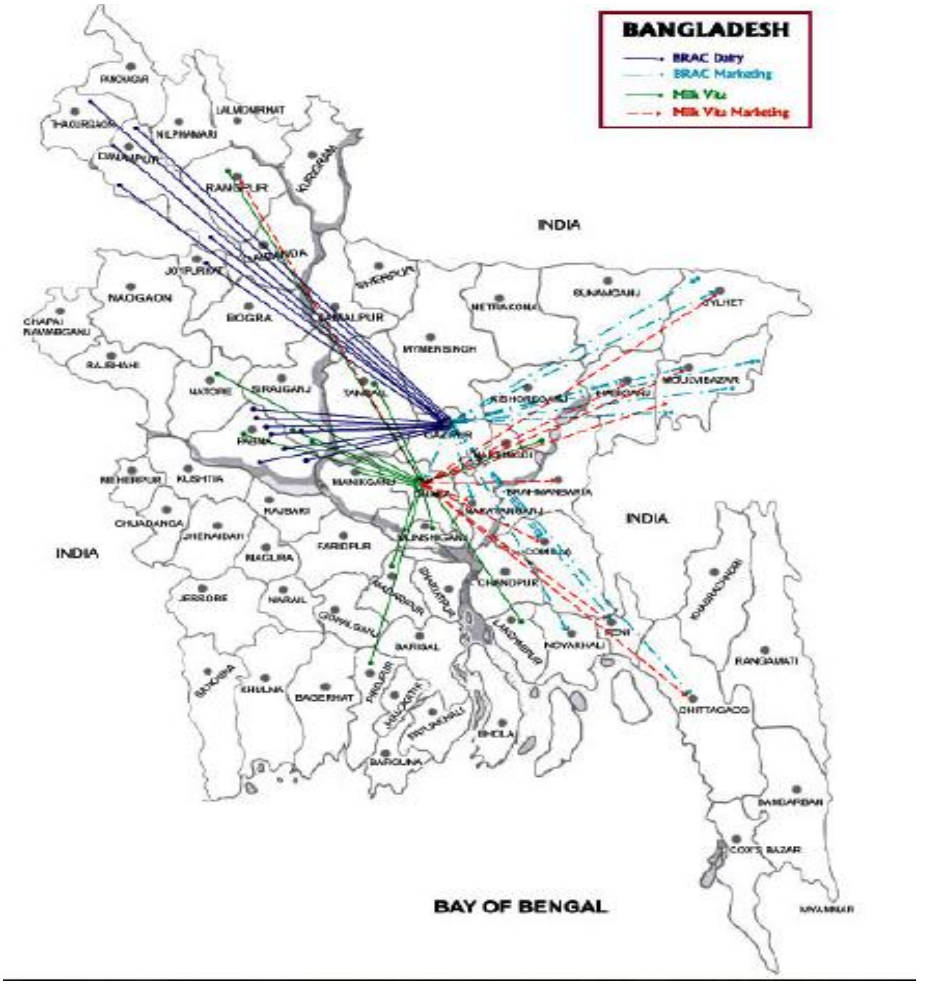


Exhibit 12. Key Facts on Competition

Milk Vita

- Founded in 1973 by Prime Minister Mujibur Rahman with support from foreign government aid programs including the Danish agency, DANIDA.
- Bangladeshi government owns about 70 percent of the company's equity and has given it a large loan facility; cooperative members own the remaining shares.
- In 2008, MilkVita collected milk from over 180,000 small dairy farmers that are members of over 1000 village cooperatives in 15 districts of the Rangpur, Rajshahi, Khulna, and Barisal Divisions. In 2008, the cooperative produced about 650 million liters of milk (Daily Star Bangladesh 2009).
- Cooperative members have access to veterinary, breeding, and training.
- MilkVita has 26 cooling and storage facilities in its production areas with processing plants in Sirajganj, Rajshahi Division and in the Mirpur part of Dhaka.
- The Mirpur Plant (Security Manager, MilkVita Mirpur Plant 2010).
    - Primary conduit for distributing to the city of Dhaka.
    - Supplied with milk by about 24 large (10,000 liter) and 8 small (5000 liter) tankers that bring processed milk to Mirpur from the Sirajganj plant.
    - It produces about 200,000 liters of packaged milk per day
    - Liquid milk is also further processed to make ice cream, sweet yogurt, and other milk-based sweets.
    - MilkVita distributes to 32 places around Dhaka using 24 refrigerated trucks that have 10,000, 3,000, or 1,000-liter capacities. Trucks are met by up to 20 bicycle rickshaw vans that deliver the products to retail stores.

