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Consumer intercept surveys were obtained from a sample of urban and suburban farmers markets to measure consumers' attitudes toward and behaviors at the farmers markets. One of the primary purposes of this study was to ascertain clusters or segments that may be useful in helping managers develop farmers markets and similar retail channels.

Five behavioral segments were identified using cluster analysis: Market Enthusiasts, Recreational Shoppers, Serious Shoppers, Low-involved Shoppers, and Basic Shoppers. Each of these segments represents a group of consumers with different attendance and purchasing behavior. Furthermore, different segments look upon the farmers market shopping experience differently, ranging from an opportunity to quickly purchase fresh vegetables to a regular outing of on-site consumption and entertainment.

The implications are that different farmers market structures and organizations can compete favorably for different segments within the same market geography. Additionally, organizers should not expect a single market organizational emphasis to attract all segments.

Italian Consumer Attitudes toward Products for Well-being: The Functional Foods Market

Azzurra Annunziata and Riccardo Vecchio

Many researches in literature highlight how consumers today are more concerned about self-care and personal health and seemingly demanding more information on how to achieve better health through diet. Consequently, the development and marketing of a growing spectrum of products called functional is a major trend in today's food industry.

Consumer acceptance has regularly being identified as the decisive factor in the successful marketing of functional foods, thus relevant papers explore cognitive, motivational and attitudinal determinants of consumer acceptance of functional foods in different countries. The empirical analysis conducted in this study was constructed to investigate the factors which influence Italian consumers behaviour towards functional food products and verify the opportunities for further expansion of this market segment.

The current work has confirmed that the existing opportunities for functional foods manufacturers that operate in Italy require further consumer studies to target product development and marketing efforts to specific consumer groups. Therefore, the paper suggests new research avenues that should focus on identifying the needs and wants of Italian functional foods users and try to detect the most effective instruments that deliver simple and valuable information to the final purchaser. Other interesting results provided by the present study (as the importance of taste in purchasing a functional food, or the consumers' interest in a specific logo for these products) would benefit from additional qualitative and quantitative research methods to extend findings legitimacy.

Economic Analysis of Options for Food Aid Policy in Honduras *Michael Boland and Alena Brautigam*

The purpose of this research was to formulate an analysis of alternative food diets for three different family income levels based on four types of schools located in Honduras. Personal interviews were conducted with children, parents, and teachers over the course of two summers. A linear programming model was used to evaluate the economic and nutritional feasibility of four policy options.

The economic impact was found to be greatest in rural areas using a targeted approach to identify the poorest while working cooperatively with the parents in a nutrition education program. The two programs (and their combination) serve as a basis for better understanding the mix of foods in a low cost diet and the food policy options for food aid in Honduras. This research is of interest to managers of agricultural and food firms since they are heavily involved in the supply chain for distribution of US food aid.

Bio Energy Entry Timing from a Resource Based View and Organizational Ecology Perspective *Desmond Ng and Peter D. Goldsmith*

Over the past decade U.S. energy policy have promoted the growth of the bioenergy industry. Companies initially entering the industry were focused on converting corn into ethanol. Recent advances in the technology hold the promise of commercial operations that convert cellulose into ethanol. The ability of this new technology present a quandary for those investing in the industry: Should they invest in plants using the old technology or in the new technology, when should they invest, and how is this decision influenced by the number of plants in the industry and market price uncertainty for ethanol?

This paper provides a hypothetical analysis of this decision by integrating the resource based view of strategy with that of organizational ecology. The analysis is performed using a dynamic programming (DP) model that jointly accounts for this flexibility-commitment tradeoff and the market dynamics of the ethanol market. The results of the model demonstrate a basic trade-off for managers and investors between gains from a commitment to specialized assets and those from remaining flexible with lower levels of fixed investment. This trade-off is influenced by the number of plants (population) and uncertain conditions of the market. The results demonstrates that, while corn-based plants using dry milling technology may not be ideal, they have been optimal given the uncertain business environment.

While the results are hypothetical at this time, this "experimental" approach to strategic decisions has been strongly recommended as the appropriate approach in a dynamic world where information is limited. As information improves and increases certainty regarding assumptions made in the analysis, the analysis can be rerun and the quality of the answers improved.

Factors Influencing Growth of Dairy Product Manufacturing in the United States *Fafanyo Asiseh, Stephen Devadoss, Yuliya Bolotova, John Foltz and Robert J. Haggerty*

The paper analyzes factors influencing the growth of the number of dairy product manufacturing establishments in the United States using publicly available data reported by the U.S. Economic Census and U.S. Census of Agriculture. Factors hypothesized to affect the growth are associated with dairy industry input and output markets, labor markets and agglomeration. Furthermore, we hypothesize that the patterns of growth of small-size and medium-large-size dairy product manufacturing establishments are different and we find empirical support for this hypothesis.

The growth of the number of small-size dairy product manufacturing establishments is strongly affected by the proximity of both input and output markets as well as by the presence of competition from medium-large-size establishments. In contrast, the growth of the number of medium-large-size establishments is affected by the proximity of the input market and the absence of competition from small-size establishments. The proximity of the output market does not seem to have a strong effect on the growth of the number of medium-large-size establishments.

The identified differences in the growth patterns have implications for the dairy product manufacturing businesses' strategic decision-making, as well as for developing policies targeting small-scale food manufacturing businesses that are typically locally owned and/or operated by a group of agricultural producers.

CASE STUDIES

Appellation of Origin Status and Economic Development: A Case Study of the Mezcal Industry *Carlos Omar Trejo-Pech, Ma. Carmen López-Reyna, Lisa A. House, and William Messina*

Mezcal is an alcoholic beverage produced only in seven states in Mexico (Durango, Guanajuato, Guerrero, Oaxaca, San Luis Potosí, Tamaulipas and Zacatecas) under appellation of origin status from the Word Intellectual Property Organization. While it has been produced in Mexico for many centuries, mezcal's appellation of origin was only granted in 1995. Therefore efforts to produce and market mezcal as a premium product have a relatively short history.

Until relatively recently, mezcal had been considered a low quality spirit in Mexico. (i.e., the alcoholic beverage for the poorest groups of the population). This was similar to consumers' perception of tequila in Mexico about thirty years ago when tequila received its appellation of origin. Consumer perception of mezcal has started to change and it is now being sold in some of the most exclusive stores in Mexico, in some cases at prices higher than those of well known premium tequila brands.

Most of the areas where mezcal is produced are rural with high levels of poverty, and most farms are small. Technology is a constraint for these producers along with access to financing, marketing and legal information. Furthermore, available equipment for bottling firms in the market was designed for producing high volumes that could not be reached by individual mezcal enterprises in Mexico. In an effort to overcome some of these obstacles, in 1994 the marketing cooperative El Tecuán was formed in Guerrero State.

El Tecuán was one of the first cooperatives established to help market and promote mezcal and it has had success in helping to establish and maintain consistent high quality, and in launching its own brands of mezcal into the marketplace. As such, it can be considered representative of other mezcal enterprises in Mexico, and this case study documents some of their successes and the challenges currently being faced.

'Tenderstem' Broccoli for Export Markets: An Analysis Study on the AgroFood Company *Sayed F. El-Sayed, Walid Y. Sallam, Daniel F. Warnock, and David Hahn*

This case study, *'Tenderstem' Broccoli for Export Markets: An Analysis Study on the AgroFood Company,* was developed for use by the Faculty of Agriculture at Cairo University in Egypt. The case explores an agricultural situation that can be taught to both classroom and extension learners. The current case study discusses the situation of a vegetable producer and exporter located along the Cairo-Alexandria Desert Road, northwest of Cairo, Egypt. The owner produces vegetable crops, mainly focusing on broccoli, green bean, and peppers, in field and greenhouse environments. The challenges faced by the management of the AgroFood Company are similar to those faced by other farms producing horticultural crops including potential market identification, cultivar longevity, production expansion, labor management, using middlemen effectively, and increasing market share for product. A primary challenge this farm faces is to produce specialty vegetable crops not commonly found in Egypt. The case chronicles how the management decisions for production of 'Tenderstem' broccoli have impacted the farm's ability to effectively compete in the current export market. This case provides basic production, market, and financial information for evaluating the economic potential for shifting current production practices of broccoli towards the production of a specialty vegetable crop, 'Tenderstem' broccoli. The case uses a documentary format, secondary data resources, and interviews with the company management team. The teaching notes narrative describes the opportunities for producing 'Tenderstem' broccoli in Egypt for export and offers strategies for classroom learning situations. Students completing the case will have a better understanding of protected vegetable production systems, gain decision making and analysis skills, and become familiar with using financial analysis principals for strategic business decisions.

INDUSTRY SPEAKS

Building a Talent Pipeline: The Development of the 'Alltech Mini-MBA' *Aidan Connolly and Kate Phillips-Connolly*

By its 20th anniversary, Alltech's growth had surpassed even the most ambitious goals of its founder, Pearse Lyons. This success, however, has led to a dilemma faced by many agribusinesses—a need to create a new cadre of managers who can take the company forward, develop and manage opportunities while maintaining the corporate culture and vision.

After analyzing how best to fill this gap a commitment was made to build a highly customized, internal education program using lecture, case study and project-based learning processes. Alltech's goal was to find a way to systematically develop the management potential of existing employees, in ways that would work with the technical nature of the industry and corporate culture. In the end, building its own program by taking the best, most relevant elements from the available options and adapting them to the company was more cost efficient than sponsoring MBAs and more focused than off-the-shelf programs.

Alltech's commitment to its customized executive education program is providing a series of positive outcomes including improving managers understanding of the corporate vision and strategy as well as of their industry; creating a cadre of the next generation of leaders, while deepening their loyalty; developing corporate competencies; and in the process identifying new business strategies.

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Consumer Segments in Urban and Suburban Farmers Markets

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Abstract

Using cluster analysis, this study used a consumer intercept survey to measure consumers' attitudes and behaviors at a sample of urban and suburban farmers markets. Five consumer segments were identified using cluster analysis, namely: Market Enthusiasts, Recreational Shoppers, Serious Shoppers, Low-involved Shoppers, and Basic Shoppers. Each of these segments represents a group of consumers with different attendance and purchasing behavior. Furthermore, different segments look upon the farmers market shopping experience differently, ranging from an opportunity to quickly purchase fresh vegetables to a regular outing of on-site consumption and entertainment. Managerial and marketing implications of identified consumer segments were hence drawn.

Keywords: cluster analysis, consumer segments, farmers markets

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Introduction

In retail outlets such as shopping malls, consumer segments have been identified for the benefit of mall managers and vendors (Ruiz et al., 2004; Reynolds et al., 2002; Bloch et al., 1994; and Roy, 1994). In an effort to assist market managers and vendors target their customers, some studies have been conducted to segment shoppers at farmers markets ([Reserved], 2004; Wolf and Berrenson, 2003; and Eastwood, 1996). Based on their shopping behaviors, shoppers at farmers markets have been grouped into frequent and infrequent shoppers ([Reserved], 2004 and Eastwood, 1996), or into planned purchasers, impulse (unplanned) purchasers, planned non-purchasers, and unplanned non-purchasers (Wolf and Berrenson, 2003). However, there is still need to investigate the potential existence of consumer segments stemming from consumer preferences as it has been found to be the case in shopping malls (Reynolds et al., 2002).

Identifying consumer segments based on behavior and preferences rather than merely demographics is not new. A study published by the Coca-Cola Retailing Research Foundation (2004) provides evidence that individuals' "membership" in a behavioral or preference-based consumer segment is dynamic. That is, an individual can be classified into different consumer shopping segments based on their grocery shopping "mission." The study identified nine separate and distinct missions, each of which characterized a market segment, namely: *Care for Family, Smart Budget-Shopping, Discovery, Efficient Stock-Up, Specific Item, Bargain-Hunting Among Stores, Reluctance, Small Basket Grab and Go, and Immediate Consumption.* Thus, grocery store managers could use this information to attract and serve people on different missions, rather than treat all missions alike, which may result in unfulfilled customers.

Reynolds et al. (2002) segmented shoppers at both a traditional and an outlet mall based on their preference for mall attributes such as: mall essentials, entertainment, convenience, and brand-name merchandise. They identified five customer segments as being common to both the traditional and an outlet mall. These segments included: Basic, Apathetic, Destination, Enthusiasts, and Serious. The sixth consumer segment, Brand Seekers, was unique to the factory outlet mall. The knowledge of these consumer segments also led to the identification of key mall attributes for the benefit of mall managers and vendors.

For similar reasons, this study extends consumer segmentation analysis to farmers markets. Although their organization and shopping environment are different from that of either shopping malls or grocery stores, knowledge of customer segments and preferences can be useful. Therefore, the main objective of this study is to provide insights into consumer segments found in farmers markets, to assist market managers and farmer vendors in designing successful farmers markets. Three specific objectives are identified: first, to identify consumer segments existing in farmers markets based on their preferences for market attributes; second, to distinguish among consumer segments in terms of their demographics and shopping behaviors; and third, to interpret the characteristics of consumer segments and suggest managerial and marketing implications for each segment.

The remainder of this paper is organized in major sections of methodology, results, and implications to market managers and vendors.

Methodology

Markets were selected to include a stratified sample of urban and suburban markets, but no other sampling restrictions were imposed. At the time of data collection there were 34 urban and 48 non-urban farmers markets operating in Illinois. Data were collected from six farmers markets randomly selected from the Chicago and Metro East (St. Louis) metropolitan areas using a standardized questionnaire in 2004. Two were within the city of Chicago, three were suburban, and one was in suburban East St. Louis. The questionnaire was developed based on previous studies ([Reserved], 2004; and Reynolds et al., 2002). Shoppers were intercepted randomly at the selected farmers markets and were asked to complete the questionnaire. In total, 508 questionnaires were completed, of which only 379 were completely filled by respondents and hence, useful.

The markets selected included a variety of market characteristics. Some were only open on a weekday afternoon and evening while others were open on a weekend day. Days of operation varied from Thursday through Sunday.

The survey was comprised of three principle sections. One section asked about the respondents demographic characteristics. Another section asked the respondent to indicate relative importance (seven point Likert scale) of twenty-four characteristics of farmers markets. These characteristics are identified below in Table 3. A third section asked about the respondent's behavior on that day and in general at this and other farmers markets (time, money spent; other missions, patronage frequency and products purchsed).

Consumer segments existing in farmers markets were derived through the use of the multi-step cluster analysis method. The multi-step cluster analysis method has been used to segment consumers shopping in malls (Reynolds et al., 2002; and Bloch et al. 1994). The multi-step cluster analysis method involved the successive application of factor analysis, Ward's and k-means clustering methods. The Statistical Package for Social Scientists (SPSS) software was used in the data analysis as it was capable of performing factor analysis and both the Ward's and k-means clustering procedures.

Results

The results of the data collection and analysis are presented in the sequence of sample demographics, consumer segment identification and analysis of segment behavior.

Demographic Characteristics of Sample

Table 1 compares the demographics of the sample collected with similar data from the 2000 Census. A large proportion of the shoppers in the selected farmers markets were highly educated, middle aged or older, professional, white, and female. These results are quite consistent with those obtained from other consumer surveys ([Reserved], 2004; Govindasamy et al., 2002; Sovell, 2001; and Kezis et al., 1998). Women often are the dominant gender shopping at farmers markets in Illinois and elsewhere, which might be related to their primary shopping role for groceries in the household.

Table 1. Demographic Characteristics of Farmers Market Consumers Compared to U.S. Population.[1]

Characteristic		Sample	U. S. Population	Chi-square
Gender	Male	23.3%	49.1%	
	Female	76.7%	50.9%	26.6***[2]
Age	Under 25	6.7%	35.3%	
	25-34	15.9%	14.2%	
	35-44	23.0%	16.0%	43.5***
	45-54	18.4%	13.4%	
	55-64	19.5%	8.6%	
	65 and over	16.6%	12.4%	
Household size	1	18.2%		
	2-3	54.0%		
	4-5	25.1%		
	Over 5	2.7%		
Education	Some high school	1.1%	19.6%	
	High school graduate	5.2%	28.6%	
	Some college	16.2%	21.0%	210.3***
	College graduate	33.7%	21.8%	
	Post-graduate	43.7%	8.9%	
Ethnicity	Black	10.7%	12.3%	
	Asian	2.6%	3.6%	
	American Indian	0.2%	0.9%	2.7
	White	82.9%	75.1%	
	Native Hawaiian	0.0%	0.1%	
	Other	3.5%	5.5%	
Occupation	Student	9.6%		
	Professional and related	41.8%		
	Other	19.9%		
	Unemployed/Homemaker	11.2%		
	Retired	17.5%		
Income	Less than $20,000	10.7%		
	$20,000-49,000	23.9%	57.9%	(< $50,000)
	$50,000-74,999	22.1%	19.5%	
	$75,000-99,999	16.0%	10.2%	
	$100,000 and over	27.2%	12.3%	

[1]Source of U.S. Population Data: U.S. Dept. of Commerce, U.S. Census Bureau, Census 2000.
[2]*** indicates significant at p= 0.01.

Consumer Segment Identification

Component Factors

Because there were many (24) market attributes, some of them correlated, it was first necessary to reduce them to a few uncorrelated component factors through factor analysis. However, the use of factor analysis in data reduction has been criticized for the occurrence of multiple factor loadings or correlated factors (Aldenderfer and Blashfield, 1984). To get uncorrelated factors, this study employed both principal component analysis and varimax as extraction and rotation methods respectively (Kim and Mueller, 1978a).

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.829. Normally, the KMO measure should be at least 0.5 for the sample size to be adequate for factor analysis, indicating

the sample size was adequate in this case. The Bartlett's test of sphericity was also significant (*chi-square* = 3642.60, *df* = 276, $p < 0.001$), implying that the correlation matrix was not an identity matrix. The Bartlett's test further showed that the factor model was appropriate.

Two unrelated, popular criteria were used to determine the number of component factors: Kaiser criterion and scree plot (Santos, 1999, and Kim and Mueller, 1978a & b). Using both criteria, seven component factors were extracted. These component factors accounted for approximately 65% of the total variance. Table 2 (see Appendix) shows the factor loadings of market attributes, the extracted component factors, and their respective names: *nearby stores*, *shopping experience*, *adjunct products*, *convenience*, *superior produce*, *assorted produce*, and *organic produce*. It is also important to note at this point that not all market attributes were regarded by respondents as being important as shown by the mean scores. Moreover, mean scores of most attributes were statistically different across study markets as shown by the F-test.

Consumer Segments

The Ward's Method was used to derive initial cluster seeds as in previous studies (Reynolds et al., 2002; and Bloch et al., 1994). Consumers were clustered based on standardized factor scores. Standardized factor scores were computed using the Anderson-Rubin criterion to ensure orthogonality of component factors (Kim and Mueller, 1978a). From the dendrogram, the number of appropriate-sized clusters lay between 2 and 6. The search for economically viable consumer segments also required the generation of fairly sizeable clusters and hence, made this method more appropriate.

The initial cluster seeds derived from the Ward's method were used in the k-means method to obtain final clusters of consumers. For two, three, and four clusters, some base variables were insignificant implying these clusters were not distinct. In contrast, five and six clusters were distinct. However, by conducting split half analysis, the optimum number of clusters was found to be five. The largest cluster has 119 consumers whereas the smallest one has 43 consumers (Table 3). The other three remaining clusters have 107, 62 and 48 consumers. The identified consumer segments were then designated the following names: Market Enthusiasts, Recreational Shoppers, Serious Shoppers, Low-involved Shoppers, and Basic Shoppers. The reasons for these interpretive names are discussed in the description section below.

Table 3. Final Cluster Centers Based on Standardized Factor Scores

Factors	***Enthusiasts***	***Recreational***	***Serious***	***Low-involved***	***Basic***
Nearby stores	-0.41	1.94	-0.22	-0.069	-0.19
Shopping experience	0.69	0.48	-1.15	-0.32	-0.07
Adjunct products	-0.28	0.76	-0.01	-0.14	0.04
Convenience -	0.16	0.29	0.39	-0.06	-0.14
Superior produce	0.17	0.10	0.40	-2.18	0.48
Assorted produce	0.67	0.31	0.76	-0.31	-0.98
Organic produce	0.29	0.28	-0.45	0.03	-0.14
Total	107 43		62	48	119

Note: Factor scores have mean 0 and standard deviation 1

Validation of Consumer Segments

Consumer segments were validated by performing both reliability and external validity tests. The reliability test was carried out to ascertain the degree of consistency of consumer segments. In contrast, the external validity test was done to determine whether the formed consumer segments were representative of shoppers in the urban and suburban farmers markets of Illinois. Both reliability and validity tests which were performed to validate consumer segments are discussed below. Successful reliability and validity tests enable commingling of data among markets as well as inferences about consumers at other markets.

The use of multiple clustering algorithms served as a test for the reliability or consistency of clusters. This reliability test has been commonly used in segmentation studies (Ketchen, Jr. and Shook, 1996). Both the Ward's and k-means methods indicated the optimal number of clusters were five. Under the Ward's method, the largest cluster had 111 consumers whereas the smallest one had 41 consumers. The other three remaining clusters had 88, 75 and 64 consumers. Therefore, the sizes of segments under the Ward's method were more or less similar to those obtained by the k-means method (Table 3).

Two approaches were taken to test for the validity of consumer segments: multivariate analysis of variance (MANOVA) of base variables and non parametric tests (chi-square and F-test) on non-clustering variables (Ketchen, Jr. and Shook, 1996; Aldenderfer and Blashfield, 1984). The MANOVA test indicated that consumer segments were distinct since all base variables were significant (Table 4).

Table 4. MANOVA of Component Factors

	Cluster		**Error**			
Component	*Mean Square d*	*f*	*Mean Square d*	*f*	*F*	*Sig.*
Nearby stores	46.951	4	0.509	374	92.326	.000
Shopping experience	36.928	4	0.616	374	59.974	.000
Adjunct products	8.571	4	0.919	374	9.327	.000
Convenience 4	.505	4	0.963	374	4.680	.001
Superior produce	66.950	4	0.295	374	227.218	.000
Assorted produce	51.622	4	0.459	374	112.565	.000
Organic produce	6.900	4	0.937	374	7.365	.000

Description of Consumer Segments

Non parametric tests showed that consumer segments differed significantly in some of their demographic and behavioral characteristics (Tables 5 and 6).

Moreover, consumer segments identified from farmers markets were somehow related to those found in shopping malls even though the two retail outlets differ so much in organization and product involvement. And, to a certain extent, consumer segments in farmers markets were comparable to known typologies of grocery shoppers. A description of each segment follows. It should be noted that due to the demographic make up and size of the sample, the cells in three rows in Table 5 (those labeled Some High School (Education), Asian and Other (Ethnicity)) had expected frequencies less than five.

Table 5. Demographic Characteristics of Consumer Segments

Characteristic		*Enthusiasts*	*Recreational*	*Serious*	*Low-involved*	*Basic*	*Chi-square*
Gender	Male	13.5%	18.6%	21.3%	51.1%	29.1%	26.822***
	Female	86.5%	81.4%	78.7%	48.9%	70.9%	
Age	Under 25	3.8%	12.2%	6.6%	12.8%	7.7%	36.177**
	25-34	6.7%	17.1%	21.3%	19.1%	20.5%	
	35-44	15.4%	26.8%	27.9%	19.1%	28.2%	
	45-54	23.1%	24.4%	16.4%	14.9%	15.4%	
	55-64	30.8%	17.1%	16.4%	21.3%	15.4%	
	65 and over	20.2%	2.4%	11.5%	12.8%	12.8%	
Education	Some high school	.0%	.0%	1.6%	4.3%	.8%	45.013***
	High school graduate	7.6%	11.6%	1.6%	.0%	3.4%	
	Some college	13.3%	34.9%	19.4%	8.5%	10.1%	
	College graduate	36.2%	39.5%	35.5%	29.8%	33.6%	
	Post-graduate	42.9%	14.0%	41.9%	57.4%	52.1%	
Ethnicity	Black	6.0%	39.0%	3.3%	10.6%	6.0%	59.035***
	Asian	3.0%	7.3%	.0%	.0%	3.4%	
	American Indian	.0%	.0%	1.6%	.0%	.0%	
	White	86.0%	51.2%	91.8%	85.1%	86.2%	
	Other	5.0%	2.4%	3.3%	4.3%	4.3%	
Occupation	Student	1.9%	19.5%	11.7%	15.2%	12.1%	27.258**
	Professional and related	59.2%	43.9%	41.7%	47.8%	51.7%	
	Service and other	8.7%	22.0%	16.7%	13.0%	8.6%	
	Unemployed/Homemaker	11.7%	9.8%	15.0%	13.0%	9.5%	
	Retired	18.4%	4.9%	15.0%	10.9%	18.1%	
Income	Less than $20,000	4.4%	20.0%	12.7%	9.1%	8.3%	27.782**
	$20,000-49,000	16.7%	37.5%	23.6%	20.5%	22.0%	
	$50,000-74,999	23.3%	22.5%	25.5%	20.5%	22.0%	
	$75,000-99,999	24.4%	10.0%	9.1%	25.0%	14.7%	
	$100,000 and over	31.1%	10.0%	29.1%	25.0%	33.0%	
	Total	107	43	62	48	119	27.2%

Note: *** and ** significant at 1% and 5% respectively

Table 6. Behavioral Characteristics of Consumer Segments

Characteristic		*Enthusiasts*	*Recreational*	*Serious*	*Low-involved*	*Basic*	*Sample*	*Chi-square*
Frequency of Visits	0-10	52.3%	75.0%	49.2%	70.8%	67.5%	61.0%	21.698***
	11-20	30.8%	10.0%	37.7%	25.0%	26.5%	28.3%	
	> 20	16.8%	15.0%	13.1%	4.2%	6.0%	10.7%	
	Mean	11.25	6.88	10.97	8.15	8.59	9.6	
Average Money Spent	$0-9	10.5%	11.9%	16.4%	18.8%	15.7%	14.6%	12.295
	$10-19	40.0%	40.5%	34.4%	37.5%	29.6%	34.7%	
	$20-25	18.1%	21.4%	19.7%	31.3%	23.5%	21.8%	
	$25 & Over	31.4%	26.2%	29.5%	12.5%	31.3%	28.9%	
	Mean($)	21.22	22.19	19.45	19.39	19.74	20.44	
Average Time Spent	< 1 hr.	64.2%	39.0%	69.4%	66.0%	56.9%	59.4%	11.713**
	1 hr. & above	35.8%	61.0%	30.6%	34.0%	43.1%	40.6%	
	Mean(hr)	0.77	1.05	0.70	0.77	0.83	0.84	
Market Patronage	New Customer	8.4%	27.9%	9.7%	14.6%	14.3%	12.8%	10.932**
	Old Customer	91.6%	72.1%	90.3%	85.4%	85.7%	87.2%	
Total		107	43	62	48	119	379	

Note: *** and ** significant at 1% and 5% respectively

Market Enthusiasts

Market Enthusiasts were the second largest segment in the market constituting 28% of the total sample (Table 3). These consumers considered the cleanliness and the general appearance of the market as important factors in deciding to come to shop there compared to other consumer segments. They also cared about how markets were organized, amenities at the market, and the general service they were accorded at the market. The presence of exceptionally high quality produce, such as organic produce influenced their patronage decisions more than any other group. Because they were enthusiastic about the market, they attached a lower value to the existence of other retail outlets nearby the market or other non-produce in the market. They were not inconvenienced much compared to other groups in visiting the market. Perhaps, they lived nearby the market or if they did not, their greater admiration for the market offset any inconveniences that they faced while patronizing the market.

Typically, *Market Enthusiasts* came to the market eleven times in a season. Approximately 48% of them came to the market more than ten times during the market season. On average, they reported spending about $21 per trip. Approximately one-half of them spent $20 or more per trip. They usually spent 0.77 hr (about 46 minutes) at the market per trip. Approximately 36% of them spent at least one-hour at the market (Table 6).

The demographic characteristics of *Market Enthusiasts* were typical of general sample of shoppers at the market (Table 5). They comprised 28 percent of the sample. A large proportion of *Market Enthusiasts* comprised of individuals who were older, highly educated, high income, professional, white, and female. More specifically, slightly over one-half of them were 55 years or older, 78% of them were at least college graduates, and 31% of them had household incomes of $100,000 and above. Eighty-six percent of them were whites. Similarly, 87% of them were female. In terms of occupation, a large proportion (59%) of them was professionals.