BRAC Aarong

- Began in 1998 using a holistic model for livestock rearing which focuses on providing training, credit, and extension services to dairy farmers.
- Extension services include subsidized feed, basic veterinary services, vaccinations, and cattle insemination facilities. In 2008, BRAC conducted over 550,000 artificial inseminations and distributed more than 31,000 metric tons of feed to cooperative members.
- Individual producers are organized into cooperatives that provide 40-1800 liters of milk a day. Using this system, in 2008, BRAC collected more than 300 million liters of milk and maintained 92 chilling and storage centers in 25 districts around the country (Social Enterprises 2010).
- The majority of BRAC's milk comes from the areas around Pabna, which is on the banks of the Padma (Ganges) River, and Shahajadpur, which is near the Jamuna (Brahmaputra) River (Halder and Barua 2003).
- The primary processing and packaging facility is about 40 kilometers north of the Dhaka in Gazipur; it produces and packages eight products including fresh milk, lowfat milk, chocolate milk, butter, ghee, yogurt, mango milk drink, and powdered milk packets.

- Finished products are distributed to retail stores by agents who meet refrigerated trucks at fixed points. Each agent employs van drivers who distribute the products to retail stores on commission.

Other Notable Competitors (Foreman, Savar Dairy 2010)

- There are 5 government-owned dairy farms in Savar, Bogra, Sylhet, Faridpur, and Barisal that were partially funded by foreign aid.
- The Savar farm is the flagship dairy farm and is also the largest single-site cow farm in Bangladesh with roughly 400 employees and 1500 cows. The campus includes an artificial insemination program and feed production plant as well as milk processing and packaging facilities.
- Mismanagement and corruption have caused the Savar farm to decrease from a peak of 5,000 cows. During a December 2010 site visit, only 20 cows were producing milk.
- The Bangladesh Livestock Research Center is adjacent to the Savar farm and focuses on new product development, breed research, and contributes to the national livestock strategy.
- In 2002, the Savar Dairy controlled about 1 percent of the total market for processed milk, but by 2010, it was producing less than 800 liters of milk a day and primarily selling to employees.

Exhibit 13. GDF Milk Supply Chain

Company-Owned Milk Collection Center (Jeanveaux 2010).

- The original collection center in Sariakandi is located on the banks of the Jamuna River, and supplied by 65 farmers that live within a 2-kilometer radius.
- Farmers have 1 to 30 cows, bring 400 grams to 60 liters of milk per day, and are paid a fixed price of 26 taka per liter. With increasing market prices for milk, there is pressure to increase the fixed price to be more competitive.
- The center operates from 7 to 10:30 am and 3:30 to 5:00 pm daily, and 75 percent of milk is collected in the morning. Staff are paid a volume-based commission, which allows them to earn about $70 a month.
- The Sariakandi Center collects 600 liters of milk a day and has a daily capacity of 800 liters. Rickshaw drivers – 2 in the morning and 1 at night – transport milk to the chilling center and earn 100 taka for the 1-hour trip.
- Milk is stored in 14-liter containers and held for 1.5 to 2 hours before it is brought to the chilling center in Ramchandrapur, a large village connected to the electrical grid.
- The Ramchandrapur chilling center is located about 20 kilometers east of Bogra, it chills and stores an average 1,200 liters of milk a day and make deliveries to the factory in the evening.
- Another chilling center with the same capacity was recently established in Rangpur about 30 kilometers north of the factory, it contributes 800-900 liters of milk a day.

Grameen Livestock Foundation (Managing Director, Grameen Livestock and Fisheries 2010)

- GDF also sources 600-700 liters of milk a week from the Grameen Livestock Foundation that is based in Tarash, about 50 kilometers south of Bogra.
- Similar model as BRAC where cooperative members are provided with training, credit, cattle insemination, health, insurance, and related services.
- Since 2000, 7,500 milk cow loans and insurance packages have been distributed with an average loan package of 12,000 taka ($170) and a two-year payback period.
- The foundation maintains about 16 unrefrigerated collection centers, each with capacity of 300-500 liters, and 3 chilling centers with individual capacity of 1000-3000 liters. These 3 centers were opened in 2002 with an initial capital investment of around $60,000.
- The foundation also manages a couple small feed factories that have struggled to build demand as input costs increase and the cooperative members' ability to pay decreases.
- With increased focus on a vertically integrated supply chain, GDF collections from GLF have decreased in recent years. As a result, borrowers are now beginning to default on their livestock loan, which leaves the future of GLF in question.

Nandigram Farm

- GDF also collects milk from a large cooperative farm in Nandigram, a town about 40 kiometers southeast of Bogra.
- The farm is operated by an NGO that own 70 cows and works with about 370 local farmers.

- The farm collects, chills, and delivers the milk to the Bogra factory, which saves GDF the cost and effort.
- Collections from this source have increased recently and GDF seems poised to increase collections from Nandigram as the Bogra factory increases production.

Spot Market

- If supply from other milk vendors does not meet daily production requirements, GDF must purchase milk on the spot market.
- The prices on the spot market are about 10 percent higher than fixed rates and vary greatly based on the season.
- In 2010, purchases in the spot market have accounted for up to 38 percent of GDF's daily raw milk supply.

Exhibit 14. Other Supply Chain Items

Date Molasses

- Kajur gur (date molasses) is processed sap of palm trees and is prevalent in western and southwestern Bangladesh.
- In rural areas, pure date molasses sells for about 60 taka (86 cents) a kilogram and prices rise to over 80 taka ($1.15) in Dhaka.[a]
- The palm trees take about 8 years to reach maturity and can provide sap for up to 50 years. For commercial production, trees are planted in orchards with a density of about 75 trees per acre.
- Trees produce sap for about 5 months of the year, and the sap is harvested about 3 days a week. A healthy tree can produce more than 5 kilograms of sap per harvest, however yield is often less since trees are overharvested and unhealthy.
- Harvesting Process:
    - Tapping a hole in the top of the tree and placing a clay pot below to collect for a day.
    - Boiling collected sap down to about a third of its original weight and placed in half-kilogram molds where it cools into a solid form.

Nutrients

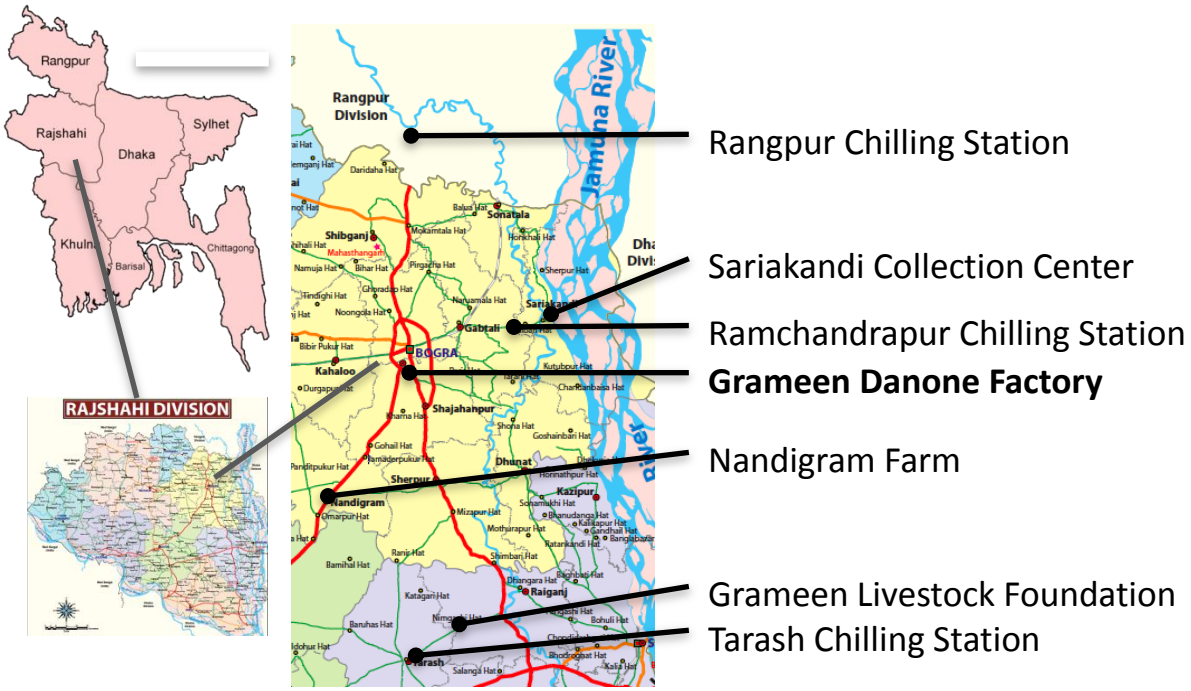
- The original yogurt recipe includes about 30 percent of a child's recommended consumption of iron, calcium, vitamin A, and iodine. Recently, GDF also introduced a yogurt product with extra protein.
- Nutrients sourced in powder form from Europe and added during the mixing stage of the production process.