Market enthusiasts were somewhat similar to "Full Experience Shoppers," "Enthusiasts," and "Mall Enthusiasts" identified in the mall (Ruiz et. al, 2004; Reynolds et al., 2002; and Bloch et al., 1994). Ruiz et al. found "Full Experience Shoppers" to like shopping at the mall and thus were more frequent and second highest money spenders there. Bloch et al. described "Mall Enthusiasts" as shoppers whose purchases, usage of the mall, and experiential consumption were relatively high. Similarly, Reynolds et al. found "Enthusiasts" to prefer both products and auxiliary services provided by the malls.

Recreational Shoppers

Recreational Shoppers were the smallest segment in the market and made up of only 11% of the sample (Table 3). In deciding to come to shop at the market, *Recreational Shoppers* placed higher value on the existence of other retail outlets nearby the market or non-produce and events at the market compared to other consumer segments. Other than shopping for produce, these shoppers also attended the market in order to buy other products. They liked to treat their shopping as an entertainment event and were looking forward to a more festive atmosphere at the market than other groups. Perhaps, they were not time-pressed, took time off their busy schedules to relax, were on family outing, or were on vacation.

Typically, *Recreational Shoppers* exhibited the following behaviors. They were less frequent than other segments and came to the market about seven times in a season. Only one-quarter of them came to the market more than ten times during the market season. However, once in the market they tended to spend more money than other segments. They spent about $22 per trip. Nearly one-half of them spent $20 or more per trip. *Recreational Shoppers* also spent more time at the market than other segments and stayed for a little over one-hour per trip. Over 60% of them spent at least one-hour at the market (Table 6).

Recreational Shoppers tended to separate out from the rest of the groups in terms of demographics except in gender and occupation. Their distribution was skewed with more younger, less educated, diverse individuals with slightly lower household incomes than other segments (Table 5). Twenty percent of them were 55 years or older, 14% of them were post-graduates and only 10% of them reported household incomes of $100,000 and above. More than one-half (51%) of *Recreational Shoppers* were white while 39% of them were black. However, like the general sample of shoppers, they were predominantly professional and female (Table 5).

Shopping motivations of *Recreational Shoppers* in farmers markets matched those of "Grazers" and "Recreational Shoppers" in malls. "Grazers" were found to spend their time at the mall browsing and eating (Bloch et al., 1994). "Recreational Shoppers" at the malls regarded their shopping at the mall as an "escape" (Ruiz et al., 2004). *Recreational Shoppers* in farmers markets can also be likened to "Discovery Shoppers" identified in supermarkets (Coca-Cola, 2004). "Discovery Shoppers," as the name suggests, went to supermarkets to browse for new products. Behaviorally, they were relatively high money spenders at supermarkets just like *Recreational Shoppers* in farmers markets.

Recreational Shoppers also had most of the characteristics of "Impulse Purchasers," a segment identified by Wolf and Berrenson (2003), in a night farmers market. "Impulse Purchasers" were less frequent and tended to be new visitors at the market. Nonetheless, they spent more money at the market. Demographically, "Impulse Purchasers" were relatively young shoppers just like *Recreational Shoppers*.

Serious Shoppers

Serious Shoppers made up 16% of the farmers market consumers (Table 3). They considered the presence of a variety of high quality produce at the market as more influential in their patronage decision making process than other segments. One could envision that these shoppers would have liked to come to shop at the market more frequently but were often busy, time-pressed, or lived far-away from the market. However, the existence of variety of high quality produce at the farmers market made them overcome any inconveniences involved in shopping in the market. Since they did not stay long at the market, they did not appreciate much the general atmosphere of the market compared to *Recreational Shoppers*.

The following behavioral characteristics were typical of *Serious Shoppers*. They shopped at the market an average of eleven times in a season. Slightly over one-half of them visited the market more than ten times per market season. They spent about $19 per visit. Nearly one-half of them spent $20 or more per trip. They spent less time per trip at the market than other segments.

They spent about 0.7 hr (42 minutes) at the market per trip. Approximately 70% of them spent less than one-hour at the market. In sum, *Serious Shoppers* were regular, high money spenders who spent less time per trip and were not likely to attend the market for recreation (Table 6).

The demographic characteristics of *Serious Shoppers* were typical of the general sample of shoppers at the farmers market (Table 5). They tended to be medium-aged or older, educated, and have medium-high household incomes. Approximately 28% of them were under 35 years, 77% of them were at least college graduates, and nearly one-half of them had household incomes of $20,000-74,999. Also, 29% of them had household incomes of $100,000 and above. With respect to gender and ethnicity, *Serious Shoppers* reflected the sample's high concentration of whites and females.

In terms of preferences, *Serious Shoppers* resembled "Serious Shoppers" in malls, who were found to be more concerned about products than auxiliary services, such as the presence of entertainment or events (Reynolds et al., 2002). Because *Serious Shoppers* were convenience-seekers, they also tended to relate to a group of grocery shoppers known as "Time-challenged shoppers" (FMI, 2002). According to the FMI study, "Time-challenged shoppers" valued convenience of the grocery outlet because of their busy schedules. For instance, they had large households and young children to take care of. In their effort to cut on their grocery costs, "Time-challenged shoppers" responded to frequent shopper programs. *Serious Shoppers* at farmers markets seemed to be busy people, too. They included a slightly larger proportion of young adults (ages 26 to 44) who were more likely to have children at home.

Low-involved Shoppers

Low-involved Shoppers were the second smallest group in farmers markets (Table 3). They were less enthusiastic about their farmers markets than other segments. A typical *Low-involved Shopper* had behavioral characteristics outlined as follows. They were less frequent patrons than other segments. They came to the market eight times per season. Over 70% of them shopped at the market ten or less times in a season. They spent about $19 per trip. Forty-four percent of them spent $20 or more per trip. They spent 0.77 hr (46 minutes) per trip. Only 34% of them spent at least one-hour at the market (Table 6).

Two demographic characteristics distinguished *Low-involved Shoppers* from other segments, namely: age and gender compositions (Table 5). This segment comprised of shoppers of all age groups more equally than the other segments. In terms of gender, more *Low-involved Shoppers* were males. More than one-half (51%) of them were male compared to the entire sample being 23% male. The rest of the demographic characteristics were typical of the general sample of shoppers at the market (Table 5). That is, most of the *Low-involved Shoppers* were highly educated whites with high household incomes. In particular, 87% of them were at least college graduates, and one-quarter of them had household incomes of $100,000 and above.

Low-involved Shoppers seemed to be analogous to "Minimalists" or "Apathetic Shoppers" identified in shopping malls. It was found that "Minimalists" engaged least in the activities of the mall (Bloch et al., 1994). Similarly, "Apathetic Shoppers" did not enjoy much shopping at the malls (Reynolds et al., 2002). This kind of shoppers, whether in the farmers market or mall,

might not be playing a primary shopping role for food or non food products in their respective households.

Basic Shoppers

Basic Shoppers formed the largest segment with 31% of the sample (Table 3). They considered the presence of high quality produce at the market more importantly in their patronage decisions than other segments. These shoppers valued more the freshness of market produce and cared little about its variety and where it came from. Although these shoppers cared less about the general atmosphere of the market, whether there were events or any stores nearby, they spent relatively more time at the market. Probably they did this in order to make the best selection of produce. Moreover, they also liked some non-produce items to be present at the market. Hence, they might have spent some time browsing and/or buying them.

Typically, they had the following behavioral features. They came to the market nine times in a season. Approximately 32% of them came to the market more than ten times during the market season. Their average money expenditure was about $20 per trip. More than one-half (55%) of them spent $20 or more per trip. They spent nearly one-hour (about 50 minutes) at the market whenever they shopped there. Forty-three percent of them spent at least one-hour at the market (Table 6).

The demographic characteristics of *Basic Shoppers* reflected those of most shoppers at the market (Table 5). They tended to be medium-aged and older, educated, and had medium-high incomes. More than 70% of them were 35 years or older, over 80% of them were at least college graduates, and nearly one-third (33%) of them had household incomes of $100,000 and above. *Basic Shoppers* were predominantly white females. Slightly over 70% of them were female and 86% were white.

Basic shoppers were somewhat akin to "Mission Shoppers" and "Traditionalists" in malls. Although "Mission Shoppers" did not like shopping at the mall, they had to go there to buy something (Ruiz et al., 2004). Likewise, "Traditionalists" visited malls with the primary purpose of buying merchandise or services (Bloch et al., 1993). *Basic Shoppers* were also related to "Basic Buyers," a segment identified from African American grocery shoppers (FMI, 2000). According to FMI, "Basic buyers" were primarily concerned with the "basics" in a grocery store such as high quality produce, meat, and fast checkout. "Basic Buyers" did not enjoy grocery shopping, tended to shop at large chain stores and were brand loyal. They also did not value much their cultural cues such as the presence of black salespersons.

Managerial and Marketing Implications of Consumer Segments

Currently, farmers markets are organized differently from one another. Farmers markets can be open or closed/ventilated, seasonal or year-round. Some farmers markets offer only farm produce while others have meat, seafood, poultry, flowers, shrubs, herbs, crafts, prepared food, and baked goods. Some markets feature educational displays, cooking demonstrations, and festivals while others do not. Some farmers markets operate on weekends whereas others open

during weekdays. The time of operation of markets varies with more markets operating in the mornings (USDA).

Moreover, farmers markets receive inconsistent support from sponsors such as government agencies, business groups, nonprofit organizations, and individuals. These sponsors also have different motives for supporting farmers markets. Some of these motives include: revitalizing downtown areas; raising awareness of healthy nutrition, stewardship of the land and ecology, and so forth (Payne, 2002; Bachmann, 2002).

In light of the above market differences, market managers likely should strive to organize effective farmers markets, that is, farmers markets containing profitable vendors, satisfied shoppers, and those that meet the market sponsors' objectives. This study identifies consumer segments patronizing farmers markets. Knowledge of consumer segments, their preferences, behaviors, and demographics, can provide useful insights for market managers in their quest to establish effective farmers markets. On the other hand, farmer vendors can directly use this knowledge to target consumer segments thereby increasing their total sales and profits. Hence, the managerial and marketing implications of consumer segments are discussed below with respect to attracting and retaining the identified segments.

Market Enthusiasts

Market cleanliness and appearance appealed to *Market Enthusiasts* more than other segments. *Market Enthusiasts* might thus be attracted by keeping farmers markets clean and pleasing to the eye. The market décor and arrangement are likely to be important. Ample parking is also important, particularly in suburban markets where most shoppers drive to the market.
With respect to organic produce, even though *Market Enthusiasts* showed more interest in it, prior work has shown that consumers make their purchasing decisions based on other factors such as price and appearance ([Reserved], 2004). Thus, while it is good to have some organic produce at the market, the maintenance of high quality and fair pricing might boost market attendance of *Market Enthusiasts* more than the mere availability of organic produce.

Recreational Shoppers

Recreational Shoppers placed more value on the market atmosphere and entertainment than other segments. However, they tended to be occasional visitors, who mostly patronized markets that operated over the weekend. Thus, care must be taken when attracting this segment to shop at the market, as *Recreational Shoppers* are less likely to be repeat visitors and may be looking for an event. Introducing snacks and entertaining activities to markets operating over weekends might attract more *Recreational Shoppers* to shop there. However, this strategy may not attract the desired blend of other segments and be a high-cost strategy for acquiring non-repeat visitors to the market.

Serious Shoppers

Serious Shoppers valued a variety of high quality, locally-grown produce more than other segments. These produce attributes are likely to attract this segment to shop at the market.

However, the word "locally-grown" produce seems to be viewed differently across markets. For example, shoppers at Chicago markets take locally-grown produce to mean produce coming from the Midwest region (four state area). Thus, recruiting Midwest farmers from a larger radius to participate in Chicago and suburban markets might pull more *Serious Shoppers* to shop there. However, the definition of "local" may tighten outside major metropolitan areas.

In addition, *Serious Shoppers* sought convenience when deciding to shop at the market more than other segments. Location choice and accessibility are important to attract this segment.

Low-involved Shoppers

These shoppers were less appreciative of most of the market features compared to other segments. Anecdotally, they appeared to wander the farmers market, consuming coffee and donuts on site. One strategy for approaching this segment is to convert them to another segment, thereby getting them more involved at the market. Specific activities could be organized that target them, perhaps organizing family or community activities at the market, or food awareness development activities.

Basic Shoppers

Basic Shoppers placed more weight on the presence of high quality produce when deciding to shop at the market than other segments. Therefore, translating "quality" from the consumers' perspective to farmers may help vendors attract this segment. *Basic Shoppers* also liked some non-produce items to be present at the market implying that their interests in the market might be aroused by expanding the product category offered by markets to include such items.
Conclusion

It can be concluded that five preference-based consumer segments exist in urban and suburban farmers markets: *Market Enthusiasts*, *Recreational Shoppers*, *Serious Shoppers*, *Low-involved Shoppers*, and *Basic Shoppers*. These consumer segments significantly differ in demographic and behavioral characteristics. Thus, steps to attract one or more segments simultaneously can be undertaken consciously or unconsciously. For example, *Market Enthusiasts* and *Basic Shoppers* are focused on produce quality and variety. Although they differed in other aspects, none of the above groups expressed a strong desire for entertainment, recreational travel, or lengthy stays at the market. Another key managerial implication from these findings is for market organizers to pay attention to their nearby community demographics for indicators of their potential and actual customers. This will enable a more targeted offering which can be adjusted with experience and feedback.

Further Research

Further research should investigate consumer segments existing in farmers markets located in rural areas. Also, research should be conducted on the motivations and behaviors of other stakeholders in farmers markets, specifically sponsors, organizers and farmer vendors. Doing so would facilitate a deeper understanding of future directions to be undertaken in the successful development and evolution of farmers markets. Given the expected demographics of

respondents, similar future research can avoid small issues experienced in this research with cross tabulation tables having a few instances of expected frequencies less than five.

Lastly, this study has contributed to the development and validation of constructs (*nearby stores*, *shopping experience*, *adjunct products*, *convenience*, *superior produce*, *assorted produce*, and *organic produce*) which can be used to measure why consumers patronize farmers markets, these constructs can be the basis for further research, thereby reducing the need for factor analysis in further research.

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Appendix

Table 2: Component Factors (Factor Loadings of Market Attribute Variables)

		Factors							
Market Attribute	Mean score	Nearby stores	Shopping experience	Adjunct products	Convenience	Superior produce	Assorted produce	Organic produce	H^2
Presence of nearby grocery stores	2.04***	.841	.196	.125	.078	-.106	.084	.039	*.754*
Presence of nearby non-grocery stores	2.06***	.824	.216	.172	.046	-.085	.058	.075	*.769*
Presence of meat	2.28***	.586	-.087	.386	.151	.064	.046	.297	*.475*
Price of produce	5.18**	.484	-.121	.154	.334	.220	.150	-.401	*.635*
Appearance of market	5.16**	.140	.777	.157	.220	.156	.120	-.010	*.643*
Cleanliness of market	5.82**	.051	.726	.101	.280	.212	-.048	.051	*.615*
Time of operation of market	5.38	.011	.620	.181	.264	.117	.031	.097	*.641*
Payment method at market	4.01***	.492	.563	.118	.087	.116	.045	-.155	*.615*
Availability of parking space	4.63***	.169	.455	.159	-.077	.107	.225	-.426	*.587*
Customer service	5.62**	.119	.441	.097	.394	.169	.212	.143	*.618*
Presence of snacks	3.12***	.205	.075	.791	.019	.026	-.231	-.035	*.729*
Presence of events/activities	3.11***	.140	.196	.767	.006	.003	-.080	.044	*655*
Presence of flowers	4.11***	-.068	.189	.657	.115	.022	.359	.023	*.612*
Presence of crafts	2.41***	.325	.184	.628	.081	-.001	.315	-.035	*.467*
Presence of processed food	2.42***	.479	.021	.543	.169	.108	.063	.136	*.797*
Location of market	5.84	.031	.219	.135	.858	.046	.099	-.002	*.816*
Accessibility of market	5.80	.046	.225	.104	.837	.104	.148	.000	*.511*
Distance of market	4.90**	.248	.233	-.060	.578	-.044	-.099	.030	*.466*
Produce freshness	6.79	-.072	.139	.001	.025	.840	.152	-.003	*.668*
Produce quality	6.76	-.088	.178	.043	-.004	.839	.152	.010	*.511*
Food safety	6.09**	.188	.267	.031	.208	.529	-.172	.123	*.736*
Produce variety	5.84	.135	.121	.080	.167	.172	.733	-.096	*.620*
Presence of locally-grown produce	5.84*	.085	.022	-.078	-.009	.039	.635	.465	*.787*
Presence of organic produce	4.86***	.209	.082	.167	.050	.134	.126	.706	*.773*
Cronbach's α		*.792*	*.771*	*.787*	*.769*	*.548*	*.474*	*.401*	

Note: *** significant at the 1% level, ** significant at the 5% level, and * significant at the 1% level

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Italian Consumer Attitudes Toward Products for Well-being: The Functional Foods Market

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Abstract

The current paper investigates the factors which influence Italian consumers' behaviour towards functional food products and verifies the opportunities for further expansion of these products through a survey with a sample of 340 consumers responsible for family shopping. Findings show that there is a large number of factors that influence consumer purchasing behaviour. The empirical analysis emphasizes that, although Italian consumers are rather confused on the exact meaning of the term functional foods, their high interest on the bond between diet and health can be a potential element for the development of the demand of these food products. The work also provides a segmentation of the sample to verify the existence of homogeneous groups of consumers characterized by a different propensity towards functional foods.

Keywords: Functional foods, Italian consumers, Market segmentation

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Introduction

Consumer interest in the relationship between diet and health has increased substantially in Europe in recent decades. Research has amply shown that the consumer is today more concerned about self-care and personal health and is seemingly demanding more information on how to achieve better health through diet.

Trends in population demographics and socio-economic changes also point to the need for foods with added health benefits. An increase in life expectancy, resulting in an increase in the number of the elderly and the desire for an improved quality of life, as well as increasing costs of health care, has stimulated governments, researchers, health professionals and the food industry to observe how such changes can be managed more effectively. As a result, today foods are not intended only to provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve the physical and mental well-being of consumers (Menrad 2003); (Roberfroid 2002).

Consequently, the development and marketing of a growing spectrum of products such as *nutraceuticals, medifoods* and *vitafoods* is a major trend in today's food industry. However, the term functional food has become the predominant one even though several organizations have attempted to differentiate this emerging food category[1]. The heterogeneity of definitions used internationally to classify functional foods makes it difficult to collect homogenous statistic data on this market (Goldberg 1994); (Sheeby and Morrissey 1998); (Roberfroid 2002); (Gray et al. 2003). Despite the mismatch of information on total turnover and volume of functional foods sold, there emerges a business in rapid growth. According to a Euromonitor survey, Japan is the world's largest market, the US is the second largest while the European market is less developed. The major European markets are the UK, Germany, France and Italy (Bech-Larsen and Scholderer 2007). Despite the economic opportunities, functional foods have not as yet been defined by legislation in Europe and there is broad consensus that there needs to be a regulatory framework in the EU that will protect consumers, promote fair trade and encourage product innovation in the food industry.

Consumer acceptance of the concept of functional foods, and better understanding of its determinants, are widely recognized by the economic literature as key success factors for market orientation, development, and successfully negotiating market opportunities (Gilbert 1997); (Grunert et al.) 2000); (Weststrate et al. 2002).

The competitive environment for functional foods has been reported to suffer from a lack of data and understanding of consumer market segments (Gilbert 1997). Undeniably, despite the vast

[1] Typically, a food marketed as functional contains added, technologically developed ingredients with a specific health benefit (Niva 2007). Although the term ''functional food'' has already been defined several times (Roberfroid 2002), so far there is no single accepted definition for this group of foods.

interest of the food industry and the alleged prospect of a bright future for functional foods, few empirical studies of European and Italian consumer acceptance based on primary data collection have been reported (Hilliam 1998); (Poulsen 1999); (Niva 2007); (Bech-Larsen et al. 2001); (Makela and Niva 2002); (Verbeke 2005, 2006); (Vassallo et al. 2009).

In this context the main intention of the current paper is to investigate the factors which influence consumer behavior towards functional food products and ascertain the opportunities for further expansion of this segment in order to subsequently develop appropriate consumer communication strategies based on market segmentation. In this study, the term *functional food* is used in accordance with the European Commission's Concerted Action on Functional Food Science in Europe (FuFoSE): *''a food product can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases"* (ILSI Europe 2002).

Based on the previous considerations the first part of the current work carried out an overview of the development projections and market potential of functional foods at the international, European and national scale. This section is followed by a brief review of the literature on consumer attitudes towards functional foods, useful to identify core issues to be investigated in the empirical part. Subsequently the results of a direct survey are presented providing several indications for developers and marketers as well as government bodies that are interested in designing consumer communication strategies and effective health programs. The final section concludes with a discussion of the implications of the results and suggests some future research avenues.

Economic Opportunities in the Functional Foods Market

The lack of an official definition is one of the main constraints for the analysis and monitoring of functional food markets (Menrad 2003), as well as for their growth (Castellini et al. 2002). Hence whether a broader or a more specific classification is applied a variety of estimations on global and regional market values have been formulated. Nevertheless, academic researchers and professionals agree that the functional foods market is continuously growing worldwide (Menrad 2003; Verbeke 2005; FAO 2007). Some of the most reliable estimates of the functional foods market valued the industry at €7 billion in 2000, considering only markets in the USA, Japan and Europe (Weststrate et al. 2002), while global market estimates vary from $33 billion (Hilliam 1998), to €32 billion (Urala and Lahteenmaki 2004) and up to $47.6 billion (Sloan 2002). Other even brighter estimates report that the global market is currently worth around $60 billion per annum.

Regarded as the birthplace of functional foods and world leader in the development of related technologies, Japan is the largest market in the world and has the highest per capita consumption with around $166 per annum (World Nutraceuticals 2006). The Japanese functional foods market has exhibited a steady average growth rate of 9.6% per year for the past decade, and in 2003 its

functional food industry was estimated to have a total turnover of around $11.7 billion[2] (Euromonitor 2004).

The United States currently possesses the second largest and most rapidly expanding functional food and nutraceutical market in the world. Estimates of the industry's value, in 2003, range from $10.5 billion (Euromonitor 2004) to $21.3 billion (Datamonitor 2007)[3]. Functional foods have a market share of around 2-3% in the US food market (Menrad 2003) and it is constantly increasing. This growth can be explained by the legislative framework which continues to be more favorable than in Europe (Hilliam 1999) and (Side 2006).

Other important markets for functional foods include Canada, India, China, Brazil and Europe. The Canadian functional foods industry totaled C$2.9 billion in revenues for 2004 (Statistics Canada 2007). In India the most common forms of functional foods and nutraceuticals are available as traditional Indian Ayurvedic medicines[4], which are marketed under different brand names (Patwardhan et al. 2005), making it quite difficult to set an exact value on the market: according to some researchers India's national industry is worth $10 billion per annum, with exports of $1.1 billion making a significant contribution to the export market (Singh et al. 2003). Functional foods and nutraceuticals are also part of the traditional Chinese diet and are a large component in traditional Chinese medicine, with the functional foods market estimated at $6 billion per year (FAO 2007). In Brazil, the sector is relatively young but growing rapidly: sales are projected to reach $1.9 billion by 2009 (FAO 2007). The functional food market in the European Union has grown in recent years from about $1.8 billion in 1999 (Kleter et al. 2001) to between $4 and $8 billion[5] in 2003, depending which foods are regarded as functional (Menrad 2003); (Datamonitor 2007). According to results from these studies, European consumers are generally far more critical of new products and technologies (e.g. GMO food, irradiated food) compared to American consumers (Bech-Larsen and Grunert 2003); (Lusk et al. 2004); (Lusk and Rozan 2005). Bredahl (2001) showed that across European countries, the attitude towards genetic modification in food production was deeply embedded in more general attitudes held by the consumers, in particular towards nature and towards technology. Particularly Italian consumers turned out to be significantly less negative towards genetic modification in foods than Danish and German consumers. In contrast, Canavari and Nayga (2009) suggest that the majority of Italians are not willing to buy GM food products even if they are nutritionally enhanced.

Europeans are not only suspicious of the safety of novel foods, but are also critical of the whole process through which food production becomes increasingly anonymous and distanced from everyday life (Poppe and Kjaernes 2003). Therefore, European acceptance of functional foods would appear less unconditional, better thought-out, and with more concerns and reservations as compared to US consumers[6]. Furthermore, demand for functional foods inside the EU varies

[2] Other estimates valued the Japanese market at 5 billion US$ in 2003 (Side, 2006) and total turnover at around $14 billion USD in 1999 (Hilliam, 2000).
[3] By contrast, Hufnagel (2000) estimated the market value in 1999 at around US$15.5 billion and the Nutrition Business Journal $31 billion in 2006.
[4] Ayurveda is a system of traditional medicine native to India, and practised in other parts of the world as a form of alternative medicine.
[5] Other recent studies estimate this value at around $15 billion in 2006 (Kotilainen et al. 2006) and €9 billion in 2009 (Nomisma 2008).
[6] This may also originate from the recent sequence of food safety scares (Verbeke 2005).

considerably from country to country mainly due to food traditions and cultural heritage (Castellini et al. 2002) and in general the interest of consumers in functional food in central and northern member states is higher than in Mediterranean countries (Van Trijp 2007). According to the 2004 Euromonitor, the biggest European markets are United Kingdom ($2.6 billion), Germany ($2.4 billion), France ($1.4 billion) and Italy ($1.2 billion). However, many other European markets are experiencing high growth rates, such as the Netherlands (Makinen-Aakula 2006) and Spain (Monar 2007). In addition, Euromonitor forecasted that sales of functional foods will rise moderately from 2005 to 2009 in the newly emerging markets of Hungary, Poland and Russia (Benkouider 2004).

In Italy the demand for functional foods is constantly increasing due to mounting scientific validation of their effectiveness, its aging population and changing lifestyles. In addition, Italians over the past 40 years have robustly reduced daily calories (from 2600 kcal to 2200 kcal per day, in particular reducing fatty foods, animal protein and wine – Italian Ministry of Health, 2007) and are paying rising attention to foods that can combine nutrition and health. Industry reports show that over 4000 products have been reformulated by reducing or eliminating saturated fats, cholesterol, salt, fatty acids to fulfill the demands of national consumers and functional foods now account for around 17% of food sales in the country (Censis 2007). Several nationwide surveys also show that Italian families, especially those with children, seek quality and healthiness of food products ahead of price (Nielsen 2007) in contrast with the general decrease in food purchases, and highlight that at the end of 2007 30% of families claimed to consume functional foods (ISMEA 2007); (Nomisma 2008). Moreover, functional foods are experiencing wide-ranging success thanks to the recent introduction of new EU laws that have improved Italian consumer confidence in labels and advertising information related to the nutritional and health virtues of food products. However, the escalating demand for health-related foods is stimulating companies and farmers associations to offer new products. Effectively demonstrated by the decision of Barilla, the biggest Italian food brand, to launch at the end of 2007 Alixir[7] a new line of food products entirely dedicated to welfare and health. The offer includes ten products, divided in four categories, that (allegedly) help the cardiovascular system, the immune system, the intestinal functions and slow cellular aging.

Currently, on the Italian market, the only noteworthy functional foods, in terms of value, are yogurts, dairy products, beverages and energy drinks[8]. As a result, the Italian market, with plenty of underdeveloped functional food categories, offers interesting growth opportunities for food businesses involved in supplying products with enhanced nutritional and healthy compounds. At present, the market, as elsewhere worldwide, is dominated by large multinationals that are able to afford to pay for R&D and marketing efforts required for success in this area (Menrad 2003); (Thompson and Moughan 2008), though there is an increasing number of small Italian companies focusing on a specific product or health need that are starting to achieve notable results.

[7] No official market data on this product line is currently available. Noteworthy to remark is that on September 2008 the Antitrust Authority has imposed a fine of € 200,000 to Barilla for incorrect commercial practices, considering misleading Alixir's commercials, forcing the company to review its packaging and remove many recommendations.
[8] An interesting case in Italy is represented by "Selenella", potatoes rich in selenium. The Consortium Selenella, owner of the registered trademark, in 2008 had 23.5 million euros in revenues and a volume of about 30 thousand tons. The product is particularly appreciated also on foreign markets, particularly in countries of Northern Europe.

Consumer Attitudes Towards Functional Food: A Review

Despite the general socio-demographic and behavioral trends which are in favor of functional foods there are specific challenges in marketing such products (Menrad 2003). For successful functional food expansion, as broadly recognized in the literature, consumer acceptance of the concept of functional foods, and a better understanding of its determinants, are key success factors for market orientation, development and successfully negotiating market opportunities (Gilbert 1997); (Grunert et al. 2000); (Weststrate et al. 2002). Accordingly, in recent years several papers have reported empirical studies of consumer acceptance based on primary data collection, especially in the United States (Childs and Poryzees 1997); (Gilbert 1997,2000); (IFIC 2007) and the European Union (Bech-Larsen et al. 2001); (Makela and Niva 2002); (Van Kleef et al. 2002, 2005); (Verbeke 2005 and 2006); (Urala and Lahteenmaki 2006, 2007); (Nielsen, 2007), providing insight into the profile of functional food consumers.