Packaging

- GDF's yogurt cups are packaged in dairy quality plastic that is imported from Saudi Arabia.
- The plastic is delivered in sheets, heated, and then molded into 60 and 80 gram cups.
- Shipping process is costly and can take months to complete, this makes it difficult for GDF to quickly react to demand increases.
- Squeezable sachets have significantly decreased packaging costs and could provide a cheaper alternative to cups in some market segments.

[a]Based on field visit to Date Molasses farm in the town of Amani Bazaar in the Rajshahi Zila.

Exhibit 15. GDF Raw Milk Supply Chain Map



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The Benefits of Sugarcane Chain Development in Africa

Industry Speaks

Marcos Fava Neves[a] and Fabio Ribas Chaddad[b]

[a] *Professor, School of Economics and Business (FEARP) University of São Paulo Bloco C, Sl 64. São Paulo, Ribeirão Preto, 14.040-900, Brazil.*

[b] *Assistant Professor, Assistant Professor, Agricultural and Applied Economics. University of Missouri and Insper, 125 Mumford Hall, Columbia, Missouri, 65211, U.S.A.*

Abstract

As consumers continue to be concerned about the future of sustainable agriculture and the scarcity of natural resources, biofuels can be an important component of the "people" solution through job creation, development and interiorizing economic activities of a country through moving money from cities into rural areas.

The Brazilian sugarcane industry is well developed in terms of corporate social responsibility and can serve as an example for other countries such as Africa. The objective of this article is to show how sugar cane can contribute to the development of Africa by producing renewable fuel for use in booming African cities. A supply of sugar can be developed for use in local markets and exports. Other opportunities exist to produce bioelectricity from the process of burning the bagasse and other new products such as plastic and diesel. In the case of Ethanol, this fuel has proven to be the most efficient in competing with gasoline in the last 40 years, and Africa may gain with a strategic plan on ethanol.

Keywords: Agribusiness, Sugar Cane, Strategy, Africa

Corresponding authors: Tel: + 55.16.3456.5555
Email: mfaneves@usp.br
Website: www.markestrat.org

Tel: +1 573.882.0155
Email: chaddadf@missouri.edu

Introduction

Sustainability has received a great deal of attention across the world in recent years and has become a central part of the agribusiness agenda. This increased awareness can be attributed to the rise in consumer expectations about the way food is produced and where it comes from; the emergence of a new generation more worried with planet conditions; the scarcity and, in some cases, depletion of natural resources as farmers increase production to feed a growing population; and the effects of climate change. Perhaps more importantly, the advent of the Internet and the viral growth of social networking enable real time dissemination of information about natural disasters, unethical behavior of companies, among others, mobilizing groups and broad societal reaction as never seen before.

The impacts for agrifood system participants are hard to ignore. Farmers and agribusiness companies are now expected to reduce their environmental footprint, to increase transparency and facilitate a better flow of information, to be better governed and promote corporate social responsibility, to be more inclusive, and to be better stewards of the environment and increase the usage of renewable energy sources. The legitimacy of agribusiness firms – and entire agrifood value chains – is not only dependent on economic factors but also on social and environmental sustainability. Simply put, in the 21st Century planet and people matter as much as profits.

The current consensus on sustainability is based on three major pillars: the economic dimension (profit), the environmental dimension (planet) and the social dimension (people). On the economic side, the major factors to be considered are how companies, value chains and networks are dealing with margins, profits, compensation, chain losses, communicating with final consumers, improving credit conditions with benefits to sustainable projects, risk management, information technology and overall strategies to reduce costs and eliminate waste. Without economic sustainability, private firms cannot afford to respond to society's demands – a fact sometimes forgotten by some sustainability advocates.

Doing well economically is not enough. On the social side, society demands companies to comply with labor laws and adopt world-class working conditions not only for employees but also for suppliers and distributors. In addition, society increasingly expects businesses to foster local community development, to incentivize collaboration and cooperation along the value chain, to adopt smallholder-friendly initiatives, to facilitate technology transfer and capacity building for smallholders and to offer broader consumer benefits. Finally, on the environment side, the major factors to be considered are related to the impacts of the company – and integrated suppliers – on the environment. These include transportation issues (food miles), packaging (recycle/reuse/rebuilt and using new materials and fewer materials), waste management, emissions, water management, green buildings and facilities, and carbon footprint, just to name a few.

To some extent, these changes are occurring in developed and some emerging economies. But how about poor countries – particularly in Africa?

The Role of Biofuels in Delivering Sustainability

Some researchers suggest that biofuels could play a big part in the solution for poor countries to diversify business and ensure sustainable development. According to Zarrilli (2007), several countries that implemented biofuels development programs have experienced significant job creation, especially in rural areas but also along the value chain. Poschen (2007), the senior International Labor Organization's specialist on sustainable development, estimates the amount of jobs created in the renewable energy sector will double by 2020 with about 300,000 new jobs. In the

early phase of the bio-ethanol program in the US, around 147,000 jobs were created in different sectors of the economy.

This short article outlines some potential benefits of biofuel development in Africa. The development of the sugarcane industry in Brazil may serve as a model. The industry output is impressive: 550 million metric tons of sugarcane is used as raw material to produce 31 MMT of sugar (equivalent to 20% of world production), 27 billion liters of ethanol (30% of world production) and bioelectricity. Ethanol production alone creates 465,000 direct jobs, which is six times larger than the oil industry in Brazil. According to industry estimates, the average wage paid by member companies of the Brazilian Sugarcane Industry Association (UNICA) was double that of the current federal minimum wage. Ethanol production is present in 1,042 municipalities across the country, compared to only 176 for oil. This translates into more income distribution and community development in rural areas. As for the environment, the use of sugarcane ethanol has generated a reduction of 600 million tons in CO2 emission since 1975, an amount equivalent to the carbon sequestered with the planting of 2 billion trees. In economic terms, specialists conclude that for every liter of ethanol use, the country saves US$ 20 cents in carbon mitigation costs. Air Quality researchers at the University of São Paulo School of Medicine estimate that if every car in the São Paulo metropolitan region were fueled exclusively with gasoline, the city would face annually more than 400 additional deaths, 25,000 hospitalizations and an increase of US$ 80 million in healthcare expenses.

Chaddad (2010) describes the leadership role of the Brazilian Sugarcane Industry Association (UNICA) in coordinating value chain participants and also in advancing the sustainability agenda. Since 2007 UNICA has been working on several fronts to facilitate industry-wide sustainability efforts, including:

- signing an agreement with the government of São Paulo state – called the Green Protocol – in which the industry voluntarily agreed to speed up the phasing-out of the practice of sugarcane burning;
- leading the Brazilian Climate Alliance with 15 other organizations to propose proactive policies in Brazil and in global climate change negotiations. UNICA has also created an educational program about climate change that will impact more than 2 million students in Brazil;
- signing the National Commitment to Enhance Work Conditions in the Sugarcane Industry together with labor unions and the federal government – the first national agreement to recognize best labor practices. Of the 400 cane mills in operation throughout Brazil, more than 300 have voluntarily signed on to the Commitment;
- launching a "retooling" program for cane workers to lessen the impact of harvest mechanization on job losses. The project will train 7,000 workers per year (mostly sugarcane cutters) to prepare them to take on other jobs in the sugarcane industry or in other sectors;
- hiring a team of professionals to foster the adoption of Corporate Social Responsibility (CSR) practices by sugarcane mills. In addition, since 2008 UNICA has adopted sustainability reports – following the model developed by the Global Reporting Initiative (GRI) – to communicate its social, environmental and economic performance. In 2008, member companies invested over R$ 160 million in 618 projects within social, environmental,

cultural, education, sport and health areas, benefiting some 480 thousand people in communities with sugarcane production;

- engaging with several multi-stakeholder initiatives (MSIs). It is represented in the board of directors of Bonsucro and helped develop a certification scheme for sustainable sugarcane production. The first sugarcane processors to receive the Bonsucro sustainability certification in 2011 are based in Brazil.

The same economic, social and environmental benefits could also happen in Africa. The sustainability practices outlined above could serve as a benchmark for Africa. Our main message and objective is to show how biofuels – and sugarcane in particular – can contribute to economic and social development in Africa, producing renewable fuel to be used in booming African cities, sugar to supply domestic and export markets, bioelectricity from the process of burning the bagasse, and also to serve as the feedstock to all new bio-based products that are in the pipeline, such as bioplastics, biodiesel and others.

Africa Learning with the Brazilian Sugarcane Chain

The best way for Governments and researchers in Africa to understand the sugarcane Agribusiness System complexity is to describe the typical mill network. The sugarcane value chain includes many stages: the production of sugarcane on farms; the processing of sugar, ethanol and derivate products in mills; research, technical assistance and financial services; transportation; commercialization; and exports. All of these links build a network around sugarcane mills as shown in the figure below.