A common result emerging from the literature is that functional foods from the consumer's standpoint are not perceived as being one homogeneous group (Urala and Lahteenmaki 2003). It has thus been concluded (DeJong et al. 2003) that the characteristics of functional food users cannot be legitimately generalized, given the clear differences between the consumers of different functional food products. Most of such studies have demonstrated that cognitive, motivational and attitudinal determinants of consumer acceptance of functional foods vary considerably in different countries. In particular, the European market[9] is characterized by high demand heterogeneity linked to the existence of marked regional differences in the perception and willingness to use functional foods. Such heterogeneity stems mainly from socio-demographic differences, the existence of dissimilar dietary habits, the different national policies for the promotion of public health, but also differences related to cultural traditions (Castellini et al. 2002).

Considering consumer demographic characteristics, for example, the literature shows that female consumers are a more promising target group for functional foods than men (Urala 2005), partly because they show more interest in health in general (Childs and Poryzees 1997); (Bogue and Ryan 2000). Moreover, functional food users are often more educated (Anttolainen et al. 2001); (DeJong et al. 2003). Concerning age, Poulsen (1999) mentions that older participants in his research (i.e. >55 years) showed a greater intention to buy functional foods. This contrasts with previous results by Childs and Poryzees (1997) according to which the elderly were less intent on buying a food that prevents a disease compared to younger consumers. This trend seems to be confirmed in the Italian market where the "old generation", is more oriented towards so-called mature products, while young people prefer healthy foods (Ismea 2007). Furthermore, Verbeke (2005) mentions that consumer attitudes towards functional foods do not depend on their socio-demographic characteristics. These contradictory findings suggest that profiling functional food consumers should not be generalized demographically.

Some elicit evidence showing the main factors influencing purchasing behavior, related to functional foods, can be distinguished in lifestyle variables, health consciousness and attitudes

[9] Some studies show, for example, that in central and northern Europe, the interest of consumers towards functional foods is higher than in Mediterranean countries, where, undoubtedly, there is less familiarity with them (Menrad 2003); (Van Trijp 2007).

towards healthier products (Cox et al. 2004); (Urala and Lahteenmaki 2004) and variables closely related to the product's extrinsic and intrinsic attributes (Jonas and Beckmann1998); (Urala 2005); (Verbeke 2006).

With reference to lifestyle variables an important factor for the consumption of functional foods is the preservation of good health status (Urala 2005) and to what extent consumers perceive functional foods contribute to this aim. European consumers consider food healthiness to be an important factor affecting their overall nutrition choices (Lappalainen et al. 1998). However, also in this case, there is a considerable body of research that shows there are consistent individual differences in health behavior (Armitage and Conner 2000); (Gilbert 2000). The research by van Kleef, van Trijp and Luning (2005) proves that the relation between the health condition of a consumer and the type of product's health claim affects the intention to buy the product. Also, Frewer, Scholderer and Lambert (2003) emphasize that consumer risk perceptions may have an important role in the acceptance of functional foods. Verbeke (2005) found that believing in the health effects of functional foods is the most crucial factor affecting consumer acceptance and Cox et al. (2004) found that the perceived efficacy accounted well for the intention to consume functional foods that were said to improve memory. Another important factor is the presence of specific health problems: according to Verbeke (2005) the existence of a family member with a particular health difficulty positively affects the acceptance of functional foods.

With reference to product attributes, those relevant to purchasing behavior are as follows: knowledge and familiarity with functional ingredients (Herrmann and Roeder 1998); (Rams 2002), as well as food safety (Bech-Larsen et al. 2001); (Verschuren 2002), convenience (Poulsen 1999); (Rams 2002); (Verschuren 2002); (Pettinger et al. 2004) and type of base product (Poulsen 1999); (Rams 2002). Furthermore, organoleptic attributes, especially taste, are some of the most important factors that affect consumers' choice of functional foods (Jonas and Beckmann 1998); (Urala 2005); (Verbeke 2006) as well as the perception that functional foods could be less natural than conventional foods (Frewer et al. 2003); (Cox et al. 2004). Urala (2005) supports the view that trust in functional foods is affected by the type of base product (carrier) whose attributes have been improved. Bech-Larsen and Grunert (2003) agree that the type of base product contributes to how much consumers perceive functional foods to be healthy. Van Kleef et al. (2005) add that potential buyers tend to trust health claims more when the basic carrier has a positive overall image, as well as a history in health claims (e.g. yogurt, juices, etc.). Moreover, it is much easier to gain consumer acceptance for a product enriched with more familiar ingredients, such as vitamin C, calcium, Omega-3, than it is for unfamiliar ones, such as selenium (Menrad 2003); (Bech-Larsen and Scholderer 2007). Furthermore, another important issue is how to communicate the health effects of functional foods reliably to consumers (Poulsen 1999) as marketing campaigns might not necessarily be trusted. The role of information is crucial because consumers cannot perceive the benefit directly from the product, unlike for instance taste and other sensory characteristics.

The type of information and the trust in it regarding the effect of a particular product on health constitute additional factors of functional foods' success (Urala 2005). According to Tuorila and Cardello (2002), information concerning the health benefits of a food can increase the likelihood of its consumption. However, due to limited consumer knowledge and awareness of the health effects of newly developed functional ingredients, there are strong needs for communication activities (Wansink et al. 2005; (Biacs 2007); (Salminen 2007).

Analyzing the Italian market, few papers have reported empirical studies of consumer acceptance based on primary data collection. An interesting study (Vassallo et al. 2009) shows that Italian consumers perceive functional products as healthier but less pleasing than conventional, and tend to show little willingness to accept the derivatives of functional cereals. In addition, consumers tend to be influenced more by the health message concerning the reduction in disease risk in assessing the wholesomeness of foods.

Italian Consumer Attitudes toward Functional Foods: An Empirical Analysis

Objectives and Procedures

The main purposes of this paper are to investigate the factors which influence consumer behavior towards functional food products and verify the existence of market segments formed by consumers with similar preferences, in order to subsequently suggest and develop appropriate consumer communication strategies based on market segmentation. From the available studies, socio-demographic characteristics, cognitive and attitudinal factors emerged as potential determinants of consumer acceptance of functional foods.

Based on the evidence found in the literature, we hypothesize that consumer attitudes toward functional foods are affected by several factors, including knowledge, consumer trust in health claims as well as trust in regulatory bodies. We thus seek to explore general consumer attitudes about food, nutrition and health; consumer awareness and interest in functional foods; motivation to buy this type of food or to reject it respectively; knowledge and beliefs about specific food benefits. In addition, our analysis pays particular attention to the various ways in which information about functional foods is conveyed to consumers, trying to identify possible strategies to improve its effectiveness. This latter aspect is noteworthy considering that in recent times, in Italy, there has been growing interest in adopting an identification label for "health foods", to help consumers recognize them and clearly distinguish their benefits[10].

For this purpose, a quantitative survey was conducted to explore Italian consumers' knowledge and attitudes toward functional foods. A questionnaire was developed to conduct data and administered to a sample of consumers, living in the three cities of Bologna, Rome and Naples, respectively located in the north, center and south of Italy[11].

To determine the sample a two stage procedure was adopted. Firstly a simple sampling technique was used; setting 0.95 as the level of confidence, for an infinity population, 340 personal interviews were carried out fixing the sample error at 5.3%. Subsequently, interviews were conducted using two criteria: the city of residence and place of purchase. Face-to-face interviews (125 in the north, 100 in the center and 115 in the south) were conducted from July to September 2008 at different outlets (supermarket, discount, traditional store) so as to include the different consumer types in the sample. The number of questionnaires administered among modern

[10] The National Consumers Union has proposed to adopt a brand that identifies "health food" to help consumers distinguish and recognize the benefits provided. The brand should be under the close supervision of the Antitrust authority, to ensure the accuracy of the claims used and the completeness of the information, including contraindications written on food packaging.

[11] Rome is the largest Italian city in terms of population (approximately 2.726.593), and Naples the third largest (1.226.594), while Bologna has 374.057 inhabitants (ISTAT 2007).

distribution chain outlets reflects the national share of food sales (ISMEA 2007); (Federdistribuzione 2007). Hence around 50% of the interviews were conducted in supermarkets; 20% in hypermarkets; 10% in discount stores and 8% in traditional stores. All respondents were responsible for food purchasing within their household. This choice is reflected in the gender distribution with approximately 35% male and 65% female[12]. Although this sample is not strictly statistically representative, it includes respondents with a wide variety of socio-demographic backgrounds (Table 1). More specifically, the sample is biased towards age[13]. However, the distribution of education and marital status closely matches that in the Italian population. Moreover, whether this bias has an impact on the general findings is rather questionable since the literature includes studies that report differing associations between age and functional food acceptance or use. For example, Poulsen (1999) mentions that relatively older participants in his research (i.e. older than 55 years) showed a greater intention to buy functional foods. Urala (2005) also maintains that elderly consumers put more emphasis on the results of food consumption relevant to the prevention of a disease compared to younger consumers. On the contrary, Childs and Poryzees (1997) found that the elderly show less intention to buy a food that prevents disease compared to younger consumers.

The questionnaire used during the survey consists of 34 questions, mostly multiple-choice, divided into five sections that examine, respectively: consumer knowledge of the link between food choices and health issues; purchasing habits and consumption of interviewees; perception and willingness to purchase functional foods; their views about the current level of available information, their socio-demographic characteristics and lifestyles. The collected data were analyzed in two phases. The first, purely descriptive, is an overview of the frequency of responses, based on the construction of contingency tables, through which there were early indications on the degree of association between two or more characters. Recognizing that knowledge of the distribution of consumer preferences forms the basis for product differentiation and market segmentation (Green et al. 2001), the second phase of analysis provides a market segmentation identifying different profiles of consumers, through the use of PCA and Cluster Analysis. PCA enables simultaneous analysis of the complex information provided by a large number of variables and turns the initial variable into a reduced number of artificial variables or factors explaining a high percentage of the information included in the original variables. After extracting the main components the statistical units can be aggregated through the CA aimed at classifying the statistical units identified in a set of "exclusive and exhaustive" clusters so as to maximize the internally homogeneous nature and the externally heterogeneous nature.

[12] The literature shows that female consumers are a more promising target group for functional foods than men (Urala 2005), partly because they show more interest in healthy food consumption and health in general (Bogue and Ryan 2000); (Childs and Poryzees 1997).

[13] Respondents aged between 26-45 were over-represented with respect to population demographics. This effect is partly due to the decision to include in the sample only individuals responsible for household food shopping (excluding from the survey consumers under 18 years old and over 75) and also due to the fact that we sought to include consumers sensitive to healthy products (who, judging from latest available data from the ISMEA (2007) survey on Italian food consumption, are mainly young, married with children and have a medium/high annual income). This may be a problem for the evaluation of the cluster size in the population since it probably overestimates the size of the clusters, grouping the most interested respondents. However, this paper does not aim to estimate segment sizes or market shares for particular product profiles.

Main Results from Explorative Analysis

Socio-demographic analysis of the interviewees displays the predominant presence of women (66.6%) aged between 35-45 years (35.5%) and 25-35 (27.7%), married with children under 10 years (36.4%), with an average level of education: most of them hold a high school degree (58.8%), but the sample also includes university graduates (27.2%). In terms of occupation, the sample mainly comprised housewives and employees.

Table 1. Demographics

		Sample	Population*
Gender	male	33.4	48
	female	66.6	52
Age	18-25	9.8	8.5
	26-35	27.7	17
	36-45	35.5	19.8
	46-55	18.2	17.8
	56-65	5.9	16.2
	66-75	2.7	9.6
Marital status	single	24.6	27.8
	married with children under 10 year	36.4	
	married	28.6	62.5**
	Separated/divorced	8.1	6.2
	widow(er)	2.4	3.5
Education	Master degree	6.6	
	Bachelors degree	27.2	31.9***
	High school diploma	58.8	57***
	Middle school diploma	5.9	*n.a.*
	other	1.5	*n.a.*
Profession	employee	31	*n.a.*
	self-employed	12.2	*n.a.*
	doctor/paramedic	3.9	*n.a.*
	housewife	18.5	*n.a.*
	retired	4.8	*n.a.*
	student	12.5	*n.a.*
	trader	4.5	*n.a.*
	unemployed	3.9	*n.a.*
	other	8.7	*n.a.*

* Istat (National Statistics Institute) data, 2007
** Italian total married population
*** Eurostat and OCSE data 2009, referred to the 2007 population between 25 - 64 years old.

With reference to the level of healthy eating habits and lifestyle of the sample (ascertained by a set of specific questions) it appears that in most cases (36.4%) the former can be considered intermediate healthy, while with regard to lifestyle healthy habits are predominant (40.7%). Importantly, there is also a significant incidence of unhealthy habits (26.6%) linked to the fact that many of the interviewees have a sedentary lifestyle[14].

[14] For the evaluation of dietary habits we asked interviewees to indicate the frequency with which they consume fruits and vegetables, legumes and cereals, fried foods, carbonated drinks, snack between meals, high-fat products, white meat and organic products. To evaluate the lifestyle of the interviewees we asked how often they watched TV, did physical exercise, had check-ups, if they consulted a nutritionist, or attended health centres, if they had a job that forced them to stay seated for a long time. The replies were analysed and summarised on a scale of health ranging from 1 = not at all healthy to 5 = very healthy.

However, respondents appear satisfied with their diet, 40% stating they are mildly satisfied with their choices and consider them quite healthy. Food consumption style was further analyzed by verifying the existence of any specific needs that may affect purchasing decisions and that potentially lead to a greater propensity towards functional foods. About 51% of respondents claim to be influenced in their food choices by specific requirements related primarily to specific medical disorders (22% overweight, allergies/intolerances 8%, heart problems 8%, diabetes 5%) but also by ethical considerations (vegetarian diet 3%) and sports (5%).

Regarding the awareness of the link between food style and health issues, the results clearly show that respondents are quite aware of the fundamental role played by their food choices in determining their health status (52% of the sample strongly agree with this statement) and the availability of specific products that have significant health properties. Moreover, they show complete disagreement (in 27.7% of cases) with the statement that they can monitor their health independently of their food choices, but do not always state their willingness to give up the foods they like to improve their health status. Hence, even though respondents are aware of the close relationship between diet and health, their choices lead towards the pleasure of consumption rather than wellbeing[15]. This trend is confirmed by the analysis of the variables related to shopping habits, validating that the respondents tend to be influenced in their food choices mainly by taste, pointed out in the majority of cases (59%) as the most important attribute. Significant sensitivity is attributed also to the nutritional aspects, selected in 36% of cases as quite important, while price and brand are perceived on average as important attributes, respectively in 44.5% and 45.7% of cases. The least important attributes are the indication of origin (18.2%) and the presence of quality certification (12.4%).

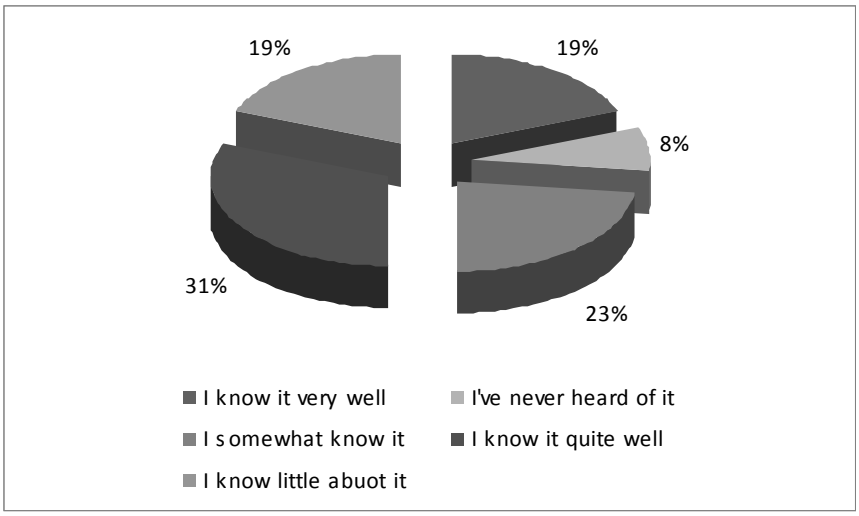
Consumer attention to nutrition is also confirmed by the interest shown by respondents in the nutrition information on labels. 28.5% of interviewees state to read always nutritional information on the label; while 35% claims to read it on a regular basis, particularly in relation to specific products. Differently 18% declares to read it only on the first purchase and 10,5% only occasionally, whereas just 8% never reads it. Taking into account consumers' propensity towards functional foods, our research tested the level of knowledge of such products displayed by the respondents and their purchase frequency. Analysis of the data shows that consumers are not well informed on the concept of functional foods. As regards the level of knowledge, only 8% of interviewees stated they had never heard of this new type of food product, while 31% stated they knew it quite well (Graph1).

However, this data is not confirmed by the definitions of functional foods given by respondents. Undoubtedly, the term *functional foods* is still not very common in everyday language, and in many cases (Graph 2), generates confusion with the "light" and diet products (20%), or functional food is incorrectly associated with food for those who have health problems (16%). In many cases respondents are unable to give a definition (24%). This finding confirms the results from other studies developed in various European countries that consumers often do not know the term *functional food* or similar phrasing, but show a rather good agreement with the concept[16]. The lack of familiarity with the concept of functional foods becomes more evident on

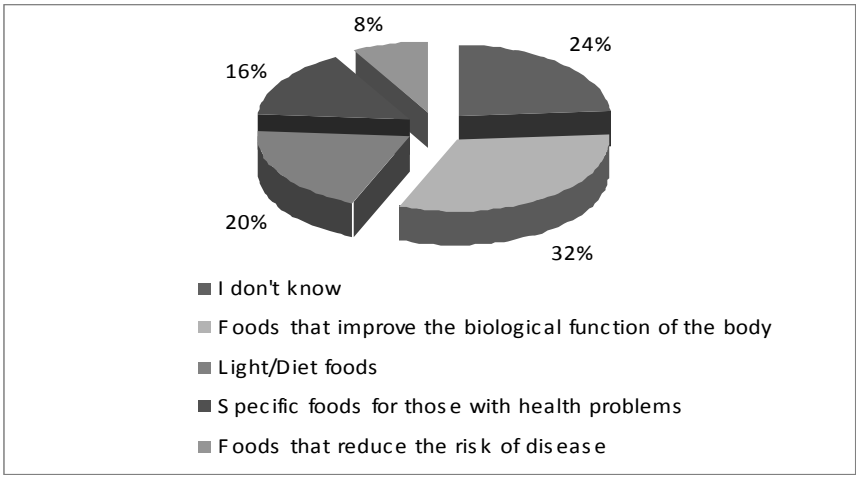
[15] This phenomenon is known as ''optimistic bias'' in the health behaviour literature, that is, people's general tendency to see only others at risk from lifestyle diseases, but not themselves (Frewer et al. 2003).

[16] In the United Kingdom, France and Germany, up to 75% of the consumers have not heard about the term ''functional food'', but more than 50% of them agree to fortify functional ingredients in specific food products

considering that most consumers (44%) were unable to provide an example of functional foods or gave incorrect examples (26%), while the proportion of those who indicated one or two examples (24%) was lower, and the lowest share was of those who indicated more than two (6%).



Graph 1. Knowledge of Functional Food

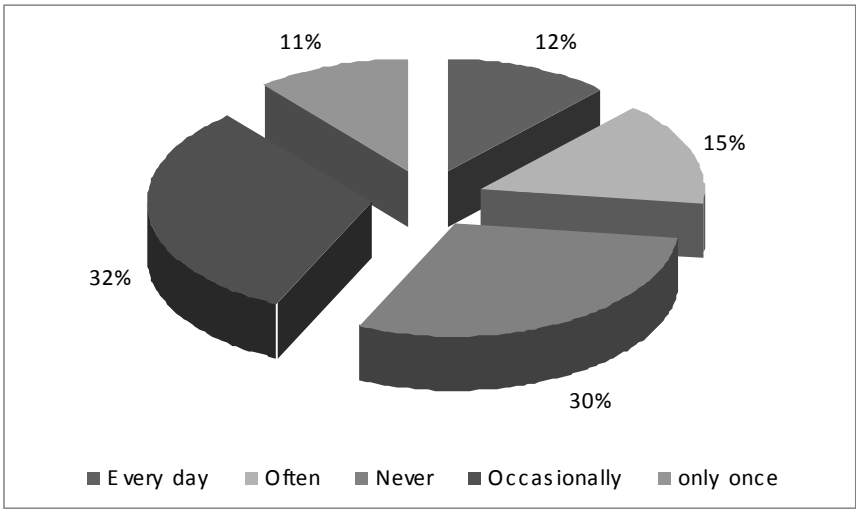


Graph 2. Definition of Functional Foods

With respect to the frequency of consumption (Graph 3), 30% of respondents stated that they had never consumed these products, mainly because they do not know their properties (32%) but also because they are doubtful about their potential benefits (17%), or consider these products only suitable for the sick (15%) or simply because they are not interested in this kind of product

(Hilliam, 1998; 1999). Another study found that while in Belgium 49% of the consumers is familiar with the term of functional food, this ratio in Poland is only 4% (Krygier & Florowska, 2007). In Hungary the expression of ''functional'' proved to be unknown for about 70% of the respondents, according to a market survey at the University of Kaposvar, Hungary (Szakal et al., 2004).

(15%). In order to highlight the characteristics of this segment of consumers, a cross analysis was made with the social demographic variables and the variables related to food habits and lifestyle (Table 2). The analysis shows that there is no significant relationship between consumption frequency and the socio-demographic variables although there is a significant relationship with respect to dietary habits and lifestyle (Table 2). In particular, this group is characterized by the highest concentration of individuals with eating habits not at all healthy (around 10%) or slightly healthy (34%), who have no food habit related to specific health problem (61%) and a fairly unhealthy lifestyle (41.9%).



Graph 3. Consumption frequency

Table 2. Main differences between consumers and non consumers

		Consumers	Non Consumers	Sig.
Specific health problem	None	40.3	61	.002
	Heart problems	6.1	3.9	
	Allergies/Intolerances	8.3	6.7	
	Overweight/obesity	26.5	20.9	
	Diabetes	7.8	2.5	
	Gastrointestinal disorders	4.3	2	
	Other	6.7	3	
Eating habits	Very unhealthy	2.6	9.8	.000
	Fairly unhealthy	12.5	34.3	
	Somewhat Healthy	36.9	32.2	
	Fairly healthy	29.1	20	
	Very healthy	18.9	3.7	
Lifestyle	Very unhealthy	1	5.7	.000
	Fairly unhealthy	19.6	41,9	
	Somewhat Healthy	53.9	43,8	
	Fairly healthy	22.2	7,6	
	Very healthy	3.5	1	

Deleting this segment of consumers from the sample, the survey focused on those who said they consumed functional foods, albeit with different levels of frequency. Among these prevail occasional consumers (32%), followed by those with a higher consumption frequency (15%) and

those reporting daily consumption of such products (12%). The lowest absolute incidence is of those who say they have tested functional foods only once (11%). In 83% of cases consumers bought these products at modern distribution chain outlets (such as supermarkets and hypermarkets), the most widely consumed products are probiotic yogurts (29%), vitamin-enriched/omega-3s milk (21%) and enriched breakfast cereal (15%) followed by ready to drink products (11.5%), vitamin fruit juice (10%) and fortified biscuits (6%). Among the least consumed are low-cholesterol butter / margarine (5.3%) and energy drinks (2.2%).

The main reasons that lead consumers to purchase such products are to improve their personal well-being and that of their family members (23%), the need to reinforce their immune system (18%), and the need to improve their gastrointestinal functions (15%). However, there are also those who consume functional products just out of curiosity (14%) or without a specific reason (6%).

On analyzing the variables that affect the perception of functional foods it is quite apparent that the sample interviewed considers such products useful for improving their health status (42%) even if they state that they are not always able to fully understand the effects of such products (29.6%). Nevertheless, it should be noted that 15% of respondents strongly agree with the statement that these products are intended only for those who have health problems, while 11% believe that they can lead to side effects and 9% consider them simply a passing fad. These data highlight once again great respondents' confusion on functional foods.

Table 3 shows that consumers do not perceive these products less tasty than conventional; nevertheless in the preponderance of cases (53%) they point to their higher costs and consider the current available variety limited. Consequently high cost, difficult availability and limited range can be considered the main obstacles to the purchase of these products.

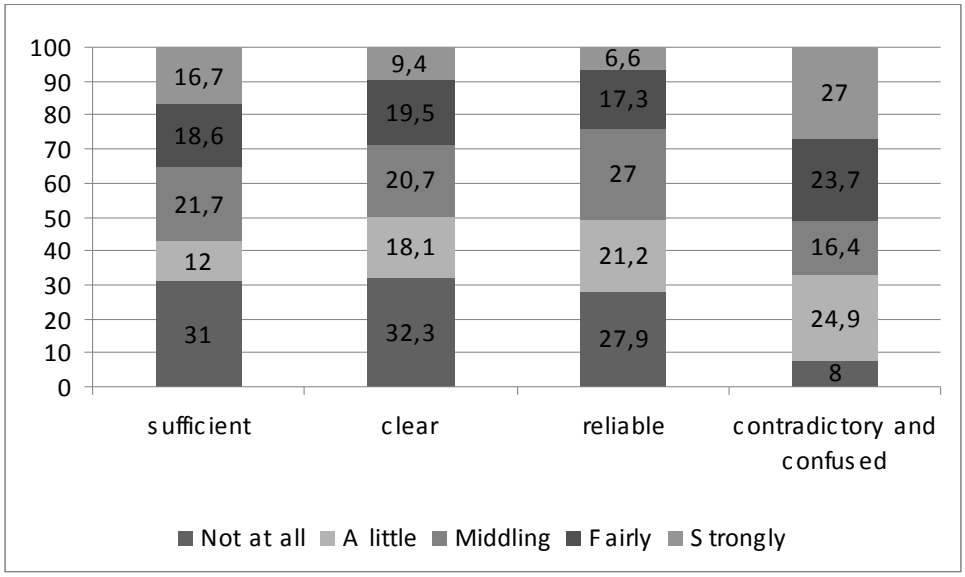
Table 3. Perception of Functional Foods

Degree of agreement	Not at all	A little	Middling	Quite strong	Strong
I fear that these foods may have side effects	16	40.2	17.7	14.6	11.5
These products are simply a passing fad	19	45.1	16.4	10.2	9.3
They are intended only for those who have health problems	10.2	32.2	27	15.6	15
I do not believe their property	22.6	55.3	13.7	3.1	5.3
I do not understand their effects or their consumption	8	16.1	25.4	20.8	29.6
Consuming these foods improves my state of health	0.9	12.8	19	25.2	42
They are less tasty	35.8	41.5	12.8	4.4	5.3
They are more expensive	5.3	11	12	18.2	53.5
It is not easy to find these products	11.5	36.2	26.2	11.1	15
The range on the market is limited	8.9	34	19	12	27
It's difficult to distinguish functional from conventional foods	10.2	26.1	25	15.5	23.4
The information on the label is difficult to understand	7.5	29.6	20.3	13.7	28.7

Moreover, respondents say that there are some difficulties in distinguishing functional from traditional products, denoting the complexity of the information contained in the label. Consistent with findings from other studies, the existence of a smooth flow of information between businesses and consumers, allowing proper assessment of the benefits that may result from the consumption of functional foods, plays a central role in determining the greater or lesser success of these products (Wansink et al. 2005); (Biacs 2007); (Salminen 2007).

Following the above arguments, the last part of the survey analyses the different ways in which information on functional foods is conveyed to consumers, trying to identify possible strategies to improve their effectiveness. Specifically, we tested the opinions expressed by respondents regarding the adequacy, clarity and reliability of the information, the degree of importance and trust attributed to the different sources of information and, finally, possible ways of improving such information flows.

From the analysis of the results summarized in Graph 4, it is clear that consumers express a negative opinion towards the current level of information available, since in more than 30% of cases information is considered inadequate and not simple to understand, as well as contradictory and confused, showing also some skepticism about their reliability.

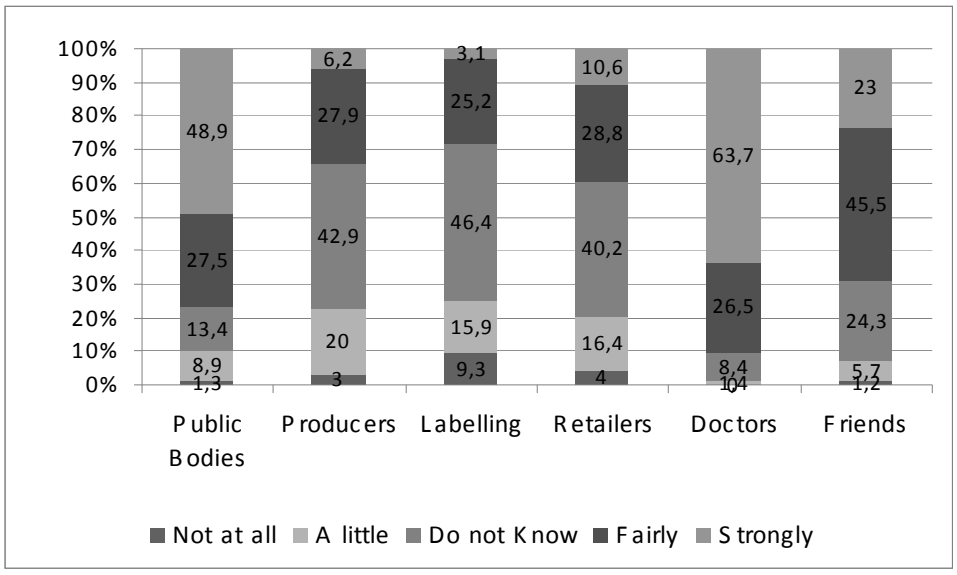


Graph 4. Consumer opinions on current available level of inform

The results also show that the main sources from which consumers obtain information are from advertising (32%) and product labels (27%), followed by doctors / nutritionists (15%) and television programs (8 %). The Internet (6%), word of mouth (6%) and the specialized press (5%) are ranked at the bottom, while only 1% of the information is acquired through public information campaigns. The sources in which respondents have most confidence are doctors and public bodies, trusted amply by, respectively, 63% and 49% of consumers, while a lesser degree of confidence is given to producers and labels, which 42% and 46%, respectively, state they do not know whether or not to trust. As the respondents place greater inherent trust in the sources from which they receive least information, this would indicate such sources need to be strengthened.

Finally, we asked interviewees to express their opinion on the need to improve the current level of information and also indicate possible ways to do so by giving them several options. Almost all of the consumers would like more information (only 5.4% stated otherwise), considering it necessary to implement information campaigns and public education (23%) and improve

descriptions on nutritional labels (25.5%), but also introduce a logo or symbol that might draw attention to the health benefits of the product (22.2%).



Graph 5. Consumers' confidence in different sources of information

Segmentation Analysis

Traditionally the segmentation of the sample entails the breakdown of the statistical units identified based on socio-demographic features. However, to develop a profile of consumers based on their higher or lower propensity to functional foods, our analysis showed that there are many different variables that seem to be correlated and play key roles in influencing consumer behavior.

Through principal components analysis, we sought to verify the existence of latent factors that summarize consumer attitudes towards functional foods in a smaller set of underlying dimensions which explain the inter-relations amongst an original, large set of metric variables. The choice of the variables to submit to factorial reduction was made on the basis of the analysis of the correlations existing amongst the original variables, verified using Bartlett's test for sphericity while the choice of the factors was made on the basis of the eigenvalue criterion, as well as considering of the cumulated variance explained by the factors taken together. Analysis of principal components (varimax rotation method) reveals the existence of four factors which together explain 72% of the original variance. Table 4 presents the matrix of rotated components from which it emerges that the first factor summarizes up five variables related to the degree of adequacy, clarity and reliability of information available to consumers on functional foods and about the labels of these products. Thus we can consider the first factor as information.

Table 4. Matrix of rotated component

	Factors				com[17]
Variables	1	2	3	4	
Degree of importance attributed to quality label	-.288	-.239	.158	.229	.740
Degree of importance attributed to brand	-.134	-.038	**.835**	.132	.590
Degree of importance attributed to indication of origin	-.134	-.045	**.777**	.154	.696
Degree of importance attributed to price	-.143	.044	**.772**	.059	.665
Degree of importance attributed to taste	.584	.113	**.893**	.063	.767
Degree of importance attributed to nutritional attributes	.598	.231	**. 653**	.038	.757
I'm cautious about the consumption of these products	.484	**.866**	-.069	.162	.625
These products are simply a passing fad	.501	**.751**	-.014	.055	.637
They are intended only for those who have health problems	.034	**.783**	-.140	.295	.686
I do not believe their property	-.259	**.791**	-.080	.112	.652
I do not understand their effects or their consumption	.479	.239	-.054	.349	.711
Consuming these foods improves my state of health	.304	**-.743**	-.108	.018	.709
It is not easy to find these products	.562	**.807**	.021	.263	.643
The range on the market is limited	.431	**.837**	.081	-.003	.790
It's difficult to distinguish functional from conventional foods	.532	**.704**	-.130	.255	.810
The information in the label is difficult to understand	**.825**	**.633**	-.131	.295	.851
The information about functional foods is sufficient	**-.774**	.173	-.143	.299	.854
The information about functional foods is clear and simple	**-.784**	-.099	.139	-.172	.832
The information about functional foods is truthful	**-.788**	-.096	.006	-.193	.534
The information about functional foods is confused	**.847**	-.111	.004	.202	.722
My food choices affect my health	.203	.235	-.102	**.651**	.697
I have control of my health no matter what I eat	.018	.333	.069	**.728**	.668
I don't want to give up the foods that I like	.042	-.104	.067	**.509**	.526
I do not need to worry what I eat	.062	-.066	.432	**-.748**	.762
Degree of healthiness in food choice	-.111	-.065	.389	**.842**	.645
Degree of healthiness in lifestyle	-.152	.333	.209	**.826**	.646
Eigenvalue	5.574	2.579	2.059	1.716	
Variance %	23.33	19.11	15.9	13.5	
Total variance %	23.3	42.41	58.3	**71.81**	

Extraction method: principal component analysis. Rotation Method: Varimax with Kaiser normalization.

The second factor, however, summarizes a number of variables related to the opinion that consumers have of functional foods, in terms of availability in food stores, range extent and also their beliefs on products' properties and potential health benefits. Therefore this factor expresses the *opinion* that consumers have of functional foods.

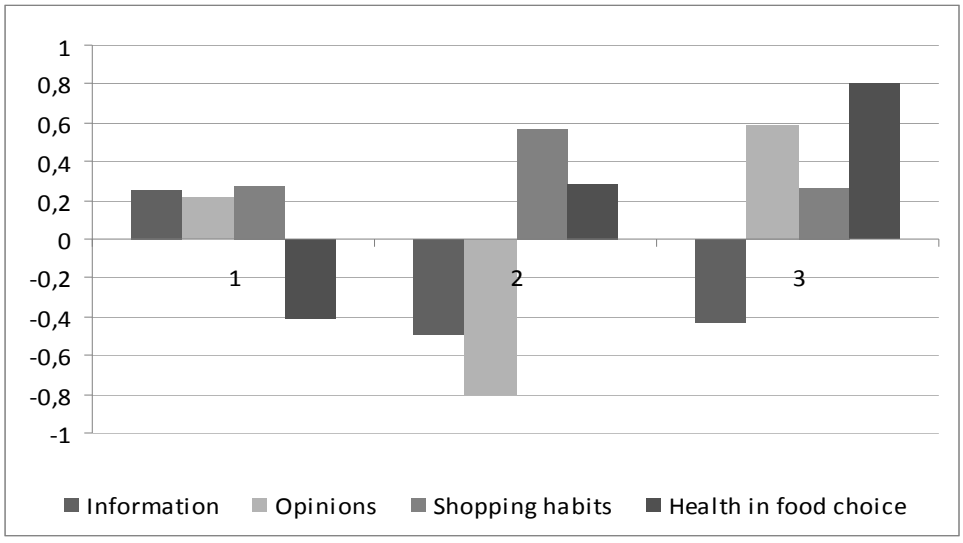
On analyzing the third column of the matrix of rotated components it is possible to describe the third factor as *shopping habits*, which summarizes several variables that indicate the degree of importance attributed by respondents to various attributes in their food choices. Finally, the fourth factor summarizes a number of variables used to measure the health consciousness of respondents and their awareness about the links between diet and health, and may thus be called *health in food choices*.

Based on these four factors, a segmentation of the sample was created to verify the existence of homogeneous groups of consumers with a different propensity towards functional foods. For this

[17] Extraction communalities are estimates of the variance in each variable accounted for by the factors (or components) in the factor solution.

purpose a cluster analysis was applied, using the K-means method, which is a non-hierarchical algorithm, widely used in literature for analogous studies (Poulsen 1999); (Ares and Gambaro 2007), (Cox et al. 2008); (Herath et al. 2008); (Hailu et al. 2009); (Foutopoulos et al. 2008); (Wadolowska et al. 2008).

The non-hierarchical k-means algorithm splits the sample into a predefined number of clusters to maximize, using grouping variables, the ratio between external variance (between groups) and internal variance (in groups). There are no specific rules or statistical methods for choosing the number of clusters (Bretton-Clark 1993), and, as in many other cases, the trade-off between clarity and precision is partly what determines the choice. From the application of this method it results that the division into three groups was the ideal solution where homogeneity is maximized within the individual clusters and minimized between them; any further group would have determined an excessive fragmentation of the sample.



Graph 6. Final cluster centers

The results reported in table 5 elicit that highly significant differences were found in the scores of the four factors between the clusters, suggesting that the three identified clusters might give different importance to the evaluated factors.

Table 5. Final cluster centers

	Cluster 1 *38%*	**Cluster 2** *32%*	**Cluster 3** *30%*	**F tests**
Information	,25509	-,48592	-,43395	64,040
Opinions	,21162	-,79976	,58661	55,628
Shopping habits	,27613	,56911	,26723	40,647
Health in food choice	-,41633	,28902	,79994	76,616

To better understand which aspects characterize the different groups, crosstabulation and Anova analysis to compare means has been done between them and several different variables; as well as on attitudinal variables and personal motivations and also socio-demographic aspects. With

regard to the latter, our results suggest that these variables are not very different among the groups, except for the level of education (see Table 8 in Appendix 3). This confirms the findings of Urala (2005), Dagevos (2005) and Verbeke (2005) that show consumer demographic characteristics are only partially correlated with the acceptance of functional foods. Otherwise significant differences between clusters were found for the variable related to the existence of specific needs related to definite diet needs ($p<0.05$).

Moreover Anova analysis (see Table 6 in Appendix1) suggest that the three groups are differentiated mainly in relation to variables related to the consumers' perception of information ($p<0.01$). These findings confirm the results of some previous research conducted by Hailu and colleagues (2009) that also report significant differences between-clusters regarding health-related behavioral; while Cox et al. (2008) report significant differences concerning information.

Cluster 1 - Curious Consumers

The first cluster groups 83 individuals (38% of respondents) showing least interest in functional foods confirmed by the high concentration of occasional consumers who are unfamiliar with functional foods. In the cluster there is a greater percentage of consumers who say they know them only vaguely, they are unable to give any example of these products or they tend to indicate incorrect examples (respectively 36.5% and 37.7% in the cluster). As this group also has a propensity to buy functional products just out of curiosity or without a specific reason, this segment can be termed *curious consumers*. In evaluating purchasing and consumption habits, it should be emphasized that so-called curious consumers show less sensitivity to nutritional properties, as confirmed by the low frequency of reading nutritional labels, and give more emphasis to extrinsic attributes such as brand and price. In addition, this group concentrates several individuals who claim to have control of their health despite their food choices and state they are unwilling to reject their favorite foods for health reasons. We can argue, then, that these consumers show less attention to the impact that their food choices can have on their health status. This is confirmed by the negative relationship with the factor *health in food choices*. Finally, with regard to socio-demographic variables (although as indicated previously there are no statistically significant differences in the clusters) it is interesting to see how this group is the only one characterized by a higher incidence of men, who represent 38% of the total.

Cluster 2 - Confused and Skeptical Consumers

The second cluster includes 32% of respondents who have a strong interest in nutritional aspects, as shown by the relatively high importance assigned to this attribute, and a keen awareness about the links between diet and health issues. This is also confirmed by a concentration of individuals who have both fairly healthy food habits and lifestyle and by the major presence of individuals who have a special diet for health problems. Despite this characteristic, these consumers have no clear idea of the concept of functional foods. Compared to the other two groups the consumers in cluster 2 tend to confuse functional products with "light" or dietetic products or consider such products as special food for people with specific health problems. This confusion is also reflected in consumers' propensity towards functional foods. Indeed, this group is quite cautious towards these products because they fear they might have side effects. Furthermore, this group of consumers state they have some difficulties finding these products since it is not easy to

distinguish functional from conventional foods, and they also consider functional foods limited in range. Another interesting element that distinguishes this cluster is the negative opinion expressed towards the information currently available, which is considered contradictory and mostly confused, scant and not always reliable. A negative opinion is also expressed with regard to the labels of functional foods, described as quite incomprehensible. Based on this evidence it is possible to classify this cluster as the *confused and skeptical consumer*.

Cluster 3 - Health-aware

The third cluster made of 30% of respondents groups individuals with a greater propensity towards functional foods, particularly attentive to health aspects in their choice of food and aware of the link between nutrition and health. They can thus be called health-aware consumers. This group has a greater presence of individuals who claim daily consumption of functional foods and who actually show a good level of knowledge of such products, confirmed by the high incidence of individuals who not only provided a correct definition but were also able to offer correct examples. In addition, this group aggregates consumers with a good level of awareness of functional foods, whereas the responses indicated there is a lower incidence of generic reasons for consumption. However, these consumers also complain that there are some difficulties in distinguishing these products from conventional and in interpreting the labels. Finally, it should be highlighted in relation to socio-demographic variables that this group has a higher incidence of women with a high level of education, as there is a greater concentration of university graduates or individuals with a master's degree.

Discussion and Conclusions

Functional foods have been amply shown to represent a rapidly developing and particularly promising market segment. This phenomenon is largely due to significant social changes in recent decades, such as increased life expectancy and increases in health costs related to diseases arising from poor dietary habits, which have led to increasing food demand for products with strong health connotations.

Consumer acceptance has regularly been identified as the decisive factor in the successful marketing of functional foods, with cognitive, motivational and attitudinal determinants of consumer acceptance of functional foods being widely explored in different countries (Bech-Larsen and Grunert 2003); (Cox et al. 2004); (Urala and Lahteenmaki 2004); (Verbeke 2005). However, with particular reference to the European market, most research in the literature focuses on northern European countries, which represent the most developed European markets, while surprisingly little research has been conducted in Mediterranean countries. Specifically, despite substantial growth opportunities for food businesses involved in supplying products with enhanced nutritional and healthy compounds on the Italian market, few papers have reported empirical studies of Italian consumer acceptance based on primary data collection (Messina et al. 2008); (Stewart-Knox et al. 2007); (Vassallo et al. 2009). The empirical analysis conducted in this study was therefore constructed to investigate the factors which lead consumers towards functional food products and verify the existence of market segments formed by consumers with similar preferences in order to explore the opportunities for further expansion of this market.

Though not considered representative of Italy as a whole, since the sampling procedure was not appropriate to obtain a truly representative sample; our analysis provides interesting indications for functional food developers and marketers as well as government bodies charged with designing effective health programs. From a critical analysis of the results it may be stated that interviewed consumers, despite having a marked awareness of the link between diet and health and a high level of interest in the nutritional and health aspects of their consumption choices, are rather confused on functional foods. Similar findings were found in other studies conducted in other European countries (Bech-Larsen and Grunert 2003); (Bech-Larsen and Scholderer 2007); (Krygier 2007); (Urala and Lahteenmaki 2007). These consumers are often unaware of the term *functional food* or such like, but show considerable agreement with the concept, substantiating the results from previous studies. The analysis reveals that the degree of knowledge of these foods is quite poor, demonstrated by the fact that in many cases consumers have problems defining and distinguishing them from other types of similar products. This confusion is reflected clearly in the frequency of consumption which appears predominantly occasional; indeed, only in 12% of cases did respondents report daily consumption.

From multivariate analysis it emerged that a large number of factors influence consumers' propensity towards functional foods, related not only to their socio-demographic characteristics, but also attitudinal variables, as well as health in food choices and personal motivations to engage in health-conscious behavior. This confirmed the findings of similar studies elsewhere (Ares & Gambaro 2007); (Hailu et al. 2008). The image that consumers usually have of such products, relative to their taste, cost and market availability, also plays an important role in determining the greater or lesser propensity to purchase such products, as does the type and amount of trust in health-related information, consistent with the findings from other similar researches (Urala 2005); (Tuorila and Cardello 2002).

Cluster analysis based on the four factors revealed the existence of three different groups of individuals with a different degree of interest in functional foods, in relation to which it would be necessary to build different marketing strategies to capture the best opportunities offered by the market. The clusters found in our sample provide limited indications on the size of the corresponding segments in the national population, since respondents were not randomly recruited. Although this can be considered a minor issue as other published research, that do not aim to estimate segment sizes or market shares for particular product profiles, demonstrate (Hailu 2008); (Ares and Gambaro 2007); (Ares et al. 2009).

In particular, only the consumers in the third cluster (30% of respondents), defined as health-aware, displayed good knowledge of functional foods and thus a greater propensity to consume such products, unlike the first two clusters which had a concentration of individuals who appeared quite confused and skeptical about such products (Cluster 2, 32% of respondents) or who stated they bought them mainly out of curiosity (Cluster 1, 20% of respondents).

Interestingly, albeit showing a different degree of inclination towards functional foods, the three clusters denoted deficiencies in the level of information available about these products, considered by all three segments inadequate and often difficult to understand. Another element to highlight is the skepticism expressed by many respondents about the reliability of information, with particular reference to that conveyed through corporate advertising and through labeling.

As confirmed by exploratory analysis, almost all the consumers sought more information, considering it necessary to implement information campaigns and public education. Moreover, descriptions on nutritional labels needed to be improved, and a logo or symbol introduced to call attention to the health benefits of the product.

These findings support the idea that information sourced from a trusted, credible and recognizable agency may have a positive impact on the valuation and the likelihood of acceptance of functional foods (Cox et al. 2008); (Hansen et al. 2003); Roe et al. 1999). Given these findings, it may be stated that to define the medium/long-term prospects of the functional products market two factors become crucial: the existence of a proper and clear flow of information between businesses and consumers, enabling sound evaluation of the benefits that may result from the consumption of the products; and full consumer confidence in companies and bodies called to protect consumption. Information that considers the consumer's perspective can help all food and nutrition communicators better connect with consumers and guide them towards informed and healthful food choices. Therefore, more clearly defined policies need to be developed for functional foods to avoid false health claims during the marketing process.

The results of our analysis suggest the need to focus mainly on education campaigns and communication from public authorities: although consumers attribute a high degree of confidence to the information conveyed by public authorities, such information is still scant on a nationwide basis. However, as underlined by Bech-Larsen and Scholderer (2007), such activities require enormous resources and may yield effects only after considerable lengths of time; hence, actors in the food chain and public health administrations will have to join forces to reach critical mass. Finally, given that consumers need to understand the benefits, not the science behind the product (Leathwood et al. 2007), more efforts would seem to be required to improve the clarity of messages in nutrition labels. As indicated by respondents, labels should use less medical-scientific language and seek to highlight more clearly the potential benefits of consuming these products.

Our research also confirmed that, for functional foods manufacturers in Italy to exploit existing market opportunities and target product development and marketing efforts to specific groups, further consumer studies are required. New research avenues should focus on identifying the needs and wants of Italian functional food users and seek to detect the most effective instruments that deliver simple and useful information to the final purchaser. Other interesting results provided by the present study (such as the importance of taste in purchasing a functional food, or consumer interest in a specific logo for such products) would benefit from additional qualitative and quantitative research methods to reinforce the legitimacy of our findings.

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Appendix 1

Table 6. Comparison between cluster averages

Variables[18]	Cluster 1	Cluster 2	Cluster 3	Total	Sig.
Importance of nutritional properties	3.7	4.8	4.3	4.4	.002
Importance of quality marks	2.8	3.5	3.8	3.4	.000
Importance of brand	3.6	2.5	3.3	3.1	.000
Importance of price	4.2	3.1	2.8	3.3	.002
Importance of origin	2.7	3.5	3.7	3.3	.000
Frequency of reading nutrition labels	3.2	3.3	3.7	3.4	.023
Monitoring my health independent of what I eat	3.3	2.9	2.6	2.9	.012
I don't give up the foods I like	3.8	3.5	2.8	3.3	.000
I fear they may have side effects	2.4	3.06	2.2	2.6	.005
Passing trend	2.8	2.4	2.2	2.4	.033
Intended only for those who have health problems	3.3	2.6	2.3	2.8	.001
I do not believe their properties	2.4	2.1	1.9	2.1	.026
I don't always understand but I consume it	2.9	3.6	3.5	3.3	.003
Difficult to find	1.9	3.6	3	2.8	.000
Less tasty	2.04	2.9	1.9	2.2	.018
Limited in range	1.9	4.05	3.6	3.1	.000
Difficult to distinguish	2.33	3.9	3.4	3.2	.000
Incomprehensible labels	2.7	4.05	3	3.3	.000
Clear and simple information	2.5	1.8	3.3	2.5	.000
Truthful and reliable information	2.4	1.9	3.3	2.5	.000
Satisfactory information	2.8	1.9	3.5	2.7	.000
Confusing and contradictory information	3.1	3.8	2.5	3.1	.000

[18] Variables showing significant differences with a probability level of 95%.

Appendix 2

Table 7. Comparison between qualitative variables

Variables		Cluster 1	Cluster 2	Cluster 3	Sig.
Knowledge of functional foods	I know them vaguely	27.3	14.5	10.8	.038
	I know them quite well	21.6	23.3	18.5	
	I know them	32.5	38.6	38.5	
	I know them very well	18.6	23.8	32.2	
Functional food definition	Specific foods for health problems	7.2	8.4	4.1	.016
	Reduce the risk of disease	18.7	20.1	26.1	
	Light foods	12	18.2	5.8	
	Improve the organism functions	40.8	45.2	58.2	
	Do not know	21.3	8.1	5.8	
Number of correct examples	No example	36.5	21.6	13.2	.162
	<2	21	28.4	34.8	
	<4	4.8	4.5	25.3	
	Wrong examples	37.7	45.5	26.5	
Consumption frequency	Once	28.1	16.2	13	.414
	Seldom	55.8	48.2	31.9	
	Often	11.3	29.7	45.3	
	Daily	4.8	5.9	9.8	
Consumption reason	Improve my health	28.4	31.2	16.5	.062
	Strengthen my immune system	19.4	20.3	27.2	
	Prevent cardiovascular diseases	4.3	7.8	9.2	
	Improve gastrointestinal functions	12.7	11.2	30.6	
	Follow nutritionist's advice	4.3	7.6	10.4	
	Curiosity	22	16.4	6.1	
	No specific reason	7.4	5.5	0	

Appendix 3

Table 8. Comparison of socio-demographic variables in clusters

Variables		Cluster 1	Cluster 2	Cluster 3	Sig.
Age group	18-25	4.8	14.9	8.7	.554
	26-35	25.3	24.3	27.5	
	36-45	43.4	39.2	31.9	
	46-55	20.5	13.5	21.7	
	56-65	4.8	5.4	5.8	
	66 - 75	1.2	2.7	4.3	
Education	Master	6.4	7.2	8.5	.032
	Bachelors degree	25.7	26	30.3	
	High school	59.2	60.8	56.4	
	Middle school	6.4	2.7	4.8	
	Other	2.3	3.3	0	
Gender	Men	37.3	32.4	24.6	.244
	Women	62.7	67.6	75.4	
Occupation	Employee	24.8	30.4	34.1	.840
	Self-employed	15.6	11.6	10.4	
	MD/paramedical	4.2	6.2	5.7	
	Housewife	22.9	19.5	25.5	
	Retired	3.8	5.8	6.3	
	Student	16.3	15.2	13.8	
	Other	12.4	9.3	4.2	
Origin	North Italy	32.5	43.2	31.9	.601
	Centre Italy	27.7	23	27.5	
	South Italy	39.8	33.8	40.6	
Specific diet	No	42.1	40.6	49.2	.026
	Yes – health problems	53.1	57.3	42.7	
	Yes- ethical reasons	4.8	2.1	8.1	
Lifestyle	Unhealthy	22.8	18.2	14.4	.256
	Average	63.4	63.2	61.4	
	Very healthy	13.8	18.6	24.2	
Eating habits	Unhealthy	24.5	18.9	15.7	.200
	Fairly healthy	75.5	73	81.4	
	Very healthy	0	8.1	2.9	

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Economic Analysis of Options for Food Aid Policy in Honduras

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Abstract

This research uses data from a nutrition program implemented by Land O' Lakes International Agriculture division through the U.S. Agency for International Development and funded by the Millennium Challenge Account. The combination of foods in this program includes a tortilla, cheese, and milk. The United Nations World Food Programme provides rice and beans in Honduras. The two programs (and their combination) serve as a basis for better understanding the mix of foods in a low cost diet and the food policy options for food aid in Honduras. This research is of interest to managers of agricultural and food firms since they are heavily involved in the supply chain for distribution of US food aid.

Keywords: economics, food policy, Latin America, nutrition

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Introduction

The purpose of this research was to formulate an analysis of alternative food diets for three different family income levels based on four types of schools located in Honduras. Personal interviews were conducted with children, parents, and teachers over the course of two summers. A linear programming model was used to evaluate the economic and nutritional feasibility of four policy options.

The policy options included the provision of milk; a provision of a multi-nutrient bar; a combination of a multi-nutrient bar and milk; and a nutritionally complete diet. All four of these policies increase the supply of nutritious food for children who attend schools. The economic impact was found to be greatest in rural areas using a targeted approach to identify the poorest while working cooperatively with the parents in a nutrition education program.

Background

Between 1960 to 2003, Gardner (2000) shows that Honduras had the second lowest Gross Domestic Product (GDP) relative to 11 other Latin American countries. The United Nations World Food Programme (UNWFP) and United States Agency for International Development (USAID) work through schools to improve nutrition. The objective is to formulate an analysis of alternative food diets for an average Honduran child for three different family income levels based on four types of school locations. The results are used to develop and analyze the feasibility of four policy options available for food aid in Honduras. They include the implementation of school nutrition programs. The first policy option is the provision of ultra-high temperature (UHT) milk ("milk") in the diet. The second policy option is the provision of a multi-nutrient bar. The third policy option is to provide a provision of a multi-nutrient bar and milk. The fourth policy option is the provision of a nutritionally complete diet. All four policies increase food supply and more importantly, increase the supply of nutritious food. Thus, these programs should also help reduce poverty as suggested by Smith and Haddad (2001) and improve Honduras' relatively low agricultural productivity as noted by Gardner (2000).

The research uses data from a nutrition program implemented by Land O' Lakes International Agriculture division through the USAID and funded by the Millennium Challenge Account which is managed by the Millennium Challenge Corporation. The combination of foods in this program includes a tortilla, cheese, and milk and is referred to as the School Nutrition Program (SNP). The UNWFP provides rice and beans in Honduras. The two programs (and their combination) serve as a basis for better understanding the mix of foods in a low cost diet and the food policy options for food aid in Honduras. This research is of interest to managers of agricultural and food firms since they are heavily involved in the supply chain for distribution of U.S. food aid. There was recently a large debate in the United States Congress over the role of U.S. food aid programs. U.S. food aid to Honduras was over $40 million in 2008.