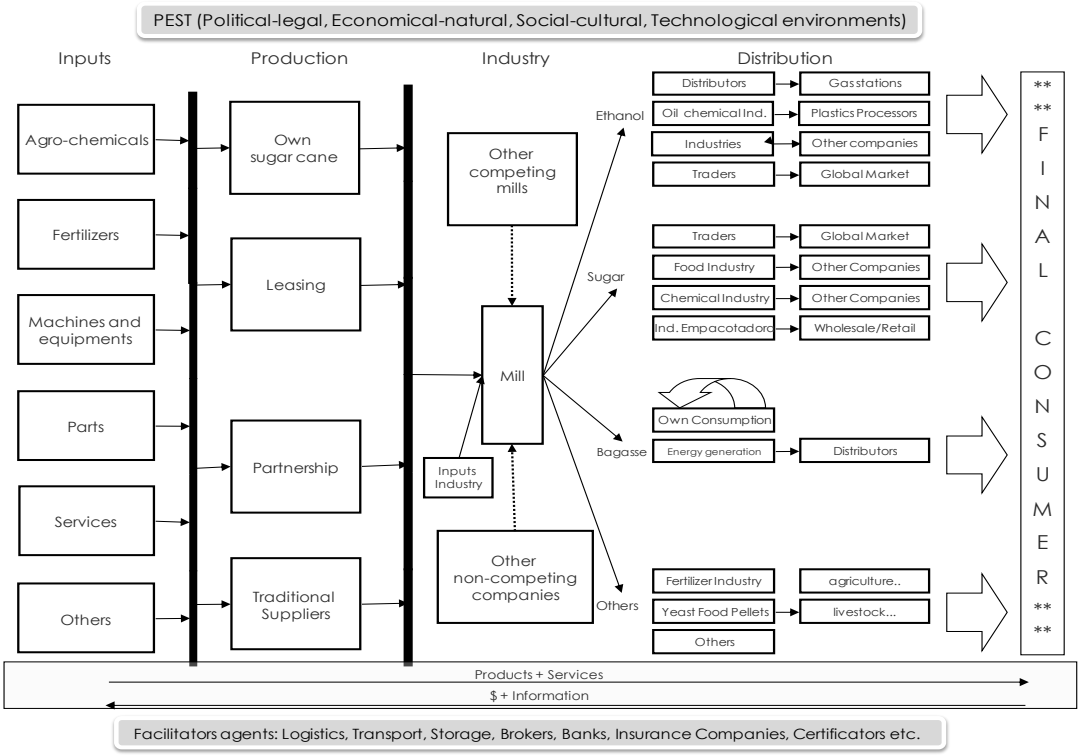

Figure 1. The Network of a Sugarcane Mill in Brazil

The output of a mill depends on the supply of sugarcane and capital goods. The main products (ethanol, sugar, and energy) are sold to fuel distributors, the food industry, wholesalers, retailers, exporters and electric energy distributors. Byproducts are destined to other industries, wholesalers and retailers of other sectors such as orange juice and animal feed. In addition, sugarcane mills use residues, such as vinasse and cake filter, as biofertilizers.

There are different institutional arrangements governing the transaction between sugarcane producers and the mills, from spot market to vertical integration. The supply of sugarcane accounts for almost 70% of a mill's production cost and the sugarcane transaction with the mills is complex due to the need of relationship-specific investments, the perishability of the product and uncertainties related to the effects of Mother Nature. Vertical integration is observed when sugarcane is grown in farmland owned by the mill. Farmland leasing for sugarcane production using the mill's farm equipment and labor is the next governance option. Less integrated options include partnerships, long-term supply contracts and spot market relationships with independent producers.

Vertical integration has historically been the dominant governance mechanism in the industry. But there is a trend towards less vertical integration and increasing use of contracts with suppliers. Leal (2006) estimates that 65% of the area cultivated with sugarcane is either owned or leased by mills while 35% belongs to independent producers – mostly under some form of contract.

Potential Benefits for Africa from Ethanol Industry Development

The Brazilian experience with the sugarcane industry – and, in particular, the recent growth fostered by ethanol mandates in Brazil and other countries – suggest ethanol may generate the following benefits for the African people and society at large.

- A first potential benefit is that ethanol reduces dependency on foreign oil – particularly as the oil industry generates increasing negative externalities and is fraught with geopolitical risks.
- A second benefit is the amount of jobs generated in all stages of the ethanol chain, from equipment suppliers to ethanol distribution systems, but also including allied industries such as research, trade and services.
- One of the most important potential benefits for the African people is the immediate reduction in pollution at large cities. As compared to gasoline and diesel, emissions from engines run on ethanol are increasingly smaller with considerable improvements in air quality and thus quality of life.
- Another benefit for African society is to, via an ethanol strategy, increase economic relationships and trade with important emerging partners among African nations and also with other emerging economies such as Brazil, China and India.
- From a business perspective, ethanol can generate opportunities for foreign direct investment for African people and companies, selling products and making profits outside Africa and repatriating these resources to help the development and income distribution in the continent.
- These investments will also allow Africa to have access to world-class technology that is currently dominated by ethanol producing countries.