Methodology

Figure 1 is a diagram of the methodology used in this research which has been used by the U.S. Department of Agriculture and other organizations in conducting similar research. The food must

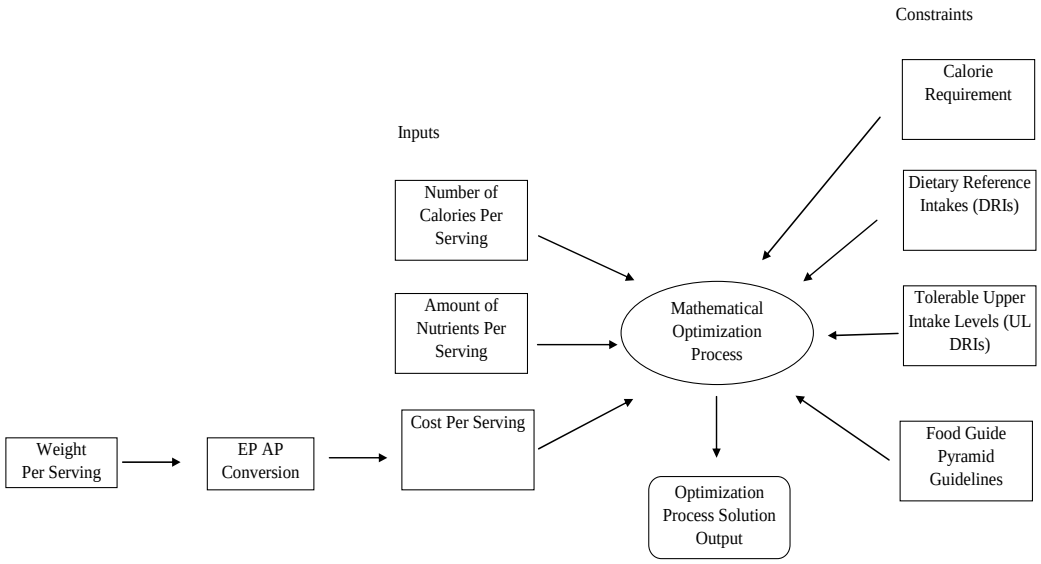

Figure 1. Overview of the methodology used in the model

first be measured into appropriate serving sizes. Then, each serving is weighed in order to know the exact number of grams per serving. A conversion must be used to convert the "as purchased" (AP) weight into "edible portion" (EP) weight. Then it is possible to calculate an accurate cost per serving using these weights. The number of calories and amount of nutrients per serving are provided by the U.S. Department of Agriculture (2006) Nutrient Data Laboratory. The constraints on the model are the dietary reference intakes (DRIs) for calories and nutrients, maximum limits on these nutrients, and the Food Guide Pyramid guidelines.[1] The optimization model generates a solution using these inputs, while meeting the constraints.

The objective function is designed to determine the least cost of a nutritionally adequate human diet. Constraints are used to enable a person to meet certain levels of calories and nutrients which are essential for healthy growth and development. Minimum levels must be met to avoid becoming malnourished, while maximum levels cannot be exceeded because over nourishment can have equally harmful effects. A person cannot consume negative amounts of food; therefore, non-negativity constraints are also necessary.[2] The objective function is:

$$(1)\ \text{Minimize } C = \sum_{i=1}^{n} x_i p_i$$

where C is the daily cost of a diet, p_i is the price of food i (i=*tortillas, rice, . . . , n foods*), and x_i is the number of servings of the ith food. A person must consume food in order to obtain calories for sufficient energy each day. Mathematically, this can be seen as

$$(2)\ \sum_{i=1}^{n} e_i x_i \geq E$$

[1] Stigler (1945) was the first to develop this type of model and applied it to diets developed in 1939 and 1944. Wheat flour, cabbage, spinach, navy beans, and evaporated milk were the optimal low cost foods in the diet.
[2] The Food Guide Pyramid is designed to help people understand the consumption guidelines established by the USDA. The Food Guide Pyramid is designed to represent the five food groups including, grains, vegetables, fruits, dairy and calcium-rich foods, proteins, and fats and oils.

where e_i is the number of calories in each serving of food, and E is a scalar which corresponds to the DRI for calories, based upon age and sex. E is the DRI for Calories established by the U.S. National Academy of Sciences Institute of Medicine (2006) and is equal to 1,742 calories. It is also important a person receive a certain amount of each nutrient each day to meet their DRIs for nutrients. This can be represented as

$$(3) \quad z_j = \sum_{i=1}^{n} h_{ji} x_i \qquad \forall i, j$$

where z_j is the amount of nutrient j (j= *Vitamin A, Vitamin D, . . . , n*) and h_{ji} is a matrix containing the amount of nutrient j in the ith food. This constraint states that the nutrients are all derived from the foods consumed daily per serving.[3] It is important that a person not receive too much of a nutrient as certain nutrients may be harmful to a person's health if consumed in excess. Excessive intake over a period of time may lead to toxicity. The amount of time required for toxicity to occur varies according to the nutrient and the individual. Thus both lower bounds (LB DRIs) and upper bounds (UL DRIs) are needed on nutrient j. This can be seen as

$$(4) \quad l_j \le z_j \le u_j \qquad \forall j$$

where l_j and u_j are the lower and upper bounds on nutrient j. Finally, a person cannot consume a negative amount of food. Consequently, a constraint is needed to ensure that this will happen. This equation is

$$(5) \quad x_j \ge 0 \qquad \forall j.$$

A summary of these variables is shown in Table 1. There is an established DRI for calories; however, an upper bound has not been established. Therefore, no upper bound is built in the model. The model is thus allowed to exceed the lower bound as needed.

Table 1. Definition of variables and scalars in the model

Variable or Scalar	Definition
x_i	Number of servings of food $_i$ where $_i$ =bread, rice, tortillas, spaghetti, cheese, sour cream, milk, yogurt, beef, chicken, pork, beans, eggs, avocados, green pepper, tomato, onion, potato, bananas, papaya, mango, plantains, coffee, Coca-Cola, Churros, multi-nutrient bar
z_j	Number of units of nutrient $_j$, where $_j$ = vitamin A, vitamin D, riboflavin, niacin, vitamin B-12, vitamin B-6, vitamin C, calcium, phosphorus, potassium, iron protein, folate, and zinc.
h_{ji}	Matrix which has the amount of nutrient $_j$ in each food $_i$.
e_i	Amount of energy (measured in calories) in each food $_i$.
p_i	Price of each $_i$ food.
L_j	Lower bound for nutrient $_j$
U_j	Upper bound for nutrient $_j$
E	1742 Calories

[3] This matrix is not reported in this paper (it is a 12 nutrient by 26 food matrix) but can be found in the appendices in Bosse (2006). The data came from the Nutrient Data Laboratory in the U.S. Department of Agriculture's National Agricultural Library at http://www.nal.usda.gov/fnic/foodcomp/search

It is important to know how this model's optimal solution changes when the assumptions are changed. Sensitivity of prices and selected constraints (i.e., calories, nutrients bounds, etc.) are tested by calculating arc elasticities, analyzing sensitivity reports, and creating solver tables. Once the model has been shown to reflect a reasonable representation of the needs of Honduran children, who are the recipients of the existing food aid programs, the model is used to analyze the effects of the four policy options.

Data

Consumption Data Collection

Interviews were done in Honduras with children, parents, and teachers from May to July of 2005. The region chosen for the interviews included the departments of Copan, Santa Barbara, Atlantida, Colon, Yoro, Olancho, Comayagua, Francisco Morazon, and Cortes (western northern and central Honduras). Data collection was conducted in 2005 with the help of the Land O' Lakes DairyLink team in Honduras who was working under a contract with USAID. The selected schools were chosen because they were recipients of the SNP. Some were also recipients of the UNWFP. They represented a broad geographic area with household incomes typical of those being targeted by the program. The geographic region included the very western part of Honduras where poverty and chronic malnutrition is wide-spread with almost 50% of the children exhibiting stunting (2006, 5 and 22).[4] They represent Gallo's "Povericum" or the 39% of the world's labor which is used in agriculture.[5] The more urban regions of San Pedro Sula and Tegucigalpa have malnutrition rates under 15% according to the World Bank (2006).

Schools were categorized into four classifications based on the Land O' Lakes SNP coordinator's recommendations. These were Highly Impoverished Rural, Highly Impoverished Urban, Impoverished Rural, and Impoverished Urban. In the extreme poor and very poor regions of Honduras, a recent assessment by the World Bank (2006, 19) reported that 23% of children ages six to eleven years do not attend school and 91% of children ages twelve to seventeen years of age do not attend school. The impoverished definition used in this research corresponds to the World Bank's poor definition. Thus, Highly Impoverished is analogous to Extreme Poor and Impoverished is analogous to Very Poor.

The total people participating in the interviews in 2005 were 241. This number included 82 parents, 17 teachers, and 142 students. The dietary recall method was used to collect consumption data. When using the dietary recall method, the respondent is asked to recall his or her food consumption during the 24 hours prior to the interview. The data collected included number of meals consumed per day, types of foods consumed, and number of servings per day. The children, parents, and teachers were interviewed separately in Spanish. All surveys were conducted verbally. Pictures and serving sizes of each food shown with a typical person's hand was used to help each respondent choose the correct serving size. The pictures were shown on laptop computers. This was done in order to ensure accuracy when reporting the number of

[4] A person is said to be stunted when they have low height-for-age. A person who is stunted was undernourished at some point during the growth years as a child. This happens because the body has to prioritize. It gives greater priority to the maintenance of vital functions rather than growth.
[5] 39% of the world´s labor force works in field of agriculture, in non OECD countries; which generate only 2.9%of the world GDP. These workers are poor by definition.

servings consumed. Students, parents, and teachers received a bag of Sun-Maid™ raisins (approximate value of $0.50 per bag) for participating in the interviews.

The Land O' Lakes program finished in 2005 and another research partner was identified in Honduras to assist in the research. Escuela Agrícola Panamericana Zamorano in Honduras was interested in the food policy and rural development aspects of the research. The Department of Socioeconomic and Environmental Development at Zamorano agreed to coordinate interviews and assist in data collection in 2006. In July of 2006, additional interviews were conducted with different Honduran parents, teachers, and children. The team visited nine schools from July 6 to July 20. They interviewed 201 people (in Spanish), including 31 parents, 44 teachers, and 126 students. The 2005 interview questions and methodology were used in 2006.

Nutrient Data Collection

Nutrients are the chemicals the body absorbs from food. Thirteen vital nutrients are included in the model: vitamin A, vitamin D, riboflavin, niacin, vitamin B-12, vitamin B-6, vitamin C, calcium, phosphorus, potassium, iron, protein, and folate. All of the recommended l_j and u_j are established by the Institute of Medicine of the U.S. National Academy of Sciences (2006). These are established for the United States and many countries use these as their standards. The precise amount of each nutrient contained in each serving of food was collected from the U.S. Department of Agriculture Agricultural Research Service's Nutrient Data Laboratory (2006). This corresponds to the nutrient matrix h_{ji} in equation (3) in the previous section. The AP to EP conversions were taken from Shugart and Molt (1989).

There is not a significant difference between the nutrient and calorie requirements for a typical girl or boy at eight years of age. Until age 14, males and females have the same nutrient requirements with the exception of calories. Models for this research were run for an eight-year-old male. This particular age and sex combination was chosen because it best suited the average Honduran child surveyed during consumption data collection.

Price Data Collection

Honduras, like many low income countries, does not publish food price data. Therefore, food price data was collected by Supermercado, Junior Barrio Barandillas in San Pedro Sula, Honduras on June 27, 2005 and again on July 9, 2006. Serving sizes were taken from University of Illinois Extension (2007) which is used by food service and homemakers for serving conversions. These data are shown in Table 3. The relative prices of food have not changed significantly over the past five years as the exchange rate of $1 to Lempira, the Honduras currency, has ranged from 17.9 to 19.1 over the 2001 to 2006 time period and the 2005 average currency equivalent of 18.88 lempiras to $1 was used. Honduras has a large amount of income remittances from immigrants working in the United States (estimated at $2 billion by the World Bank in 2004) which has helped stabilize its relative food prices and overall economy.

The price and serving size data were used to create the inputs for the mathematical optimization process. The cost function of equation (1) was minimized subject to the constraints from equations (2) to (5). The food diet generated from the optimization problem was then used to

analyze the four policy options. The optimal food diet is compared against alternative food diets which may be more feasible given income limitations.

Diets Included in the Study

The median diets for each of these school types were determined from the interviews. The median diets were further classified into economical, moderate, and elaborate diets. An economical diet was considered to be the most restricted median diet found, the moderate was slightly less restricted, and the elaborate diet was the least restricted median diet as determined from the consumption data. Each school had different foods in their diets.[6]

Results

The results compare the best feasible diet against the median diets as well as the three existing programs (Land O'Lakes SNP, UNWFP, and combined program) and the policy options.

Comparison of the Diets

Tables 2, 3, and 4 provide the results based on servings, cost and nutrition (see Appendix). Table 2 shows the existing servings provided by the two food aid programs and the combined program. The cost data in the bottom row corresponds to the cost found when these serving sizes are fixed in the model and solved. They provide a baseline to better understand the cost of the policy options. Figure 2 shows how these foods meet the DRIs (see Appendix). Table 3 shows the original prices and the conversions necessary to convert food prices into prices per serving. Table 4 shows the median diets for the representative school and diet combination (impoverished rural school child's economical diet). Column 1 shows the foods which were reported being consumed daily. Column 2 shows the servings of the foods consumed daily while column three shows the servings after the inclusion of the combined program (column 2 in Table 4 plus column 4 in Table 2). The last column in Table 4 shows the best feasible diet found by optimizing the objective function subject to the constraints.

As additional constraints are imposed upon the models, the cost of the best feasible diet bundle increases ($0.33 per day for the existing diet in column 2 in table 4 to $0.92 per day for the optimal diet in column 4 in table 4). This is expected as it will be more costly to meet the additional calorie and nutrient requirements. A food not included in the diet is not necessarily less wholesome; it simply supplies those nutrients at a higher cost than another food in the mix. As nutrient-dense, low-cost foods are added to the matrix, total cost of the optimal food bundle decreases. The optimization model recognizes nutrient-dense, low-cost foods as being optimal foods for the optimal mix. It should be noted that while this is the optimal solution for this model, this particular diet was never observed in any of the interviews and represents a significant increase in daily nutrition that may not be attainable given the economic conditions of the regions where the research was conducted. In addition, some foods in this diet, such as potatoes may not be readily available.

[6] Thus, there are 12 different possible combinations of diets (four school types multiplied by three types of diets). The research in this paper reports only one which was the most common diet found in the interviews. The results for the other combinations can be found in Bosse (2006).

Table 2. Number of servings and daily cost of foods provided by Land O' Lakes School Nutrition Program, United Nations World Food Program, and the combined programs

	Land O' Lakes School Nutrition Program	United Nations World Food Program	Land O' Lakes and World Food Program Combined
Name of Food	Number of Servings of Food (x_i)		
Bread			
Rice		1	1
Tortillas	1		1
Spaghetti			
Cheese	1		1
Crema			
Milk	1		1
Yogurt			
Beef			
Chicken			
Pork			
Beans		1	1
Eggs			
Avocados			
Green Pepper			
Tomato			
Onion			
Potato			
Bananas			
Papaya			
Mango			
Plantains			
Coffee			
Coca-Cola			
Churros			
Multi-Nutrient Bar	1		1
Daily Cost per Child	$0.45	$0.06	$0.51

Table 3. Prices, quantities, serving size, and cost per serving for selected food products data

Food (i)	Brand of the sample	Price (L)	AP	CR	EP (g)	Serving Size (g)	Number of Servings	Cost Per Serving (L)	Cost per Serving $
Bread	Superman semita	14.6	480	1	480	30	16	0.91	0.05
Rice	Progresso Arroz[a]	4.25	350	3.5	1225	93	13.17	0.32	0.02
Tortillas	Tortillas Maya	4.49	550	1	550	25	22	0.2	0.01
Spaghetti	Mi Pasta/Sauce	8.9	313.4	2.5	783.5	125	6.27	1.42	0.07
Cheese	Leyde Quesillo	37	454	1	454	28.35	16.01	2.31	0.12
Sour Cream	Leyde Crema	8.75	227	1	227	4.72	48.04	0.18	0.01
Milk	Sula Leche	10.8	946.06	1	946.06	236.59	4	2.7	0.14
Yogurt	Yoplait	9.99	125	1	125	245	0.51	19.58	1.03
Beef	Carne-bistec	39.8	453.59	0.7	317.51	85	3.74	10.65	0.56
Chicken	Pollo	31.25	1133.98	0.5	566.99	85	6.67	4.68	0.25
Pork	Carne de cerdo	25	453.59	0.46	208.65	85	2.45	10.18	0.54
Beans	Frijol Cosecha	39.6	1816	2.38	4313	88.5	48.73	0.81	0.04
Eggs	Mama Gallina Huevos	22.99	930	1	930	62	15	1.53	0.08
Avocado	Fresh	4.99	202	0.67	135.34	75	1.8	2.77	0.15
Sweet Peppers	Fresh	8.6	145.12	0.73	105.94	70	1.51	5.68	0.3
Tomatoes	Fresh	5.93	299.37	0.9	269.43	90	2.99	1.98	0.1
Onion	Fresh	5.72	589.67	0.78	459.94	80	5.75	0.99	0.05
Potatoes	Fresh	5.72	589.67	0.74	436.36	78	5.59	1.02	0.05
Bananas	Fresh	1.65	250.77	0.65	163	59	2.76	0.6	0.03
Papaya	Fresh	23.14	870	0.62	539.4	70	7.71	3	0.16
Mango	Fresh	4.5	420	0.69	289.8	82.5	3.51	1.28	0.07
Plantains	Fresh	2.99	330	0.66	217.8	77	2.83	1.06	0.06
Coffee	Oro Café	26.6	453.59	38.61	17512.61	177.75	98.52	0.27	0.01
Coca-Cola	Coca-Cola	17.5	2076.18	1	2076.18	184	11.28	1.55	0.08
Churros	Churros	1	28.35	1	28.35	28.35	1	1	0.05
Multi-Nutrient Bar	Proassa	3.39	1	1	20	1	1	3.39	0.18

[a] Rice is an example used to explain this table. Rice is the food in column one. Progresso Arroz is the brand of rice purchased at the supermercado. The entire package cost 4.25 Lempiras (L) and had a total weight (AP) of 350 grams. Foods weigh different amounts when they are purchased (as purchased AP) and when they are ready to consume (edible portion EP). Therefore, an established conversion must be used to calculate the EP. The conversion ratio (CR) was 3.5 which leads to the edible portion (EP) weighing 1225 grams (3.5*350 g or grams). A serving of rice (1/2 cup) weighs 93 grams. The number of servings in the container are 13.17 (1225 grams divided by 93 grams), which makes the cost per serving 0.32 L or approximately 0.02 US dollars.

Table 4. Comparison of the Food $_i$ and cost for the food programs and the Optimal Diet of foods for the Impoverished Rural School Economical Median Diet

Food *i*	Dietary Food Recall Surveys[a]	Dietary Food Recall Surveys & Land O' Lakes & World Food Program School Nutrition Programs[b]	Optimal Diet[c]
Bread			
Rice	2	3	4.05
Tortillas		1	2.83
Spaghetti			1.16
Cheese	1	2	
Crema			
Milk		1	2.04
Yogurt			
Beef			
Chicken			
Pork			
Beans	4	5	1.31
Eggs			0.69
Avocados			
Green Pepper			
Tomato			
Onion			
Potato			3
Bananas			
Papaya			
Mango			
Plantains			2.93
Coffee			
Coca-Cola			
Churros			
Multi-Nutrient Bar			0.04
Cost	$0.33	$0.66	$0.92

[a]This diet is the number of servings found in the impoverished rural economical median diet determined from the surveys.
[b]This diet was received by the students who attended a school which received the Land O'Lakes and UNWFP SNPs in addition to their regular diet.
[c]This diet is the number of servings found in the optimal low-cost diet.

Table 5 displays the percentage of DRIs met by the impoverished rural economical diet, the food programs, and the best feasible diet. Analysis of the data shows that the students are better nourished with the programs than they are without the programs. This is determined by the amount of each of the DRIs met by the diets evaluated. The best feasible diet mix would be ideal as it meets all DRIs without providing harmful excess of the nutrients.

Table 5. Comparison of the DRIs received from the Impoverished Rural Economical Median Diet, the food programs, and the Optimal Diet

Nutrient	Dietary Food Recall Surveys[a]	Dietary Food Recall Surveys & Land O'Lakes & World Food Program School Nutrition Programs[b]	Optimal Diet[c]
Energy	0.45	0.76	1.00
Vitamin A, RAE	0.04	0.24	1.00
Vitamin D	0.00	0.47	1.02
Riboflavin	0.50	1.46	2.56
Niacin	0.36	0.55	1.88
Vitamin B-12	0.24	1.34	2.12
Vitamin B-6	0.18	0.52	2.89
Vitamin C	0.17	0.21	1.74
Calcium	0.37	1.02	1.00
Phosphorus	1.39	2.55	2.45
Potassium	0.40	0.60	1.00
Iron	1.09	1.43	1.00
Protein	2.19	3.52	2.70
Folate	2.33	3.13	2.00
Zinc	1.09	1.76	1.53
UL Vitamin A, RAE	0.02	0.11	0.44
UL Vitamin D	0.00	0.05	0.10
UL Niacin	0.19	0.29	1.00
UL Vitamin B-6	0.00	0.01	0.04
UL Vitamin C	0.01	0.01	0.07
UL Calcium	0.12	0.33	0.32
UL Phosphorus	0.23	0.43	0.41
UL Iron	0.27	0.36	0.25
UL Folate	1.17	1.56	1.00
UL Zinc	0.45	0.73	0.64

[a]This diet is the number of servings found in the impoverished rural economical median diet determined from the surveys. For example, the DRI for Energy is 0.45 or 45% of the recommended DRI which is 100%.
[b]This diet was received by the students who attended a school which received the Land O'Lakes and UNWFP SNPs in addition to their regular diet.
[c]This diet is the number of servings found in the optimal low-cost diet.

Sensitivity of the Model to Key Variables

Previous literature states different numbers for the recommended intake for calories. For example the American Heart Association (2006) recommends 1400 calories for a male four to eight years of age and Foster and Leathers (1992) recommends 2,400 calories for a seven to 10-year-old child. We imposed this figure on our results. Due to the discrepancies in the literature regarding the number of calories required for growth and development and the fact that the average Honduran child is much more active than an average child in the United States because

of their work in agriculture, household duties, and active leisure time, a solver table was generated to look at the impact of increasing this calorie constraint by 10, 20, 30, 40, and 50 percent. The results are reported in Table 6. The results of the solver table show that bread, cheese, sour cream, yogurt, beef, chicken, pork, eggs, avocados, green pepper, tomatoes, onions, potatoes, bananas, papaya, mango, coffee, Coca-Cola®, and Churros® will not enter the optimal mix.[7] The number of servings of rice, tortillas, and plantains increase as the calories required increase. The number of servings of spaghetti, milk, and beans decrease as the calories required increase. As expected, the cost of the bundle increases as the required calories increase. However, the percentage increase in the cost of the mix is less relative to the percentage increase in calories.

Table 6. Impact on the Optimal Diet when increasing the number of calories required

Percentage increased	Calories[a]	Rice[b]	Tortillas[b]	Spaghetti[b]	Milk[b]	Beans[b]	Plantains[b]	Multi-Nutrient Bar[b]	Cost of Diet[c]
10%	1916	6.38	2.49	1.4	2.19	1.35	4.61	0.05	0.88
20%	2090	7.78	2.84	1.26	2.15	1.23	4.82	0.05	0.89
30%	2264	9.18	3.18	1.11	2.1	1.1	5.03	0.05	0.91
40%	2438	10.59	3.53	0.97	2.06	0.98	5.24	0.05	0.93
50%	2613	12	3.82	0.8	2.03	0.87	5.46	0.05	0.95

[a]Measured in calories.
[b]Measured as quantities.
[c]Measured in dollars.

Arc elasticities were calculated for a 1% change above and below the base cost. The elasticities of cost with respect to the price of all the foods are relatively small.[8] The elasticities indicate that a 1% change in food prices results in a less than 1% increase in costs. These results suggest that small changes in the prices of various foods cause smaller changes in the cost of the diet. Thus, even though prices may differ the model's solutions are not likely to change significantly.

Analysis of the Policy Options

In order to be feasible, food aid policies should adhere to the following criteria. They should follow nutritional guidelines, be compatible with cultural consumption habits, have sufficient shelf lives, and consider ease of distribution and preparation. The best feasible diet not only meets the DRIs without reaching levels of toxicity, it also provides the child with a variety of grains, vegetables, fruits, milk products, meat and meat alternates. Additionally, it limits the amount of fats, oils, and sweets. To determine which foods are reasonable recommendations for policy options based upon nutrition, (e.g., provision within school nutrition programs) the foods which are selected by the model for the optimal bundles are reviewed. Rice, tortillas, spaghetti, milk, beans, eggs, potatoes, plantains, and the multi-nutrient bar were selected by the model for at least one of the optimal diets. This indicates that these are low-cost, nutrient-dense food and are reasonable foods to consider in policy implementation. The foods contained in the median diets are very similar to the foods included in the diet generated by the optimization model. A

[7] These arc elasticities can be found in Bosse (2006).
[8] This is a brand of chips similar to Cheetos. They are frequently sold to students during their lunch period.

reasonable conclusion is that the foods in the optimal diet would, therefore, coincide with cultural consumption habits.

To further evaluate the reasonableness of policy recommendations, the foods are also analyzed for shelf life longevity. Shelf lives were taken from Roberts and Graham (2006). When considering policy options in Honduras, lack of refrigeration is an issue. The 2006 survey data shows that 69% of the parents did not have a refrigerator. Any food that is not shelf stable would not be a reasonable recommendation. The reported shelf lives indicate that spaghetti, multi-nutrient bars, rice, milk, beans, Churros®, and coffee are reasonable components in a school nutrition program. Since neither Churros® nor coffee ever entered an optimal solution, they were eliminated from possible policy recommendations. The resulting foods are nutritious, coincide with the culture consumption habits, and have extended shelf lives. Thus, spaghetti, multi-nutrient bar, rice, milk, and beans are considered potential foods for food aid policy.

Infrastructure within Honduras is lacking. Therefore, transportation of food to the schools could be challenging. This would especially be true in rural areas. Electricity is not readily available which hinders refrigerated storage. Milk and the multi-nutrient bar were the only two foods of the reasonable food recommendations that do not require energy for cooking or refrigeration. This feature would greatly increase the ease of distribution to the students within the schools. Both milk and the multi-nutrient bar can be produced in a variety of flavors. They can also be produced within Honduras in order to utilize local commodities, fruit, and labor.

Due to the nutrient-dense, low-cost characteristics, the ease of distribution, and the lengthy shelf lives, both milk and a multi-nutrient bar are considered reasonable food policy options.[9] Solver tables were used to analyze how price changes for milk and the multi-nutrient bar impact the best feasible diet mix selected by the model. Bread, sour cream, yogurt, beef, chicken, pork, avocados, tomatoes, papaya, mango, Coca-Cola®, and Churros® never enter the optimal solution regardless of price changes in milk or the multi-nutrient bar. This shows that these are not low-cost, nutrient-dense foods.

When a solver table was run for the price of milk, if milk could be obtained for free, the model would select 6.27 servings of milk per day in the best feasible diet mix. As the price of milk increases, the number of servings in the optimal mix steadily decreases. A partial serving of milk stays in the mix regardless of price even if one serving costs $100. This shows that milk is vital for achieving the appropriate amounts of nutrients, given these choices of foods. Since the model always factors in milk, the cost of the mix increases as the cost of a serving of milk increases. Bread, cheese, sour cream, yogurt, beef, chicken, pork, avocados, green pepper, tomatoes, onions, potatoes, bananas, papaya, mango, coffee, Coca-Cola®, and Churros® never entered the optimal mix.

If the price of the multi-nutrient bar increases to $0.28 cents per serving, the model removes the bar from the optimal mix. Regardless of how inexpensive the bar becomes, the model never selects more than 0.05 servings of the bar. This is due to the fact that the consumption of this particular bar would violate an UL DRI. This could lead to toxicity over a period of time. Thus the model was not allowed to exceed these upper bounds.

[9] The multi-nutrient bar analyzed is a product of a company in Guatemala. Similar multi-nutrient bar are distributed by various aid programs around the world.

Table 7. Respective mix and cost for Four Policy Options

	Policy Option			
	#1 Milk	*#2 Multi-Nutrient Bar*	*#3 Milk and Multi-Nutrient Bar*	*#4 Optimal Food Mix*
Food (i)				*Number of Servings of Food (x_i)*
Bread				
Rice				4.05
Tortillas				2.83
Spaghetti				1.16
Cheese				
Crema				
Milk	1		1	2.04
Yogurt				
Beef				
Chicken				
Pork				
Beans				1.31
Eggs				0.69
Avocados				
Green Pepper				
Tomato				
Onion				
Potato				3
Bananas				
Papaya				
Mango				
Plantains				2.93
Coffee				
Coca-Cola				
Churros				
Multi-Nutrient Bar		1	1	0.04
Daily Cost per Child	$0.14	$0.18	$0.32	$0.92
Annual Cost per Child	$52.05	$65.42	$117.47	$336.43

Cost of the Policy Options

By fixing the servings of the policy options in the model, the costs (Table 7) and DRIs (Figure 3) can be calculated. The policies vary in effectiveness and cost. Nutrition programs can be either supplemental, meaning they fulfill part of the DRIs for nutrients or calories or they can be nutritionally complete, meeting 100% of the DRIs for nutrients and calories. Policy options 1 through 3 are supplemental nutrition programs while policy 4 is a nutritionally complete nutrition program.

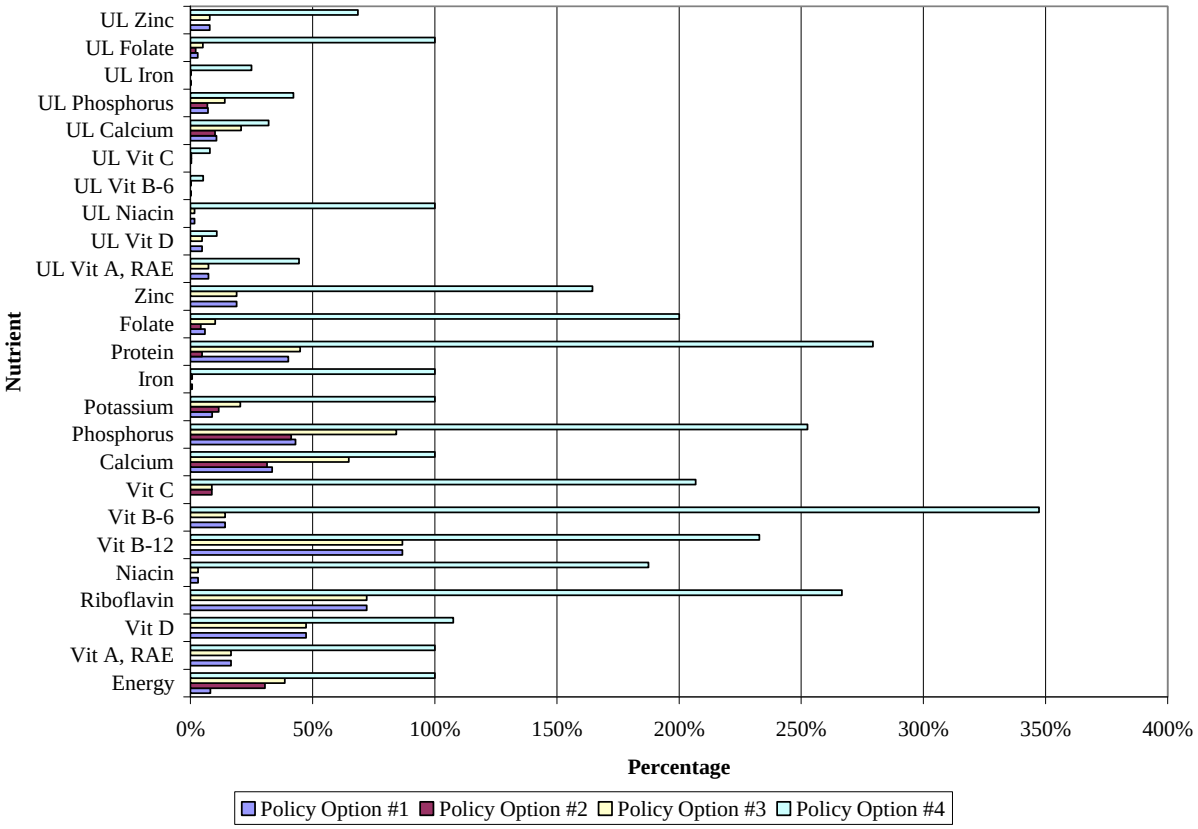

Figure 3. Percentage of dietary reference intakes received from the Four Policy Options

The first policy option analyzed is the provision of milk. Milk appeared in the majority of the optimal diets. It is both nutrient-dense and easily distributed with the ultra-high temperature technology. The second policy option tested in this model is the provision of a multi-nutrient bar. The specific multi-nutrient bar evaluated in this paper would not be ideal in its current form due to issues with toxicity. None of the other bars evaluated exceed the toxicity levels; therefore, it is assumed that modification is possible. If modified, the multi-nutrient bar could be ideal as it could be a low-cost solution to nutrient and calorie deficiencies in addition to eliminating parasites. During consumption data collection, it became clear that elimination of parasites was key to the success of any SNP.[10]

The third policy option is the provision of both milk and the multi-nutrient bar. These are an excellent combination both in terms of nutrition and convenience. The fourth policy option is the provision of the optimal food bundle. This would provide the children with a nutritionally complete diet. This could be divided into two or three meals during the school day or taken home.

[10] According to numerous statements in the World Food Programme publication (2006), parasites are a common health issue in low income countries. Parasites affect the absorption of nutrients and negatively impact the overall health of the individual. Land O' Lakes ran tests prior to the implementation of their program and found that 95 percent of the children tested had parasites. Due to the antiparasitic nature of the multi-nutrient bar, it is assumed that parasites were eliminated after the implementation of the program; however, results from post-implementation tests were not reported.

Discussion of Overall Economic Analysis

As discussed previously, malnutrition while prevalent throughout Honduras, is more widespread in rural regions than in urban areas. Because the program described here is carried out in schools, its impact would be greatest in rural regions especially in the departments located in western Honduras (e.g., Copan, Ocotepeque, Lempira, and Santa Barbara). In particular, its impact would be greatest for children in the six to 11 years of age category who are enrolled in school and lowest for children under the age of six who are not enrolled in school. Kain, Uauy, and Taibo (2002) note that, as a nutrition program becomes more important to the overall household food budget, parents are more inclined to ensure that their children are enrolled in school. Kennedy (1999) suggests that the net benefits of a school nutrition program increase if the benefits are found to be a larger share of the household budget.

A targeting approach could be used for this school nutrition program similar to what is done in Chile's School Feeding Program (2002). A committee at each school determines which children receive different types of foods based on calories. Children in rural areas where malnutrition was greatest, such as the rural departments in western Honduras, could receive quantities of foods in the third or fourth policy option whereas children in urban areas where malnutrition was less severe could receive different quantities of foods. Such a targeting approach could maximize the overall economic impact of the school nutrition program.

Furthermore, including nutrition education for parents of the children receiving the school nutrition program could help increase the impact of the program. Beretta et al. (1998) found a positive impact on the overall household nutrition from such programs. Such an education program was observed in some but not all of the schools where the interviews were conducted for this research. Duran, Caballero, and Onis (2006) found a positive correlation between stunting and underweight preschool children in Central America but also noted that obesity was increasing in this region.

The World Bank's Poverty Assessment Report (2006, p.59) found that Honduras' public food programs and rural development programs were appropriately targeted at high-poverty and considered pro-poor (e.g., the poor receive more of the program benefits than non-poor students) programs. This would suggest that a school nutrition program such as the one described in this research could be administered by the government which might help lower costs in the long-run.

Conclusions

The use of nutrition being used in food aid programs is becoming an important topic for agribusiness and food business firms especially in countries such as Honduras. Former President Bush proposed to allow food aid recipients to purchase up to 25% of their food from domestic food suppliers rather than US agribusiness companies in an effort to improve nutrition. This was controversial. President Obama has not taken up this issue yet but there is a bill in the US Congress to consider a similar program. It is apparent that agribusiness firms involved in food aid will need to recognize the role of nutrition in food aid programs in the future.

Cost increases when moving from supplemental nutrition programs to nutritionally complete programs. Improvement in nutrition is correlated with the price of the program. The choice of the most suitable option is dependent upon the condition of the children in the school and the available financial support. There is a strong relationship between malnutrition, and education, productivity and poverty. The UNWFP has begun micronutrient fortification in its programs (2006). Other organizations engaged in nutrition programs can learn from the UNWFP in southern Africa and the Indian subcontinent where it worked with local processors in microfortification. A nutrition education program is vital in accompanying SNP to help provide education on the nutrition paradox. Microfortification can help improve the nutritional content of SNPs. Food aid should reflect nutrition if the policy goal is to reduce malnutrition and improve productivity, all of which will help reduce poverty.

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Bio Energy Entry Timing from a Resource Based View and Organizational Ecology Perspective

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Abstract

Recent changes in U.S. energy policy have prompted the growth of the bio energy market. The ability to quickly enter and respond to the opportunities of this market is critical to an agribusiness' success. Understanding entry into this rapidly growing bio energy market, however, is not well understood. In drawing on management theories of the Resource Based View (RBV) and that of Organizational Ecology, this study develops a conceptual and dynamic programming model to explain the entry behaviors of different types of bio energy businesses. A contribution of this study is it demonstrates that bio energy entry decisions emphasize a basic trade-off involving gains from a commitment to specialized, and correspondingly higher cost assets, and gains from remaining flexible with lower levels of fixed and less specific assets. This commitment-flexibility trade-off not only underlies entry, but such a trade-off is argued to be influenced by the population and uncertain conditions of the market. Importantly our work also sheds light on the implicit risks of the ethanol industry, and in part explains how corn-based dry mills and cellulosic-ethanol conversion technologies may be ideal depending on the type of market conditions upon entry.

Keywords: management theory, resource based view, bio fuels, ethanol, and organizational ecology entry timing.

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Introduction

Through various considerations relating to the U.S. Clean Air Act, rising energy prices, increasing green house gas emissions, and heightened concerns for national security, U.S. energy policy has focused its efforts on reducing its energy dependence from foreign supplies. Such a policy environment has contributed to a significant growth in the U.S. production of ethanol from 175 million gallons in 1980 to 4.85 billion gallons in 2006 (Rendleman and Shapouri, 2007); (Renewable Fuels Association 2008). Furthermore, five year forecasts made in 2007 predicted ethanol supply to exceed 7.5 billion gallons before 2012 (Mosier 2007). These estimates are already dated as U.S. supply has already breached 10 billion gallons in 2009 and is expected to rise substantially if the gasoline blend level is increased by 50% (RFA 2010). These market conditions have subsequently attracted the entry of many agri- and bio-related businesses. Ethanol plants alone have increased from 50 in 1999 to 170 in 2009 (Renewable Fuels Association 2009).

With this increasing growth and entry into the ethanol market, a basic challenge facing managers and investors is knowing when and how to enter this dynamic sector. On the question of when, earlier entrants into ethanol processing had gained significant first mover advantages from not only more favorable processing margins, but it also yielded pre-emptory benefits of lower construction and facility operation costs (Hurt, et al. 2006). While, later entrants face higher corn prices, higher construction costs, and, in particular, uncertainty about policy commitments to bio fuels. For instance, U.S. policy makers have questioned the use of corn for fuel and have contemplated the importation of lower cost sugarcane-based ethanol from Brazil. Enacted policy could thereby undermine the continued profitability of the corn-based ethanol market; causing pause for entry into the industry.

The emergence of alternative ethanol technologies also complicates the business environment for bio fuels. For example, there may be second mover advantages for firms to enter directly into second generation technologies, such as cellulosic. Relative to corn dry milling, cellulosic models are viewed as a more environmental friendly technology. They use a feedstock that does not directly compete for food production, has the potential to yield more ethanol per acre, and is thought to have a more favorable carbon footprint.

As the industry deals with the issue of when and how to enter the ethanol sector, management theories offer insights into this entry problem. One theory of management is the Resource Based View (RBV). It finds specialized assets create an incentive to enter early (King and Tucci 2002); (Mitchell 1989, 1991). This is because although specialized assets can yield a firm a differential or efficiency advantage over rivals (Lee et al., 2000; (Ghemawat and Del Sol 1998); (Mitchell 1989, 1991), the returns from such specialized are “eventually” imitated or replicated by new entrants (Lee et al., 2000); (Ghemawat and Del Sol 1998); (Mitchell 1989, 1991), Hence, specialized assets create an incentive to enter so as to gain first move advantage in securing the value of such assets (King and Tucci, 2001); (Mitchell, 1989,1991). For instance, empirical studies have found early entry can increase with the presence of specialized assets, such as in the U.S. Medical Diagnostic Imaging Industry (e.g., Mitchell, 1989, 1991). We explore in this research how this line of RBV reasoning although useful to understanding other industries, may not be applicable to the case of ethanol. This is because new entrants that produce corn-based

ethanol by in large do not employ specialized assets, while the later entrants employing second generation cellulosic technologies do. This is because amongst other factors involving logistics, pretreatment activities etc, cellulose conversion to fermentable sugars is significantly more complex, and requires substantial R&D investments, either directly or indirectly, in specialized enzymes not used for corn or sugarcane.

Alternatively, theory from Organizational Ecology holds more promise to explaining the bio energy entry problem. Critics have maintained, and we find as well, that the firm level focus of the RBV leads to insufficient attention to the conditions of the market (e.g., Priem and Butler 2001). Organizational Ecology holds that in order to remain nimble and adaptive, the uncertainties associated with the emergence of new industries, bio energy in our case, require firms to not over invest in specialized assets. Such uncertainties however evolve with industry development and therefore different firm typologies are required to compete and survive at different stages of industry growth. We explore this theory and juxtapose it with the RBV within a dynamic simulation model of business entry and survival within the bio energy sector.

The objective of this study is to thereby integrate the specialized asset arguments of the RBV with the typologies and market level focus of Organizational Ecology. Through this integration, this study introduces a conceptual and analytical model that helps managers, investors, and analysts assess the entry decisions, especially as it relates to the dry milling and cellulosic conversion technologies of the ethanol market. This application to the bio energy sector also provides a novel context to advance the theoretical integration of RBV and Organizational Ecology perspectives to understanding a firm's entry decisions. Specifically, in this conceptual model, our contribution is that we demonstrate a bio energy firm's entry decisions depend on a basic trade-off between gains from a commitment to specialized, and correspondingly higher cost assets and gains from remaining flexible with lower levels of fixed and less specific assets. This commitment-flexibility trade-off not only underlies entry, but such a trade-off is argued to be influenced by the population and uncertain conditions of the market. Importantly our work also sheds light on the implicit risks of the ethanol industry, and in part explains how corn-based dry mills and cellulosic-ethanol conversion technologies may be ideal depending on the type of market conditions upon entry. To explore the implications of this basic trade-off for both managers and investors, a dynamic programming (DP) model is constructed that jointly accounts for this flexibility-commitment tradeoff and the market dynamics of the ethanol market.

In the development of this study's theoretical and simulation model, it is important to recognize that such a model is based on the authors' "best knowledge to date" of the ethanol industry. In particular, as the ethanol industry is a relatively young industry, much remains unknown and further analysis is needed as better information is developed. Hence, as understanding of this industry develops, our assumptions of this model will likely change and thus would need to re-evaluate the conclusions of our model (e.g. McGrath and MacMillan 2000). Our observations of this industry and the subsequent assumptions used in the development of our model thereby reflect but one possible view of the ethanol industry. Nevertheless, in spite of the changing and highly uncertain nature of this industry, we believe our study offers an "experimental" approach – a novel theoretical and simulation approach- that can help better understand some of the key risks factors impacting bio energy entry. Such an approach follows a "disciplined entrepreneurship" approach ascribed by Sull (2004) in which reduction of uncertainty can arise from not only the "experimentation of something new" but in doing so help identify the key

variables that influence their possible payoffs (see also McGrath and MacMillan, 2000). The study's theoretical and empirical model is developed with this spirit in mind in which the integration of the RBV and Organizational Ecology perspectives into a DP context not only offers a unique approach to understanding ethanol entry decisions, but in doing so identify new variables of interest for manager and investors to consider when evaluating their bio-energy firm's possible payoffs.

Conceptual Model

Model Assumptions and Entry Characteristics of the Ethanol Industry

Some key assumptions and definitions are thereby first outlined before reviewing the associated literature. As the focus of this study is on the firm's entry into the ethanol market, this study assumes that the bio energy firm only produces ethanol fuel. This study's setting is stylized as we assume first generation ethanol conversion technologies only involve dry milling and second generation technologies involve cellulosic. Although there are numerous other possible forms of bio-conversion technologies, such as algae, entry into the ethanol market has been largely fueled by debates between these two technologies (e.g. McAloon et al. 2000); (Mosier 2007); (Robertson et al. 2000). Furthermore, this study does not examine wet milling technologies. Wet milling technologies can be used to process corn into ethanol as well as many other non ethanol products, such as high fructose corn syrup, corn oil, lysine, corn meal, plastics, and dyes. This study focuses only on dry milling technologies because relative to wet milling, it remains as the dominant ethanol conversion technology for new entrants due to its lower capital costs (Dale and Tyner 2006). Given these assumption, we examine the entry arguments underlying the RBV and Organizational ecology.

A basic assertion of the RBV is that a firm's performance or profitability stems from the characteristics of its resources. In terms of dynamic entry decisions, specialized assets are of particular interest to the RBV. The RBV argues that since specialized assets promote efficiency, specialized assets offer a firm a differential or efficiency advantage over rivals (Lee et al., 2000; (Ghemawat and Del Sol 1998); (Mitchell 1989, 1991). However, as specialized assets can "eventually" be imitated or replicated by new entrants (Lee et al., 2000); (Ghemawat and Del Sol 1998); (Mitchell 1989, 1991), specialized assets create an incentive to enter early because early entry enables a firm to gain a "head start" in securing the value of such assets (King and Tucci 2002); Mitchell, 1989, 1991). In the context of the ethanol market and as argued further, this RBV explanation suggests firms with specialized assets, such as cellulosic, should enter quickly. Waiting exposes the underlying technology to competitive imitation and thus eroding the economic rents associated with the investments in the specialized technology (i.e. development of feedstock specific cellulosic enzymes). This also suggests that firms with less specific or flexible assets, such as dry milling, do not face such risks from entering early.

This RBV logic, however, does not fit well with the market entry of first generation dry mill technologies. Entry into ethanol in the late 1990s was broad and rapid with few technological barriers to entry (Renewable Fuels Association 2004). As dry mill technologies were not specific, but available to all, the lower capital requirements of this non-specialized technology allowed for easy entry. This ease of entry subsequently led to a rapid increase in production

capacity. While, as the second-generation technology, cellulosic involves significantly more specialized and as a result higher cost assets, cellulosic models have been adopted at a much slower pace. Hence, although the RBV provides some direction for explaining firm entry, the specific technology entry argument appears inconsistent or incomplete for explaining this pattern of entry in the U.S. ethanol industry.

Such inconsistencies can be attributed to limitations of the RBV. As the RBV has been criticized for its lack of attention to market conditions (Priem and Butler, 2001), entry timing research has called for a greater integration of the logic of the RBV with Organizational Ecology (Lieberman and Montgomery 1998). This is because Organizational Ecology argues that market conditions not only have a decisive influence on the entry and survival of firms, but also different stages of market development can have a distinct influence on the survival of different types of firms. For instance, during the early stages of market development, the market is commonly characterized by a high level of uncertainty and a low degree of competition (Lambkin and Day 1989). During this stage, Organizational Ecology argues that the market favors the entry and survival of flexible businesses because these firms, termed as R types, are suited to capitalizing on the emerging opportunities of early market development (Lambkin and Day 1989). Yet, as markets mature with greater certainty and competition, these market conditions favor the entry and survival of more efficient businesses characterized by K types. As a result, a shortcoming of RBV explanations is that entry decisions are not only influenced by a firm's specialized assets, but can also be influenced by the typologies and market conditions described by Organizational Ecology. However, absent in Organizational Ecology theory is it fails to provide sufficient attention to the specialized assets ascribed by the RBV. Hence, in order to develop an integrated RBV and Organizational ecology model of bio energy firm entry, the nature of a bio energy firm's specialized assets is explained in the context of the market conditions ascribed by Organizational Ecology.

Resource Based View Perspective on Entry Order: Specialized Assets

To advance this development, specialized assets are defined by a commitment to a course of action that is costly to reverse (Ghemawat and Del Sol 1998: 28). In other words, specialized assets involve significant investments upon entry and thus involve a high cost of abandonment (Ghemawat and Del. Sol 1998). In a bio energy context, dry milling firms generally face a lower commitment of resources and are associated with a lower degree of asset specificity than cellulosic. For instance, the capital cost for a typical dry mill ethanol plant is about $1 per gallon of capacity while cellulosic ethanol has capital costs 400 times greater (Renewable Fuels Association 2004); (McDermott 2009). While, more conservative estimates have found that second generation cellulosic production of ethanol from wood chips would still require $5 of capital per gallon of ethanol capacity (Mascoma Corp. 2008). Such differences in cost structure stem from bio-chemical reasons because dry milling technologies that convert starch are significantly simpler than those converting cellulose. While, cellulose conversion to fermentable sugars is significantly more complex, and requires substantial R&D investments, either directly or indirectly, in specialized enzymes not used for corn or sugarcane. Furthermore, dry milling technologies also have a long history producing industrial and food grade alcohols which has benefitted from learning curve and scale related cost efficiencies. While cellulosic is a second generation technology and has yet to be fully commercialized and thus does not benefit from the

specialized efficiencies of dry milling. Lastly, as corn is the primary feedstock for dry milling, the transportation and storage of corn can be supported by existing assets of the market. On the other hand the primary feedstock for cellulosic plants, agricultural, industrial, and municipal wastes require novel collection logistic, storage, and pre-processing configurations and specific investments (Goldsmith et al. 2009). In fact, collection logistic, storage and pre-processing treatments tend to designed for the specific feedstock being used. For instance, due to the greater composition of liquids in municipal waste, the transportation of municipal waste requires different logistics, handling and pre-treatments than that of wood chips. As a result of these factors, the dry miller faces lower entry and abandonment costs due to a lower degree of asset specialization.

This concept of specialized assets not only underscores differences in commitment between that of the dry millers and cellulosic, but the concept also exhibits heterogeneous and imperfectly immobile properties that can impact a firm's entry decision. Specialized assets are heterogeneous resources in so far as they provide an efficiency differential between the firm and that of its rivals (Isobe et al. 2000); (Peteraf 1993); (Wernerfelt 1984). Hence, although specialized assets may require greater investment, they are a source of competitive advantage (Ghemawat and Del Sol 1998); (Peteraf 1993). For instance, though cellulosic faces higher capital requirements and fixed costs, there may be economies not present in dry milling. For example, cellulosic's reliance on agricultural, forestry, or municipal solid waste – as a primary feedstock- would result in lower feedstock costs than dry millers (Lin and Tanaka 2006). Such cost advantages are important as feedstock costs are more than 60% of operating expenses.

Finally RBV argues that firms with specialized assets should enter earlier, not later as in the case of cellulosic models. Early entry promotes learning curve effects that reinforce the efficiencies of a firm's specialized assets (Carow et al. 2004); (King and Tucci 2002); (Lee et al. 2000); (Lieberman and Montgomery 1998); (Mitchell 1989). Competitive advantages from learning are much less or nonexistent with old technologies such as sugar and starch conversion because much of the dry milling technology has been readily available over the past half of the century. . While, since cellulosic is yet to be a fully commercialized technology, early entrant cellulose plant managers could gain significant advantages over competitors from "learning-by-doing."

Entry decisions also need to consider that specialized assets are imperfectly immobile (Ghemawat and Del Sol 1998), (Peteraf 1993). Imperfectly immobile assets are assets that are specific to the needs of the firm and thus tend to be "sticky" resources (Ghemawat and Del Sol 1998). For instance, because cellulosic requires a considerable commitment of resources that can lead to a potentially high abandonment cost, cellulosic involves high levels of immobile assets. Although this immobility preserves a firm's efficiency differential and thus competitive rents, markets can nevertheless shifts and thus render immobile assets useless (Ghemawat and Del Sol 1998). Furthermore, because immobile assets are "imperfect", they can "eventually" be imitated or replicated by later entrants (Mitchell, 1989, 1991); (Ghemawat and Del Sol 1998); (Lee et al. 2000). With imperfectly immobile assets, there is, therefore, an incentive to enter early.

Due to the heterogeneous and imperfectly mobile properties, specialized assets create an inherent tension for managers and investors. The first mover advantages of entering early to stay ahead of imitation and exploit gains from specialization come at a risk to the underlying investment in

the specialized assets. This because early and specialized investment in large scale facilities may be misplaced as market conditions change. In that, this line of reasoning suggests cellulosic firms, such as Mascoma, Iogen, CERES, Novozymes and Genecor International, have an incentive to enter early because early entry pre-empts the influences of competitive imitation and provides a means to exploit the temporary cost advantages of their firm's specific assets. But they can be rightly hesitant to such early mover advantages, if the market and policy environments for ethanol are too uncertain. For example the U.S. government could chose not to protect the higher cost infant cellulose-based ethanol industry in favor of free market policies that would allow entry to low cost first generation sugarcane ethanol from Brazil or Cuba. The biodiesel industry directly faces such uncertainties as extension of government subsidization has recently been allowed to lapse (Abuelsamid 2010).

While, in contrast to specialized resources, non-specialized or flexible resources are neither heterogeneous nor imperfectly immobile. Flexible resources, such as dry milling, are not a source of competitive advantage (Ghemawat and Del Sol 1998). This is because non-specialized assets do not involve significant commitments in which earlier decisions can be reversed with minimal cost (Ghemawat and Del Sol 1998). Flexible assets thereby not only reduce the cost of entry and exit into a market, but as consequence create highly competitive or contestable market conditions that erodes gains from such assets (Ghemawat and Del Sol 1998). As Ghemawat and Del Sol (1998) describes:

"Thus, while companies may invest in firm-flexible resources to reduce their exit barriers [i.e. low abandonment costs], the trouble is that this kind of investment is also likely to reduce entry barriers. In a hypothetical situation where there are no entry or exit barriers – a situation described by economists as perfectly contestable – any advantage would be ironed out in the twinkling of an eye" (Ghemawat and Del Sol 1998: 32)

With flexible assets, there is an incentive to delay entry. This is because, due to the mobile nature of non-specific assets, the returns from these assets can be readily appropriated by a firm's rivals (Ghemawat and Del Sol 1998). As a result, unlike that of the specialized asset case, early entry would not enable the firm to secure the value of these flexible assets and thus favoring later entry. Yet, since entry into the bio energy industry is predominantly driven by the early entry of dry milling firms, such a RBV explanation thereby cannot readily explain this type of entry behavior.

Organizational Ecology Explanations of Entry Order Effects: R and K type Firms

Entry timing decisions are not only influenced by a firm's specialized or flexibility assets, but are also influenced by market conditions surrounding entry. In particular, a basic premise of Organizational Ecology is that the market is the primary determinant of a firm's life cycle. Organizational Ecology argues that markets support the entry and thus growth and survival of a population of firms (Carroll and Hannan, 1989); (Hannan and Freeman 1977). For instance, in the case of ethanol, the growth in the number of ethanol plants is attributed to the market opportunities created by the Toxic Substances control act of 2000. The act called for the elimination of MTBE additives in fuel because of its potential risks to public health and the environment. The act created a standard of utilizing ethanol as a fuel additive replacement.

Consequently through this act, a large market for ethanol was created. The creation of this market subsequently supported the rapid entry and growth of ethanol processors.
As markets support the growth of a population of firms, Organization Ecology also argues that this growth yields competitive influences that favor the survival of distinct organizational forms (Brittain and Freeman 1980); (Brittain and Wholey 1988); (Lambkin and Day 1989); (Zammuto 1988). Organizational Ecology argues that as markets evolve through various stages of the product-life cycle, each stage favors the entry and survival of two archetype firms - R and K types. R types are characterized by small and flexible entrepreneurial firms that have simple organizational structures (i.e. less developed bureaucracies) (Ebben and Johnson 2005); (Zammuto 1988). These characteristics enable the R type to quickly capitalize on the newfound opportunities of an emerging market niche (Brittain and Freeman1980); (Lambkin and Day 1989) and thus the R type is proficient in exploiting first mover advantages (FMA) (Brittain and Freeman 1980); (Lambkin and Day 1989); (Zammuto 1988). That is, due to R types' speed and flexibility, R types favor early entry into the initial or formative stages of the product-market life cycle (Brittain and Freeman 1980); (Lambkin and Day 1989); (Wholey and Brittain 1986); (Zammuto 1988).

However, gains from FMA dissipate with the increasing maturity of the product-market lifecycle (Lambkin and Day 1989); (Lieberman and Montgomery 1998). With increasing market maturity, selection no longer favors the speed and flexibility of R types, but rather favors K types that compete on scale efficiencies (Brittain and Freeman 1980); (Lambkin and Day 1989). Such efficiencies stem from K types' types higher fixed investments (i.e. scale economies) and bureaucratic organizational structures (Brittain and Freeman 1980); (Lambkin and Day 1989); (Zammuto 1988). As these efficiencies enable the K type to compete in highly populated markets, K types favor entry into the mature stage of the product-life cycle (Brittain and Freeman 1980); (Lambkin and Day 1989); (Zammuto 1988).