- Finally, Africa can provide a strong contribution towards mitigation of climate change in the 21st century.

An Outline of Strategies for Sugarcane Industry Development in Africa

This article had the objective to show how Brazil has benefitted from adopting an ethanol development policy for the last 40 years that resulted in the development of a booming sugarcane industry with several economic, social and environmental benefits to society. Just to summarize, in 2010 the Brazilian sugarcane industry supplied 100% of the domestic sugar market and produced enough of a surplus to export 53% of the international sugar market. In addition, the industry produced enough ethanol to supply 52% of the domestic market use of light-vehicle fuels (compared to 48% for gasoline). In 2015, this share is expected to reach 80% versus only 20% for gasoline. This was accomplished with the use of 9 million hectares of sugarcane from the estimated 350 million hectares available farmland in the country.

Africa can follow several strategies to foster the development of the sugarcane chain, including emulating the Brazilian experience. In what follows, we offer some possible contributions to this debate.

- A Strategic Plan should be developed as, to our knowledge, it is not existent yet. This article and Chaddad (2010) provide several pieces of relevant information about the Brazilian industry, how it is organized, the relevant policies and the leading role of UNICA. A next step would be to adapt the Brazilian model to the specific environment and conditions of countries in Africa.
- A suggestion for Africa to get started in building up supply chains in preparation for an ethanol or renewable fuel mandate (such as in Brazil, the U.S. and the European Union, to name a few). The initial mandate could start as an E10 policy (10% of anhydrous ethanol blended to gasoline), with a perspective of moving to an E25 policy when production capabilities are in place.
- In order to be able to increase ethanol production, Africa may initially invest in agricultural research and technical assistance to produce sugarcane, sugar and ethanol in some regions with existing technologies, and subsequently develop second generation biofuels from cellulosic sources, perhaps adapting Brazilian technologies that have been developed since the 1970s.
- An integrated model based on a network of small farmers may be a useful approach to foster sugarcane production and rural development.
- Another important possibility for Africa is to invest in ethanol production in some selected African countries with favorable conditions, which could supply other African nations. This would serve as the basis for an oil import substitution policy aimed at substituting oil imports with ethanol produced in the continent. This strategy will reduce dependency from oil producing countries and enhance the economic ties among African nations.

There are several alternative strategies that can be part of Africa's future positioning on sugarcane and biofuels. The international sugar market is growing and, except for Brazil, the most relevant sugar exporters face considerable challenges. In the case of ethanol, it has proven to be the most efficient biofuel in competing with gasoline in the last 40 years, and Africa may gain with a

strategic plan on ethanol. Africa has a long avenue of opportunities to follow. Increased collaboration with Brazil in this field is a future development agenda for Governments, NGOs and the private sector. The University of Sao Paulo is open for this collaboration and to help Africa in this strategic plan.

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Institutional Gaps: The Argentine Restriction on Agricultural Production

Industry Speaks

M. Alvarado Ledesma[a] and Peter D. Goldsmith[ⓟb]

[a] *Agribusiness Consultant, Leandro N. Alem 693 Piso 2, 1001 Buenos Aires, Argentina*

[b] *Associate Professor, University of Illinois, Director, Food and Agribusiness Management Program 1301 West Gregory Drive, Room 318, Urbana, Illinois, 61801, U.S.A.*

Abstract

This article aims to explain the implications of weak institutions on agribusiness investment in Argentina. Weak institutions lead to policy development and enforcement grounded in the moment, rather than based on precedent and deliberative processes over time. Political exigencies and election cycles challenge policymakers to yield to legal precedent, rule of law, international standards in an environment of weak institutions. We suggest, and welcome critique, that the weak institutional environment in Argentina allows for capricious tax, trade, pricing, and investment policies by government to the point of creating undo business uncertainty. This uncertainty results in an inferior agribusiness investment environment, which in turn reduces the potential economic impact a robust agribusiness complex could provide to the nation.

Keywords: Argentina, agribusiness, institutions, business environment

ⓟCorresponding author: Tel: + 1. 217.333.5131
Email: pgoldsmi@illinois.edu
M. Alvarado Ledesma: malvaradoledesma@gmail.com

Introduction

This article aims to explain the implications of weak institutions on agribusiness investment in Argentina.

Institutions are sets of rules, regulations, guidelines, codes and implied and express traditions which prevail in a society, which govern the relations among citizens, and also the relationship between the citizens with the government. Institutions are the backbone of the social, economic, and political organization (Aquinas 2005). Following the financial crisis of 2001, the last two administrations have broken the implicit contract between the agricultural sector and Argentina's government. It seems that the old adage is true, that those countries that don't need the agribusiness sector for economic growth provide subsidies, and those (like Argentina) that depend on agribusiness for hard currency and revenue, tax it.

Institutional failure occurs within regulatory, normative, and cognitive pillars (Scott 2003). The regulatory pillar comprises regulatory institutions; the set of rules and laws that guarantee stability and order in any given society). The normative pillar consists of the values and rules that govern people's behavior. The cognitive pillar consists of a set of cognitive rules that constitute the very nature of reality and the framework within which meaning is acquired.

Agribusinesses must honor on a daily basis government's laws, regulations and policies. Normative institutions set in a framework of business practices, policies and ethical standards. Cognitive institutions reflect the way people interpret the world around them, and how they manage to make sense of such world, on the basis of rules and schemata.

Following the crisis of 2001, the Argentinean Peso was de-pegged from the dollar and quickly devalued. The cost of borrowing dramatically rose overnight as all bank deposits and wages dropped 2/3rds in value. Argentina was cut off from international capital markets, both in terms of credit and investment. The country was a financial island. The government faced two immediate problems, how to raise revenue, and how to stay in power. Raising revenue was a taxation problem, while staying in power meant controlling inflation.

Argentina's political structure centers legislative power in the strongest and most populous region of the country, Buenos Aires. A relatively strong presidency and weak congress and judiciary too contribute to a concentration of power in the capital. A historically weak regulatory system governing investment, commerce and taxation are not anchored by strong or definable normative or cognitive belief system. Thus the strong central government not only has great impact on the business environment, but create uncertainty for investors and managers.

The weak institution-strong central government situation in 1990's created a pro-business environment and low levels of inflation in Argentina. In the 2000's inflation once again threatened the economy and a devalued Peso hurt the poor and middle class who held very few real assets or US dollars overseas. The government responded with strong anti-inflation policies that assured a strong voter base among the lower and middle classes. The strategy was to keep prices low for staple goods and services (electricity and public transportation). The policies came at a cost.

Outside faith in the integrity of the financial and political institutions of the country was shaken to the point of isolating the country from foreign investment.

Argentina has always had a comparative advantage in many areas of agricultural production, beef, soybeans, maize, wheat, soybean meal and oil, and most recently biodiesel. Beef and wheat reflect high domestic utilization, as well as strong exports, while soybeans, maize, soybean meal and oil, and biodiesel are principally exported. Exports are notoriously easy targets for tax collection, especially large volume/low value exports, such as are common in agriculture. Serendipitously there has been a boom in global agriculture, so demand for Argentinean exports soared, resulting in a windfall of government tax revenue.

Government's task was now to implement agricultural policies that minimized domestic inflation while maximizing export tax revenues. That meant controlling prices for domestic staples such as beef, dairy and wheat products, and providing incentives for greater economic activity in the export oriented soybean sector. Export bans caused beef and wheat products to remain in country, driving down domestic prices. High, but not too high, taxes on soybean product exports raised over $10B USD in tax revenue, while not adversely affecting lower and middle class voters. Argentina only domestically uses 10% of the soybeans it produces (Goldsmith et al. 2011; Puig.2011). So pro soybean meal, oil, biodiesel, and grain export policies do not adversely affect domestic consumer price levels, in a direct way.

The strategy in place for the last eight years has worked as the government was once again elected by a wide margin in the Fall of 2011. For the long term though, the damage may be severe. Uncertainty and capriciousness by government create a very poor investment environment for business (Ledesma 2008). For example, the laws, regulations, and policies recently passed by the government have done significant damage to the beef value chain. This once global leader of high quality inexpensive pasture-raised beef has been forced to shutter many of its export facilities and lay off thousands of workers.

Strong institutions provide balance to weak political systems overly affected by election cycles. Strong normative and cognitive institutions imbedded in entrepreneurship, private sector investment, strong public sector infrastructure, and equitable tax policies, and transparent regulatory systems not only take time to develop, but require nurturing by visionary leaders. Historically Latin America has not had that kind of leadership. Recently though a number of countries have made great strides improving the strength and viability of their institutions resulting in significant economic growth and poverty reduction. So there are good examples in Latin America of strengthening institutions, active investment, and growing economies.

There certainly are challenges and tradeoffs when a country emerges from a crisis like occurred in Argentina in 2001. What have we missed? Have we overstated the impacts to the agribusiness environment? Have we over simplified the state of institutional development. We would love to hear you thoughts and opinions. This is golden era for the leading agricultural producers of the world, such as Argentina. It is a wonderful time to be in the food, feed, fiber, energy, and industrial inputs business as so much of the world desires what agriculture produces.

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