Integrating the Resource Based View and Organizational Ecology

However, as Organizational Ecology focuses on a population level of analysis, it tends to overlook the underlying assets that contribute to R and K types' entry behavior (see Hannan and Freeman 1977). Our study argues that due to R types' smaller size, the R type lacks specialized assets. This is because with its smaller size, the R type does not have the same access to financial resources as larger firms and, as a result, lacks the commitment that is necessary for investing into fixed and specialized assets (Ebben and Johnson 2005). Yet in spite of this lack of specialized assets, the R type firm can shift tactics and goals as environmental circumstances change and thus can better respond to new and emerging market opportunities. This is consistent with Miles et al. (1978) and Zammuto (1988) who contend R type's flexibility stems from minimizing their long-term commitment to any single technology or market.

However, unlike the R type, the K type exhibits considerably greater specialization of assets. This is because with its larger size and more certain business environment, the K type can attract larger amounts of financial resources which enable the K type to invest in fixed and dedicated production assets. With such investments, the K type benefits from scale efficiencies and other related learning economies that serve to further K type's specialization of tasks (e.g. Brittain and Freeman 1980); (Ebben and Johnson 2005); (Miles et al. 1978); (Zammuto 1988). This is

consistent with Miles et al. (1978) who find that K type's efficiencies stems from its specialization to a single core technology. However, as specialized assets are costly to reverse (Ghemawat and del Sol. 1998), this specialization limits K type's flexibility to adapt to changing market conditions (e.g. Brittain and Freeman 1980); (Zammuto 1988).

In a bio energy context, differences in the R and K types' specialization of assets are thus argued to be analogous to the assets used by the dry mill and cellulosic firms. Namely, the flexibility of R types is argued to be analogous to the versatility of the dry milling firm. This is because since dry mill firms do not require a significant commitment of resources, dry mill firms face a lower entry / exit costs than the cellulosic firm. With these lower costs, the dry milling firm, like the R type firm, can thereby quickly respond to the emerging opportunities of the market. This is because due to the relative absence of a significant commitment of resources, it minimizes the cost of reversing earlier decisions and thus enables the R type firm to respond quickly to changes in the market (Ghemawat and Del Sol 1998). However, since such flexibility is gained at the expense of a lack of specialization, the dry milling firm – like the R type- cannot compete on low cost. Costs are higher but entry is quicker and easier, and abandonment costs are lower if markets change. With such lower abandonment costs, the dry milling firm can thereby exhibit the flexible properties of the R type firm.

While, unlike the flexibility of the R type dry milling firm, the efficiencies of the K type are analogous to the specializations of the cellulosic firm. Namely, as cellulosic requires significant commitments in R&D (Lamonica 2008); (Verenium Corp. 2010) that can span over multiple years, such investments are not only costly, but are also costly to reverse. This commitment to R&D though not only gives rise to the specialized nature of the cellulosic firm but such commitment raises costs and limits the cellulosic firm's flexibility to the changing conditions of the ethanol market. Therefore, due to this specialization of assets, the cellulosic firm exhibits the limited flexibility of the K type. However, as a commitment to specialized assets yields gains in efficiency, the cellulosic firm exhibits the scale efficiencies of the K type. For instance, key commercial challenges facing cellulosic firms are improving the efficiency of plant operations; gallons ethanol/ton of feedstock, enzymes/gallon of ethanol; ethanol/unit of time; and ethanol/ unit of capital cellulose (Knauf and Moniruzzaman 2004); (Rendleman and Shapouri 2007); (Goldsmith 2009) and(Goldsmith et al. 2010). As these costs largely stem from the firm's commitment to, or acquisition of R&D, such fixed investments can yield opportunities to exploit significant scale related economies. For example, investment in efficient enzyme technologies would yield access to new large, abundant, and low cost biomass feedstocks. In particular, dry milling technologies have a predicted maximum capacity of 15 billion gallons / year due to limited corn availability. Cellulose mills could produce upwards of 70 billion gallons of ethanol just from agricultural wastes (Mosier 2007); (Grainnet 2010). This potential to access a larger volume of cheap feedstock by the K type cellulose mills can thereby yield scale efficiencies that lower the cost of processing ethanol as compared with the R type dry milling approach (Graf and Koehler 2000); (Hammelinck et al. 2005). Some studies have suggested that once cellulosic enzymes become successfully commercialized, cellulose mills will have significantly lower operating costs when compared with dry milling (Lin and Tanaka 2006). Hence, due to the specialized nature of the cellulosic, the cellulosic firm is thereby analogous to the large scale efficiencies of the K type firm.

Based on these R and K type distinctions, Table 1 summarizes the essential features of the R and K type bio energy firms and relates their features to differences in their specialized assets.

Table 1. R and K type Bio Energy Firm Characteristics

Firm Type	Flexibility	Productive Efficiency	Specialized Assets	Bio Energy Firm Equivalent
R Type	High	High	Low	Dry Miller
K Type	Low	High	High	Cellulosic

Theoretical Propositions

Specialized Assets and Density Dependence

Differences in the specialization of assets between the R type dry milling and K type cellulosic firm not only provide Organizational Ecology a greater firm level orientation, but also yield a RBV explanation that is consistent with Organizational Ecology's theory of density dependence. Density dependence suggests that under low density environments, there is an abundance of market opportunities that favor the flexibility and speed of the R type dry milling firm. Such a view might partially explain the early and rapid entry of dry milling firms during the 1990s. During this period, early entry was motivated by a lack of investments in specialized assets because this provided the dry milling firm the flexibility to quickly enter and exploit the opportunities of the emerging ethanol market. As this early entry into the ethanol market has been largely dominated by dry milling technologies (Renewable Fuels Association 2004); (Dale and Tyner 2006), this density dependent selection of the R type firm is offered as one explanation of the early entry of the dry milling firm.

Alternatively, under highly dense populations, density dependence argues the competition for scarce market opportunities favors firms that can compete on efficiency (Brittain and Freeman 1980); (Lambkin and Day 1989); (Zammuto 1988). Since K types have specialized assets that yields scale economies, such assets thereby enable the K type to compete in highly competitive conditions. Hence, according to density dependence, competitive conditions will favor the entry of the K type cellulosic firm. In drawing on the logic of density dependence, the R type dry milling firm and K type cellulosic entry behaviors can, thereby, be explained by the following proposition:

Proposition (1): Given differences in their specialization of assets, an R and K types' entry timing is density dependent whereby low (high) population densities at founding favor R type dry milling firm (K type cellulosic firm) type entrance.

Asset Specificity and Market Uncertainty

In addition to such density dependent effects, Organizational Ecologists contend uncertainties over the various stages of the product-market life cycle can also affect an R and K types' entry timing. During the early stages of the product life cycle, consumer preferences are typically ill defined and product attributes such as price, quality, function and other demand attributes are largely unknown (Kerin et al. 1992); (Lambkin and Day 1989); (Shankar et al. 1998). With such uncertainty, the R type's lack of specialized assets minimizes their exposure to risk because by

avoiding a significant commitment of resources, changes in market conditions incur a minimal cost to R type's investments (Ghemawat and Del Sol, 1998). In addition, since R types lack of specialized assets result in a smaller scale of operations, R types are better able to with stand down turns during the early stages of market development. However, as markets mature, the greater certainty of market favors the selection of the K type firm (Lambkin and Day1989); (Zammuto 1988). With greater market certainty, customer needs become better identified to which allows marketing efforts to be precisely targeted. Input requirements also become better defined. Hence, as markets mature, markets favor K types' specializations of skills (Lambkin and Day 1989); (Robinson et al. 1992). Moreover, the K type is favored in certain markets because the reduction of market uncertainty minimizes the risk to K type's specialized assets to which enables the K type to focus on developing further improvements in their production efficiencies (Lambkin and Day 1989). With this reduction of market uncertainty, this promotes the entry by the K type firm.

Such "uncertainty" dependent predictions have parallels to the uncertainties faced by bio energy firms. There are various sources of uncertainty that can impact the demand for ethanol. Currently, the demand for ethanol is limited by an "ethanol-blend wall" in which a maximum of a 10% ethanol-fuel blend is permitted for transportation fuels. However Growth Energy has recently proposed to the EPA raising the amount to 15%. Such potential changes in fuel blend mixture are therefore one important sources of demand uncertainty. Demand uncertainties can also arise from the threat of low cost exporters of ethanol, such as Brazil. Furthermore, there have been increasing concerns by critics about the social and environmental benefits of corn-ethanol production (Roberts et al. 2000). Critics have argued that the production of fuel from corn directly competes with human consumption. Furthermore, the increasing use of chemicals and fertilizers in the production of corn-ethanol has led to increasing skepticism about the environment benefits of corn-ethanol (Roberts et al. 2000). Such debates create considerable uncertainty about the continued viability and thus demand for the US corn-ethanol industry. Such demand uncertainties also places considerable uncertainty in the underlying technologies that will define this market. Namely, will the market by defined by cellulosic or by dry milling technology?

Under such uncertain demand conditions, Organizational Ecology suggests that the R type dry milling firm is better able to tolerate the uncertainties of this market. This is because due to the absence of a significant commitment of resources, the R type dry milling firm is least exposed to the uncertainties of this market. That is, in the absence of a significant investment in specialized processing assets (i.e. minimal investments in R&D in feedstock specific enzymes); the R type dry milling faces a relatively low cost of entry / exit whereby under conditions of uncertainty, an incorrect entry decision can be reversed at minimal cost. Furthermore, as R type's lack of commitment to specialized assets leads to a smaller scale of operations, this smaller scale is suited to capitalizing on the nascent yet uncertain demands of this market.

On the other hand, under stable market conditions, the K type cellulosic firm is favored over that of the R type dry milling firm because stable ethanol markets reduce the risk to K type's specialized assets. In particular, since scale and processing efficiencies are dependent upon stable market conditions (Lambkin and Day 1989), limited disruptions in demand enable the K type cellulosic firm to not only exploit potential scale economies but also limits its exposure to the

risk associated with their investments in R&D. These "uncertainty" dependent arguments are thus proposed by the following:

Proposition (2): Given differences in R and K type's specialization of assets, entry-timing effects are uncertainty dependent whereby uncertain (stable) market conditions at founding favors the entrance of R (K) types.

R and K type Entry Decision Making

Differences in the specialization of assets by R and K types thereby yield a distinct trade-off between those gains from a commitment to specialized assets and the flexibility afforded by non-specialized assets (e.g. Ebben and Johnson 2005); (Ghemawat and Del Sol 1998); (Lieberman and Montgomery 1998); (Miller and Folta 2002). For instance, early commitments to specialized assets yield advantages from "exploiting" gains associated with efficiency. By committing to specialized assets, it promotes a firm's ability to "exploit" or build upon its existing technical competence. Yet, such a commitment reduces a firm's flexibility from "exploring" new market opportunities (Levinthal and March 1993). Exploration, nevertheless, has its costs because a firm fails to develop a distinct area of competence (March 1991). This study argues that this commitment (exploitation)-flexibility (exploration) trade-off not only drives an R and K type's entry decisions, but subsequently determines the entry timing effects of density dependence and market uncertainty.

To elaborate, an R type's entry decision involves distinctly trading off gains from a commitment to exploit the efficiencies of specialized assets for the explorative benefits of flexible assets. Since the R type lacks a commitment to specialized resources, the R type - relative to the K type – has an inherent cost disadvantage. Yet, as the lack of specialized assets reduces a firm's commitment to any particular set of assets, the R type benefits from being able to adapt and explore the changing opportunities of an emerging market. This is consistent with Zammuto (1988) who contends R types are adept at competing for first mover advantages, but fail to capitalize on efficiencies in leveraging a distinct area of expertise. This reasoning suggests that the early and rapid entry by dry milling firms in the 1990s was not due to efficiencies from the dry milling technology, but rather due to their low capital commitments. Stated differently, since dry milling involves a relatively low commitment of resources, this technology provided a low cost of entry as well as exit into this market. Yet, since the R type dry milling firm cannot compete on efficiency, this low cost of entry / exit, therefore, requires that the R type dry milling compete strictly on the first mover advantages of early entry. As a result of this trade-off, an R type dry milling firm enters early into the market in which markets are characterized by a low population and a high degree of uncertainty. This trade-off is proposed by the follow decision heuristic:

Proposition (3): Driven by non-specialized assets, an R type's early entry is the result of trading off its lack of production efficiencies for first mover advantages to which such a trade-off favors an R type's early entry into low populated and uncertain markets.

While, the K type firm's entry decision emphasizes trading off the flexibility of non-specialized assets for its commitment to exploit the production efficiencies of its specialized assets.

However, since these production efficiencies involve an irreversible commitment of resources or at the minimum involve high entry and abandonment cost, this commitment to specialize limits K type's flexibility from exploring the opportunities of emerging markets. Therefore, unlike the R type, the K type's entry decision involves trading off the first mover advantages of non-specialized assets for the gains in production efficiency that arise from a commitment to specialization. With this decision trade-off, this suggests the K type cellulosic firm distinctly favors late entrance for two reasons. First, as ethanol demand in maturing markets become well defined, late entry reduces the risk to K type's investments in cellulosic. That is, such reductions in uncertainty provide justification for cellulosic firms to not only invest in costly R&D but also enable the K type to raise capital from external investors. Second, with relatively stable market conditions, output variations are minimized to which promotes the exploitation and thus specialization of tasks (e.g. Levinthal and March 1993). This enables the K type cellulosic firm to exploit its scale efficiencies and thus compete in high-density environments. This trade-off is proposed by the follow decision heuristic:

Proposition (4): Driven by specialized assets, K type's late entry decision is a result of trading off gains from first mover advantage for production efficiency rents to which such a trade-off favors a K type's entry into highly populated and certain markets.

R and K type Learning Effects

A consequence of such decision heuristics is that an R and K types' entry decisions distinctly affect their ability to exploit learning curve advantages. Since the R type competes through an early entry of the market, the R type dry milling firm thereby affords a "head start" in developing experiences that can reduce its cost. This head start yields learning curve advantages that can create a relative cost advantage to later entrants (Kerin et al. 1992); (Lieberman and Montgomery 1998). This can be important for the R type dry milling firm because by leveraging such learning curve effects, the firm can compete with the scale efficiencies of the K type cellulosic firm. However, since the K type cellulosic firm has specialized assets, the K type should, thus, be better at exploiting such learning curve effects than the R type. This is because a firm's specialization of experiences reinforces learning curve effects (Levinthal and March 1993); (March 1991). Hence, this suggests that since the cellulosic firm largely competes through their ability to exploit scale economies, learning curve effects should have a greater impact on the cellulosic firm's performance than that of the dry milling firm. The following is proposed:

Proposition (5): Given the specialization of assets of the R and K type, learning curve effects have a more pronounced effect on K type's performance than the R type.

Method

To integrate the insights of the Resource Based View with Organizational Ecology, a dynamic programming (DP) simulation model was developed. DP models are suited to examining systems where there are a series or a sequence of decisions that are being made with respect to a number of changing state variables. Specifically, DP programming involves determining a sequence of optimal decisions that maximizes a given function for any given changes in future states of

nature (Kennedy 1986). DP also involves decisions that involve trade-offs in which there are explicit benefits and costs associated with each decision (Kennedy 1986).

This study argues that a firm's entry into the ethanol market exhibits these DP characteristics. As the product-life cycle evolves through various states of competition and uncertainty, the entry problem facing the manager is one of deciding over these changes in market states, a sequence of entry decisions that will maximize their firm's profits. Moreover, since a DP approach is suited to examining trade-offs, such an approach is thereby suited to examining the firm's commitment vs. flexibility trade-off (Ghemawat and Del Sol 1998).

Formulating a DP Model

DP involves deriving an optimal policy of interrelated optimal decisions that maximize an objective function over time. Founded on Bellman's (1957) principle of optimality, an optimal policy "has the property that whatever the initial state decisions are, the remaining decisions must constitute an optimal policy with regard to the stage resulting from the first decision" (Bellman 1957: 83). Stated in mathematical terms, DP involves solving for a sequence of decisions or an optimal policy, $\{U_1, U_2, U_3, \ldots U_{T-1}\}$ that maximizes a specified objective function, $V_t(S_t, U_t)$, given a series of states $(S_1,S_2,S_3 \ldots S_{t-1})$ for a finite period of t to T-1 simulation periods (T = end of the product life cycle). Optimal decisions and state conditions are related through a state transformation function, $S_{t+1}(S_t, U_t)$, in which a current decision, U_t and state, S_t, impacts a future state, S_{t+1}

To solve such a DP programming problem, backward induction is a commonly used algorithm (Kennedy 1986). Backward induction is a process of solving a sequence of optimal decisions by solving them backwards in time. Backward induction proceeds by first considering the decision being made in the last period and then choosing the optimal decision for the states associated with this period. Using the optimal decision made in this last period, one then determines the next optimal decision for the second-to-last period. This process continues backwards until the optimal decision has been determined for every possible state at every point in time. This backward induction algorithm is typically suited to solving problems with a finite time horizon and for problems involving discrete choice (i.e., enter or exit). Optimal solutions to such a problem are computed numerically.

This backward induction algorithm is used to solve the bio energy firm's (R and K types) optimal entry. This is because a bio energy firm's entry decision is based on a discrete entry choice that occurs over various market states. Furthermore, since a firm's decision to enter and remain within this bio energy sector is not indefinite, the entry decision is, thus, based on a finite planning horizon. That is, a finite horizon was chosen because a manager's planning horizon is typically based on returns over a finite period. Moreover, a finite horizon was chosen because optimal policy decisions are easier to compute and requires less computational resources.

To illustrate the firm's entry decision, equations 1 and 2 translate a firm's entry behavior into a DP structure. A firm – such as an R or K type - for each time period, t, faces an entry or exit decision, U_t (1 = enter, 0 = not to enter / exit), that maximizes its profits, $V_t(S_t, U_t)$ over t=0 to T-*1* simulation periods. For a given period t, a firm's profits – equation 1– is comprised of gains

from early entry or first mover advantage (FMA), X_t (U_t), and gains from its production efficiencies, P_t (U_t , S_t). Since a firm's specialized assets impacts a firm's entry timing, a specialized asset parameter, SA_t , is included into this profit equation. This specialized asset parameter, SA_t, reflects a firm's commitment to the ethanol industry. Larger values denote greater specificity and thus reflect a greater commitment to the industry than firms with less specialized assets. This characterization is also consistent with Ghemawat and Del Sols' (1998) characterization of specialized assets. As the principle of optimality requires that future decisions must be optimal to earlier decisions, a firm's profit must also include a one period future discounted profit value, $V_{t+1}(S_{t+1},U_t)$. β denotes a fixed discount rate.

$$(1)\quad V_t(U_t,S_t) = \underset{U_t}{Max}\sum_{t=0}^{T-1} X_t(U_t) + P_t(U_t,S_t) - SA_t + \beta \cdot V_{t+1}(U_{t+1},S_{t+1})$$

$$(2)\quad S_{t+1} = S_t + U_t,\ S_0 = 0$$

The dynamic optimization of Equation 1 is constrained by a state transformation function, Equation 2. Given a firm's (1) entry / (0) exit decision, U_t , Equation 2 shows a firm's one period future experience, S_{t+1}, is the sum of the firm's accumulated experience, S_t , and its optimal decision, U_t, at period t. Since a newly entering firm has no prior experience, its initial experience is equated to zero, S_0=0 (e.g. Stinchcombe 1965).

Innovation or FMA Rent: X_t (U_t)

As entry decisions involve evaluating competing gains in FMA against gains in production efficiency, FMA, X_t (U_t), are the expected returns to a firm from bringing a new product or service to an emerging market (equation 3). The new product here is fuel ethanol. The expected returns are described by equation 3 whereby Pr_t (N_{t-1}), reflects the price of the ethanol produced by the firm. However, as witnessed in the ethanol market when there has been active investment and subsequent expansion of industry capacity, the price of ethanol declined[1]. In this study, we attribute this decline in price to increases in direct and indirect competition, N_{t-1} (see also equation 8) in the ethanol market (Renewable Fuels Association 2008, 2009). Furthermore, W represents the expected returns from introducing ethanol to the market at time t = 0 (i.e. initial period of the simulation). As the gains from dry milling technologies are subject to obsolescence by newer technologies[2], such as cellulosic, this expected return should thus decline with increasing market maturity. As a result, with increasing market maturity, t, returns, W, are modeled by a non-linear function that declines at an exponential rate, δ. The level of innovation rents or FMA returns secured by a firm is then derived by the product of a firm's entry decision, U_t, (0 or 1) at time, t, price, Pr_t (N_{t-1}) and the declining value of the expected returns, W.

$$(3)\ X_t(U_t) = \Pr_t(N_{t-1}) \cdot W \cdot \exp^{\delta \cdot t} \cdot U_t$$

Gains from Production Efficiencies, P_t (U_t , S_t):

[1] Alternatively, such declines in ethanol prices can be similarly observed by declines in the corn-ethanol spread.
[2] A reviewer correctly points out that our model is a stylized view of the industry. Nobody knows for sure whether cellulosic technology will replace dry mill derived ethanol. One can surely imagine settings with excess corn with few market alternatives and poor infrastructure, e.g. Mato Grosso, Brazil (See Goldsmith et al. 2010), where low-capital cost dry milling might be competitive.

Gains from production efficiencies, P_t (U_t, S_t) are returns from better utilizing the productive capacity of a firm's specialized or non-specialized assets. A firm's capacity utilization is determined by comparing the size of the market demand for ethanol, MS_t, with the productive capacity, Q_t^*, of a firm's assets (see also Kerin et al. 1992). When the market demand or market size (MS_t) exceeds the firm's productive capacity, Q_t^*, the firm's volume of output, Q_t, is maximized at the level of its production capacity, Q_t^*. However, when market demand falls short of a firm's production capacity, such as the initial stages of market development, the firm would not fully utilize its production capacity. The firm produces a level of ethanol output, Q_t, that is determined by the current level of market demand, MS_t. A firm's volume of ethanol output, Q_t, and production efficiencies are described by the following inequalities:

$$(4) \quad \begin{aligned} &if\ Q_t^* > MS_t^*, then\ 0 < Q_t = MS_t^* < Q_t^* \\ &Else, if\ \ Q_t^* < MS_t^*, then\ Q_t^* = Q_t < MS_t^* \end{aligned}$$

Market Size

The market demand or market size of ethanol, MS_t, is expressed as the product of a market growth parameter, s, and a time trend variable, t (Equation 5). To capture mature market conditions, this growth in demand has an upper limit of $\overline{M}$. This upper limit can be interpreted as the "ethanol-blend wall" in which a maximum 10% ethanol-fuel blend is currently permitted by law.

$$(5) \quad MS_t = Min\left[s \cdot t^3, \overline{M}\right]$$

In addition, as markets mature, the demand for ethanol should become increasingly stable or certain. Market size, MS_t^*, is, thus, adjusted by a market uncertainty function, UNC_t.

$$(6) \quad MS_t^* = MS_t \cdot UNC_t \quad where \quad UNC_t = -(v \cdot RND) \cdot \left(1 - \frac{t}{T}\right) \quad RND = Random \in [-1, 0]$$

Market uncertainty, UNC_t, is driven by a random number generator, RND, with values that range between -1 and 0. Negative values were used to capture the downside risk that can arise from entry into the ethanol market. This downside risk is used to capture the uncertainties about the continued viability of the ethanol market. However, as markets mature, this uncertainty declines. Uncertainty in the demand for ethanol is, therefore, modeled as a declining function of market maturity, t. This decline in market uncertainty is consistent with Organizational Ecology depictions of the product life cycle (Lambkin and Day 1989). To model this uncertainty, it is multiplied by the second term, $\left(1 - \frac{t}{T}\right)$. By taking the product of market size, MS_t (equation 5) with this uncertainty parameter, UNC_t, it generates an increasing trend in market size with reductions in downside variability. To examine the effects of such market uncertainty on an R and K type firms' entry timing, this equation is adjusted by a scalar parameter, v.

Density Dependence

Density dependence effects are captured by the Lotka-Voltera population growth function (Hannan and Freeman, 1989) (equation 7)

$$(7) \quad N_{t+1} = N_t + \alpha \cdot N_t \left(1 - \frac{N_t}{\eta}\right)$$

The market's population, N_{t+1} , of ethanol firms in period *t+1*, grows at an intrinsic population growth rate of, α. The intrinsic population growth rate of, α, refers to the rate of new ethanol firms entering the market. This growth rate was set at a rate of 0.5 units / simulation time to reflect highly but not purely competitive markets[3]. Entry is also limited by the market's carrying capacity parameter, η. The carrying capacity parameter, η, refers to the maximum population of firms that can be supported by the market. Through the population dynamics expressed in equation 7, density dependence effects are captured through downward pressures on price. Specifically through equation 8, increases in population from equation 7 reduces the firm's product price, $Pr_t\ (N_{t-1})$, by an exponential rate of μ from an initial price of $Pr_0 + Pr_1$ to an asymptotic terminal price level of Pr_0. In particular, as a firm cannot influence the entry decisions of others, an individual firm, thereby, cannot influence population and thus price. Equation 8, thereby, assumes that ethanol firms have very limited market power.

$$(8) \quad \mathrm{Pr}_t(N_{t-1}) = \mathrm{Pr}_0 + \mathrm{Pr}_1 \cdot \exp^{-\mu \cdot N_{t-1}}$$

R and K Type Learning

Learning curve effects are captured by equation 9 which models a declining relationship between a firm's Marginal Cost, $MC_t(S_t)$, and a firm's accumulated experience, S_t . An ethanol firm's accumulated experiences, S_t, reduces its marginal cost, $MC_t(S_t)$, at a learning rate of γ from an initial value of $\rho + \phi$ to an asymptotic marginal cost value of ρ that is strictly positive. The initial value $\rho + \phi$ corresponds to the marginal cost of a firm with zero experience (S_t =0). This reflects the high costs associated with "liabilities of newness" (e.g. Stinchcombe 1965). As the firm accumulates greater experiences, S_t, its marginal cost declines to an asymptotic marginal cost value of ρ.

$$(9)\ MC(S_t) = \rho + \phi \cdot \exp^{(-\gamma \cdot S_t)}$$

Based on the entry order effects of population density, market uncertainty, and learning, a firm's returns from its production efficiencies is represented in full by equation 10. These returns are computed as the product of a firm's price, $Pr_t\ (N_{t-1})$, its level of sales Q_t , – as determined by inequality 5 – and its entry decision, U_t , less the sum of the product of its marginal cost, $MC_t(S_t)$ and its fixed level of production capacity, Q_t^* and its entry decision, U_t. and the product of its Fixed cost and entry decision, U_t. A fixed cost parameter was used to account for startup

[3] Under perfectly competitive conditions, free entry / exit would suggest a greater rate of entry, such as a value greater or equal to 1. However, since R type dry milling firms requires a minimum amount of investment, there are some positive entry and exit costs. Hence, a value of less than one was set.

and shut down costs. That is, in addition to our specialized asset parameter, SA_t, this Fixed Cost, parameter was included to reflect the cost of entry and exit to the industry[4].

$$(10) \quad P_t(U_t, S_t) = \left(\Pr_t(N_{t-1}) \cdot Q_t\right) \cdot U_t - \left(MC_t(S_t) \cdot Q_t^* + FC\right) \cdot U_t$$

To include, a firm's FMA rents, X_t (U_t), the full specification of a firm's profits is shown by the following.

$$(11) \quad V_t(U_t, S_t) = \underset{U_t}{Max} \sum_{t=0}^{T-1} \Pr_t(N_{t-1}) \cdot W \cdot \exp^{\delta t} \cdot U_t + \left(\Pr_t(N_{t-1}) \cdot Q_t^*\right) \cdot U_t - \left(MC_t(S_t) \cdot Q + FC\right) \cdot U_t - SA_t + \beta \cdot V_{t+1}(U_{t+1}, S_{t+1})$$

$$(2) \quad S_{t+1} = S_t + U_t,\ S_0 = 0$$

In drawing on equations 11 and 2, the R and K type firm is distinguished by differences in their specialized asset parameter, SA_t, as well as differences in Fixed Costs. In parameterizing these firms, the R type has a lower value for this specialized asset parameter, SA_t, than the K type. Furthermore, since the R type dry milling firm procures corn as a key input to their ethanol process, the R type dry milling firm faces a higher marginal cost, MC, than the K type cellulosic firm. Furthermore, since the R type dry milling firm has access to relatively smaller volumes of feedstock (i.e. corn) than the K type cellulosic firm (i.e. agricultural waste, wood chips, etc), the R type dry milling firm has a lower fixed productive capacity, Q_t^*, than the K type cellulosic firm. Critical will be whether the K-Type firm, with its higher capital cost, can balance its need for large scale processing with a well-matched feedstock collection model with high spatial density. Moreover, since the R type dry milling firm has fewer specialized assets (i.e. lack of R&D and lack of other supporting assets in transportation and distribution), the R type dry milling firm has a lower Fixed Cost, FC, than the K type cellulosic firm.

Model Validation

Validation of simulation models, amongst other factors, depends on the desired objectives of the research (Sargent 1999). Although simulations have varied uses, simulations have been used in management research as a means for theory development (e.g. Cyert and March 1963); (Nelson and Winter 1982). For instance, in studies of firm and market evolution, Nelson and Winter's (1982) seminal work had drew on simulation modeling to examine the dynamic behavior of firms and markets. This study follows a similar approach in which the DP simulation is used to examine the theoretical validity of this paper. As a result, the focus of this study is not one of validating the empirical results of the DP simulation, but rather the DP simulation is used to examine the logical consistency of this study's theoretical arguments. This is not to say that empirical validation is not important but this paper argues that the "empirical validation" of simulation results raises some methodological concerns.

For instance, one common method for validating simulation results is the "historical friendly" approach (Sargent 1999). This involves comparing the outputs of the simulation with a detailed

[4] For instance, since cellulosic firms require investments in R&D, such commitments, however, occur over multiple periods. These R&D investments are, thus, treated as fixed costs that accrue over time.

history of the economic system (Sargent 1999); (Windrum et al. 2007). For this study, a historically friendly approach is, however, problematic. This is because although key market concepts such as competition and uncertainty can be empirically measured, a key focus of this research is on the examination of the entry behaviors of the R and K type firms. Yet, with the possible exception of Goldsmith and Dissart (1998), there have been very limited empirical estimates of R and K type organizations in agribusiness research. In fact, to our knowledge, there have been no empirical estimates of R and K bio energy firms. As a result, even though other estimates relating to population (i.e. firm entries) and uncertainty could be drawn from prior studies, estimates of the parameters of the R and K type firm are not available. Validation, especially through comparisons with past studies, thereby, becomes difficult because there is no prior basis for comparison. The estimation of these key parameters is, thus, called for in future studies.

Furthermore, a "historical" approach also faces some deep seated methodological problems. A historical approach only shows that the underlying model is "capable" of producing the observed empirical phenomena because multiple combinations of parameter settings, initial conditions, and structural assumptions can lead to the same simulated output (Windrum et al. 2007). Nevertheless, although there are numerous possible parameter settings, the logic of our conceptual model dictates that the entry behaviors of R and K types can be still examined by relative differences in their firm level parameters, such as asset specificity, MC, Output, Fixed Costs. These parameter settings are shown in Appendix 1. Based on these settings, this study's DP simulation model was programmed with the Fortran 77 compiler. Based on this code, various simulation runs with randomized initial values were also conducted. The findings were robust across these simulations.

Results and Discussions

Density Dependence

To examine Proposition 1, the initial population conditions were varied to examine the effect of population densities on R and K types' entrance. In addition, since initial population densities impact the population densities of later periods, such variations in the initial population impact the population densities confronted by the later entrant, K type. The carrying capacity of this market is artificially limited to 100 competitors. Similar entry patterns were observed with increases in this carrying capacity. Lastly, since density effects are reflected through reductions in price, the price is reduced at a rate of -0.05 per unit increase in the population. Changes in this parameter did not appreciable affect R and K types' pattern of entry.

Given these specifications, increases in population densities prompted earlier exit by the R type and reduced R type's profits (Table 2). For instance, at a population density of 2 other competitors, R types entered in the first period and exited in period 4 with profits of $257. However, with increasing densities (e.g. initial population = 20), the R type exited in period 2 with a significant reduction in profits to $15. With further increases in population density of 25 other competitors, R types no longer entered the market. While, K type's entry and exit periods remained largely robust to these changes in population. In fact, by increasing the initial population density to the market's carrying capacity (100 competitors), the K type still remained

in the market (entry in period 8 and exited in period 15). However, K type's profits dramatically declined from $89,697 to $107. Nevertheless, the K type was more resilient to increases in population densities than the R type. This is consistent with Proposition 1.

One implication of these results is that density conditions at founding have differential effects on the survival of R and K type firms. This suggests that as competition increases, dry mill firms are not likely to enter the industry and are likely to be displaced by the efficiencies of the cellulosic firm. This result appears to be consistent with the view that cellulosic is a more efficient source

Table 2. Density Dependence

	R Type			**K Type**		
Initial Population	*Entry*	*Exit*	*Fitness*	*Entry*	*Exit*	*Fitness*
2	1	4	257.4	7	No Exit	89697.3
3	1	3	221	7	No Exit	46004.5
4	1	3	192.2	8	No Exit	23141
5	1	3	165.5	8	No Exit	16824.8
10	1	2	87.1	8	No Exit	4579.6
15	1	2	46.8	8	No Exit	2115.1
20	1	2	15.4	8	No Exit	1229
25	No Entry	No Entry	0	8	No Exit	810.9
50	No Entry	No Entry	0	8	No Exit	241.4
75	No Entry	No Entry	0	8	No Exit	138.3
100	No Entry	No Entry	0	8	No Exit	107.1

of ethanol than dry milling (e.g. Robertson et al. 2000)[5]. In particular, this result is consistent with some of the realities faced by dry milling firms. For instance, the increasing competition among dry milling firms has lead to an increase in the input price of corn which resulted in a decline in the price margins for dry millers. This reflects a decline in market opportunities to which favor more efficient conversion technologies. Hence, under highly dense population conditions, the K type cellulosic firms maybe favored for their efficiencies in gaining access to low cost feedstock. This lower cost of cellulosic feedstock not only lowers K type's input costs but also provides significant scale efficiencies for the K type cellulosic firm (Lin and Tanaka, 2006). However, such scale economies depend on the firm's ability commercially employ effective cellulosic enzymes (e.g. Knauf and Moniruzzaman 2004); (Tiffany and Eidman 2004); (Rendleman and Shapouri 2007).

Market Volatility

To examine Proposition 2, market uncertainty was varied from a value of v = 1 (low uncertainty) to a value of v = 10 (high uncertainty)[6]. When uncertainty was low (v = 1), the R type firm entered in period 1 and exited in period 9 with profits of $1,926 and the K type entered in period 7 and remained until period 15 with profits of $934,870 (Table 3). With increases in uncertainty (v = 10), the R type still enters in period 1, but exits in period 3 and its profits are reduced by 61% to $754. K type's entry was significantly delayed to period 13 and its profits fell by 56% to $414,723. This pattern of entry is consistent with Proposition 2.

[5] This a point that is not only raised by a reviewer but also is commonly understood by those involved in comparing the advantages between these energy conversion technologies (e.g. Robertson et al., 2000).
[6] Population effects are removed by setting the price decline parameter to 0.

The implication of these results is that the uncertainties in ethanol demand favor the entry of the dry milling firm, while delaying the entry of the cellulosic firm. Hence, unlike RBV explanations (e.g. Ghemawat and Del. Sol 1998), this suggests that under conditions of uncertainty, the R type dry milling firm's lack of specialized assets may promote earlier entrance or at the minimum reduces R type's exposure to risk than when compared to the K type. This appears to be consistent with the pattern of entry in the ethanol industry.

This result also has related implications to U.S. energy policy. Uncertainty declines when commitment to ethanol tax credits, import tariffs, and subsidies are strengthened. With reductions in uncertainty, greater specialized investments can be made. For instance, ADM who has long experienced with dry and wet milling technologies (ADM News release, 2007), and British Petroleum, long experienced in fossil fuel technologies, both have expanded, albeit slowly, into cellulosic ethanol production research and development.

Table 3. Market Uncertainty

	R Type			K Type		
*Uncertainty, V**	*Entry*	*Exit*	*Fitness*	*Entry*	*Exit*	*Fitness*
1	1	9	1926.2	7	No Exit	934870.3
2	1	4	1466.7	7	No Exit	922611.1
3	1	3	880.7	7	No Exit	801919.4
4	1	3	754	7	No Exit	674460.6
5	1	3	754	11	No Exit	642550.8
6	1	3	754	11	No Exit	567595.2
7	1	3	754	12	No Exit	435335
8	1	3	754	13	No Exit	414723
9	1	3	754	13	No Exit	414723
10						

Joint Density and Volatility Effects

In order to evaluate Propositions 3 and 4, density dependence and market uncertainty effects were jointly examined[7] (Table 4). Under conditions of low (2) density and highly uncertain market conditions, the R type firm enters in period 1 and exits in period 3 with profits of $2.6. R type's entry behavior is, thus, consistent with the conditions described by Proposition 3. Furthermore, as indicated by Proposition 3, R type's competition for first mover advantage (FMA) rents in periods 1 and 2 yields respective gains of $320 and $214. These FMA rents are, however, offset by respective losses in production efficiency of $-450 and $-72. This trade-off is consistent with Proposition 3.

The K type firm enters in period 7 and remains until period 15 with profits of $219,690[8] (Table 4). The K type enters into the market with a population of 20 other competing firms and in a market with reduced uncertainty. K type's entry into such founding conditions is, thus,

[7] To provide a suitable balance of population density effects and market uncertainty, the price decline parameter was set to -0.025, and the market uncertainty parameter, v, was set to a value of 2.5. Through comparisons with other combination of values, we felt that this set of values yields the greatest balance of these effects.

[8] Profits is calculated through equation 11 in which fitness is determined by the sum of the period's innovation rents and production efficiency rents and the one period discounted value of the one period future fitness.

consistent with Proposition 4. Furthermore, K type's entry into such founding conditions was attributed to K type's decision to compete for production efficiency rents. For instance, in period 7, K type's production efficiency rents are $42,291, while its FMA rents are only $29. For the remaining periods, the average production efficiency and FMA rents were, respectively, $29,889 and $10.

Table 4. Density Dependence and Market Uncertainty

		R Type				K Type			
Time	*Population*	*Entry 1 Exit 0*	*Fitness*	*Innovation Rents*	*Production Efficiency*	*Entry 1 Exit 0*	*Fitness*	*Innovation Rents*	*Production Efficiency*
1	2	1	2.6	320.1	-450	0	0	0	0
2	3	1	143.1	214.6	-71.5	0	0	0	0
3	4.4	0	0	0	0	0	0	0	0
4	6.5	0	0	0	0	0	0	0	0
5	9.6	0	0	0	0	0	0	0	0
6	13.9	0	0	0	0	0	0	0	0
7	19.9	0	0	0	0	1	219690	29	42291
8	27.9	0	0	0	0	1	191560	19.5	59369.2
9	38	0	0	0	0	1	142745	13	49122.4
10	49.7	0	0	0	0	1	101098	8.7	19793.9
11	62.2	0	0	0	0	1	87799.2	5.9	30641.2
12	74	0	0	0	0	1	61724.3	3.9	22587.3
13	83.6	0	0	0	0	1	42263.7	2.6	17544.8
14	90.5	0	0	0	0	1	26693.5	1.8	14626.4
15	94.8	0	0	0	0	1	13030.6	1.2	13029.4

R and K type Learning

This simulation draws on the parameters of the previous simulation with the exception that learning curve effects are enabled (Table 5). The R and K types' learning rates were both set at a value of -0.4 (i.e. $\gamma^r = \gamma^k = -0.4$). Such a rate is set so that the effects of each firm's non-specialized or specialized assets can be independently examined of this learning rate. The R type firm enters in period 1 and exits in period 3, while the K type enters in period 7 and remains until period 15 (Table 5). Relative to the results of the previous simulation (Table 4), learning does not alter R and K type entry and exit periods. However, learning significantly improves both R and K type's profits. In particular, R type's profits improved more dramatically than the K type. R type's profits increased by 2350% from $2.6 to $63.7, while K type's profits improved by 47% from $219,690 to $323,352.

Table 5. Density Dependence and Market Uncertainty with Learning

Learning	**R Type**			**K Type Learning rate = -0.4**		
Rate	*Entry*	*Exit*	*Fitness*	*Entry*	*Exit*	*Fitness*
0.1	1	3	20.2	7	No Exit	323351.9
0.2	1	3	36.2	7	No Exit	323351.9
0.3	1	3	50.6	7	No Exit	323351.9
0.4	1	3	63.7	7	No Exit	323351.9

The learning rate was then varied to determine the robustness of these findings (Table 5). R type's profits were examined with learning rates that ranged from -0.1 to -0.4. Lower rates of learning were used to reflect R type's lack of specialized assets. However, even with such lower learning rates, the R type firm still experienced a larger percentage growth in profits than the K type[9]. Proposition 5 is, therefore, not supported. This suggests early entry by the R type dry milling firm can benefit from learning curve economies. For instance, ADM, which has utilized both dry and wet milling processes, has been an early entrant into the corn-ethanol industry and remains as one of the lowest cost processors of corn ethanol.

The broader implication of this result is that it suggests learning curve effects may significantly affect an R type dry milling firm's ability to compete with the efficiencies of the K type cellulosic firm. Namely, although the high R&D costs of cellulosic remains a key commercial barrier, cellulosic firms nevertheless face lower feedstock costs than dry millers. Yet, despite such cost advantages, early entry by the R type dry milling firm can leverage learning curve effects from being first movers to offset their higher input corn costs, and will compete aggressively against later entering cellulosic firms. Learning curve economies may in part explain the viability and logic of the dry mill corn model in the early phase on the bio energy movement.

However, shifts in U.S. energy policy can reduce the high costs of producing effective cellulosic enzymes. For instance, expansion of tax credits and subsidies to the cellulosic ethanol sector could overcome the high R&D costs of enzyme research and development. Specifically, shifts in U.S. energy policy towards investments in R&D as opposed to fuel would benefit the cellulosic industry. Such a policy shift would reduce uncertainty and allow K types to further commit to its specialized assets and exploit the scale efficiencies of specialization.

Conclusions

Amidst rapid technological changes and shifting competing landscapes, understanding when and how firms enter into the bio energy market can be instrumental to a firm's competitive survival. Although there are various considerations that affect a firm's entry timing, the insights of the RBV and Organizational Ecology can be particularly instructive to explaining a firm's entry into the ethanol market. In drawing on these approaches, a central tenet of this study is that a firm's entry timing is dependent on the specialization of their assets to which such specializations introduce a "commitment-flexibility" trade-off that influences a firm's entry into distinct stages of the product market life cycle. This basic argument offers four implications and contributions. First of significant importance is this study's unique application of density dependence theory to the entry of bio energy firms. As the government has multiple objectives in supporting bio energy incubation, public technologies and ethanol subsidies, such objectives can lead to a more dense population, which in turn will affect the capital commitment-flexibility calculus facing bio energy managers and investors. This study shows that entry into the bio energy market can be density dependent in which the R type dry milling firm may be better able to survive in relatively low population conditions than K type cellulosic operations. While, under highly dense environments, the K type cellulosic firm is more likely to enter than the R type dry milling firm. As such density dependence effects can influence the composition of bio energy firms in the

[9] Results are available on request.

market, determining the "optimal" composition of bio energy firms is important. This is because the growth of the bio energy market requires not only innovations by cellulosic firms, but must also be commercially viable (i.e. dry milling). Policies that focus on the development of one (i.e. ethanol subsidies to dry milling) may lead to population conditions that drive out the entry of the other (i.e. cellulosic). Since cellulosic reflects a potentially important technology that can significantly reduce U.S. dependence on foreign oil as well as being more environmentally friendly, such density dependence explanations should, therefore, be considered.

Second, as bio energy entry decisions involve a basic "commitment-flexibility trade-off", such a decision framework can help bio energy managers and investors better understand the trade-offs between that of being a cost efficient processor of cellulosic biomass and that of being an early mover to the uncertainties of an emerging market. The tradeoff problem for managers and investors also in part explains why new technologies, such as cellulosic, often are by-passed in favor of older or "lesser" technologies, such as dry milling. Understanding such a trade-off not only introduces to bio energy managers and investors the distinct rent streams associated with such activities, but understanding such a trade-off can extend more traditional capital budgeting approaches, such as Net Present Value (NPV). In particular, NPV methods have been used to examine the long term profitability of market entry decisions (Briggeman et al. 2006). However, NPV approaches do not account for this commitment-flexibility trade-off nor account for changes in investment value that can arise from different states of nature. The study's DP approach allows bio energy managers and investors to examine such trade-offs in a dynamic context.

Third, from a broader research standpoint, agribusiness and agricultural economists have traditionally drawn on the concept of specialized assets or asset specificity to explain the vertical coordination of markets (e.g. Barry, 1999); (Barry et al. 1992); (Cook and Barry 2004). This study extends the concept of specialized assets to not only explain a bio energy firm's commitment-flexibility trade-off, but also their entry timing. This linking of a firm's specialized asset / asset specificity to such a trade-off has not been recognized by the Resource Based View or by Organizational Ecology explanations of market entry. The significance of this linkage is that this study provides a greater understanding of how specialized assets impact a firm's internal decision processes to which have been absent in both these perspectives.

Lastly, this study suggests entry strategies need to jointly account for a firm's specialized assets with the contingencies of the market environment (i.e. population and uncertainty). Although the RBV has been one of the key influences to the field of strategic management, the RBV has, nevertheless, been criticized for its lack of attention to market conditions (e.g. Priem and Butler 2001). This study extends RBV explanations of entry timing by attributing entry to both the specialized nature of a firm's assets as well as to the uncertain and population conditions of the market. Such an extension argues that firms with specialized assets will favor late as opposed to early entrance. A delayed entry not only leverages greater market certainty and thus reducing risks to a firm's specialized asset, but late entry enables the firm to benefit from the efficiencies of its specialized assets. Such an argument offers one explanation of the entry behaviors of bio energy firms.

On a related note, this explanation also extends more traditional "barrier to entry" explanations. Namely, as barriers to entry stem from exploiting scale economies, it typically involves investments in specialized or dedicated production assets. Hence, Industrial Organizational economic explanations would suggest first mover advantages can arise in the presence of such barriers to entry. Yet, as firms with specialized assets favor late as oppose to early entrance, this specialized asset argument is, thus, not accounted for in barriers to entry explanations.

There are nevertheless theoretical and methodological limitations to our study. Theoretically, Organizational Ecology contends "organizational inertia" limits a firm's ability to change. This is also consistent with RBV reasoning (Priem and Butler 2001). As there has been greater attention to examining organizational change processes (e.g. Ng 2007), changes in a firm's asset profiles can subsequently alter their entry behavior. Thus examination of such change processes is called for in future research.

Another limitation of this study is the DP simulation was constructed for the primary purpose of theory building. Our DP simulation results can only be interpreted as an extension to the logic of our theoretical arguments. A direction for future research is therefore to empirically test the arguments of this model. Lastly, our DP model is based on entry decisions involving discrete entry / exit choices and is based on a finite planning horizon. A limitation of a finite planning horizon is that political interests (i.e. job creation and perceived energy independence) may favor a long term government commitment to U.S. corn-ethanol. In this context, an infinite planning horizon may be a more appropriate representation of the DP model.

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Appendix 1

Market Selection Parameters

Parameter Name	Parameter description	Assigned Value
α	Intrinsic growth rate of pop.	0.5/unit time
η	Carrying capacity of environment	100 firms
N_1	Initial population levels at period 1.	2 firms
N_{15}	Max population levels in period 15.	100 firms
μ	Rate of decline in prices	-0.05 /unit time
Pr_0	Terminal industry price at high population densities.	MC^K (S_t) (MC for K type)
Pr_1	Potential price reduction associated with competitive markets.	MC^R (S_t)-MC^K (S_t) (Differential MC between R type and K types.)

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Pr_1	Potential price reduction associated with competitive markets.	MC^R (S_t)-MC^K (S_t) (Differential MC between R type and K types.)

Firm Asset Specificity Parameters

Parameter Name	Parameter Description	Assigned Value
γ	Organizational learning rate for both R- and K- types	γ =0.0 (simulation one)
B	Discount rate on objective value function	8%
ρ^r (for R type)	Asymptotic marginal cost level.	20/unit
φ^r (for R type)	Potential reductions in marginal cost	20/unit

Firm Asset Specificity Parameters

Strategy Type	Marginal Cost $MC(S_t)$ (Constant)	Fixed Cost FC (Constant)	Firm productive output U.P (Constant)
R-Type	40/unit	50	10 units
K-Type	10/unit	1000	5000 units

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Factors Influencing Growth of Dairy Product Manufacturing in the United States

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Abstract

The paper analyzes factors influencing the growth of the number of dairy product manufacturing establishments in the United States. We hypothesize that the growth pattern is affected by the size of the establishments. The empirical findings presented in the paper suggest that the growth of the number of small-size dairy product manufacturing establishments is strongly affected by the proximity of both input and output markets as well as by the presence of competition from medium-large-size establishments. In contrast, the growth of the number of medium-large-size establishments is affected by the proximity of the input market and the absence of competition from small-size establishments. The proximity of the output market does not seem to have a strong effect on the growth of the number of medium-large-size establishments.

Keywords: dairy product manufacturing, growth, United States.

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Introduction

Food manufacturing is an important segment of the food supply chain that links the agricultural production stage with consumers. Therefore, economic development trends of food manufacturing impact consumers, agricultural producers and performance of the food supply chain as a whole. In the current market environment, consumer demand and changes in consumer preferences are the key factors that influence the growth of food manufacturing industries, and thus create additional demand for agricultural commodities. Many food manufacturing industries establish their businesses in rural areas because these regions provide easy access to agricultural raw materials and to low cost labor. Thus, food manufacturing industries contribute to the economic development of agricultural communities and are traditionally considered to be important determinants of economic development of rural areas.

Location and growth of food manufacturing industries are some of the indicators that have received attention in the previous literature. Past studies (Henderson and McNamara 1997, 2000); (Goetz 1995); (Lambert et al. 2007); (Brown et al. 2008); (Davis and Schluter 2005) have analyzed various factors—often referred to as community attributes –that influence location and growth of food manufacturing industries. These factors are typically associated with agricultural input markets, food industry output markets, labor markets, agglomeration and fiscal policy. These existing studies provide a wide array of results that can be used in developing regional policies as well as in the strategic business decision-making of food manufacturing businesses.

To the best of our knowledge, the following important issues have not been addressed in the existing literature in this area. First, growth patterns of small-scale versus medium-large-scale food manufacturing businesses have not been examined. Some food manufacturing industries are comprised of many small-size food manufacturing establishments, which are likely to have a different growth pattern than medium-large-size establishments. Furthermore, small-scale food manufacturing businesses are likely to be locally owned and/or organized and operated by agricultural producers.

Second, growth patterns of individual food manufacturing industries have received very limited attention. A typical study would analyze all food manufacturing industries aggregated in a single group. According to the U.S. Economic Census, there are nine groups of food manufacturing industries: animal food manufacturing, grain and oilseed milling, sugar and confectionary product manufacturing, fruit and vegetable preserving and specialty food manufacturing, dairy product manufacturing, animal slaughtering and processing, seafood product preparation and packaging, bakeries and tortilla manufacturing, and other food manufacturing. The growth patterns of individual industries are likely to be different from the growth pattern of all food manufacturing industries aggregated in a single group.

Our study aims to address some of the identified gaps in the literature. We focus our analysis on an individual industry, dairy product manufacturing, which is characterized by a relatively large share of small-scale establishments. The objective of our paper is to examine factors influencing the growth of the dairy product manufacturing industry in the United States. In particular, we analyze the growth patterns of two groups of dairy product manufacturing establishments: small-size establishments, those with less than 20 employees, and medium-large-size establishments,

those with more than 20 employees. We use publicly available data reported by the U.S. Census Bureau, U.S. Economic Census, and the U.S. Census of Agriculture. The results of our study can be used by dairy industry participants in developing their strategies and by government authorities in drafting various policies targeting the development of small-scale dairy product manufacturing businesses.

The paper is organized as follows: the next two sections present a review of relevant literature and a brief introduction of the U.S. dairy product manufacturing industry. They are followed by a section discussing the conceptual model, data and hypotheses. Finally, the estimation results and the conclusion of our research are presented.

Literature Review

First, we provide a brief summary of the theory that developed a classification of food manufacturing industries, which is often used in empirical research on economic development trends of food manufacturing industries. Second, we present an overview of empirical studies that analyzed factors influencing the location and growth of food manufacturing industries in the United States. The majority of these studies analyzed the location decisions of food manufacturing industries. The framework used to analyze the patterns of growth is similar to the framework used to analyze location decisions.

Food manufacturing industries are traditionally classified into three categories: supply oriented industries, demand-oriented industries and footloose industries (Connor and Schiek 1997). The supply-oriented industries locate their establishments in areas providing easy access to agricultural input markets. The cost of agricultural inputs represents a high share of the total costs of the firms operating in these industries. In addition, characteristics of many agricultural raw materials such as bulkiness and high perishability are important determinants of the location decisions of these firms. Therefore, supply-oriented industries are typically located in rural areas.

The demand-oriented industries tend to locate their establishments in urban areas. These industries depend on easy access to food manufacturing output markets. The transportation and distribution costs represent a significant share of the total costs of the firms operating in these industries. The footloose industries are involved in the production of multiple products. Neither agricultural input costs nor transportation and distribution costs are prevailing determinants of their location decisions.

Past empirical studies analyzed various factors influencing location decisions and growth of food manufacturing industries (Henderson and McNamara1997, 2000); (Goetz 1995); (Lambert et al. 2007). These factors are typically associated with agricultural input markets, labor markets, food manufacturing industry output markets, agglomeration and fiscal policy. The geographic markets under analysis were as large as the national market and as small as an individual state market. Some studies used publicly available data sources such as the U.S. Economic Census and the U.S. Census of Agriculture to collect variables for empirical analysis, and some studies developed and conducted their own surveys.

Goetz (1997) examined U.S. state- and county-level determinants of food manufacturing growth and focused on the footloose firms. This study found that the level of transportation costs and wages, as well as infrastructure and property taxes, tended to have a negative effect on the growth of the food manufacturing industries. Similarly, Lambert et al. (2007) found that the infrastructure, agglomeration, accessibility of output and input markets, labor markets and fiscal policies were important determinants of the location decisions of the food manufacturing companies.

Singer and Bartels (1996) focused on the U.S. Midwestern States and they found that demand-oriented food manufacturing industries grew more slowly relative to the footloose and supply-oriented industries. A high level of transportation costs tended to prevent demand oriented firms from competing outside the local and regional markets. The footloose and supply oriented industries, on the other hand, were able to take advantage of increasing demand in distant markets. The study found that the wage level was negatively related to the growth of food manufacturing industries, while population was positively related to it. The footloose and supply oriented firms had the greatest potential.

Henderson and McNamara (1997) studied community attributes influencing local food processing growth in the U.S. Corn Belt. Their study found that food processing establishments grew in the communities located near cities that offered quality access to business services and had already established a manufacturing base. The supply-oriented industries tended to expand in areas with easy access to agricultural raw materials. The demand oriented industries grew in the areas characterized by a high population density, thus providing easy access to food industry output markets. The study concluded that rural communities had a smaller chance of attracting food manufacturing industries than urban communities.

Rainey and McNamara (1999) found that the location decisions of firms in Indiana were sensitive to labor costs and productivity, tax level, agglomeration economies, and infrastructure. Also, the presence of development groups influenced a county's success in attracting food manufacturing firms. Holcomb et al. (2000) compared the determinants of plant location for food and non-food agricultural processors in Oklahoma. The authors found that tax and crime rates were some of the major factors considered by both agricultural and non-agricultural food processors. Some other factors influencing the plant location decisions were water availability, skilled labor, telecommunications and quality of life.

Holcomb et al. (1999) studied the location decisions of eight groups of food manufacturing industries that were classified according to the type of product marketed. The results suggest that the availability of utilities, waste disposal, raw materials, and labor strongly influenced the location decisions of these firms. Jensen and Pompelli (2002) studied the location preferences of small agribusiness firms in Tennessee. Their study found that the proximity to buyers and sellers was the most influential factor in selecting location sites. Other factors affecting these decisions included labor supply as well as the proximity and adequate supply of raw materials.

Harrison and Sambidi (2004) examined location decisions of the U.S broiler complex entities. The authors used a conjoint analysis to determine factors that influenced the location decisions of industries involved in broiler growing, feed milling, and broiler processing. This study differs

from other studies in the data collection strategy. The authors interviewed the top executives of broiler firms to collect information about the factors that influenced the location decisions. The results of this study show that the top five factors that affected the location decisions of the broiler companies were feed costs, community attitude toward the broiler industry, availability of geographically concentrated growers, and unemployment rates. Other factors that were found to be important were the road quality between feed mills and growers, and the cost of electricity, heating, and sewage.

Pruitt and Tilley (2008) used both county-level and state-level data to analyze the location patterns of confectionery manufacturers in the post-NAFTA environment. Their study used data from 1993 to 2005 and employed a zero-inflated-poisson model. The results indicate that confectionary industries locate their establishments close to sugarcane and sugar beet refineries. The study also revealed that manufacturers were more likely to locate their businesses in counties close to the Mexican and Canadian borders. Agglomeration had a negative effect on the location of firms due to the presence of competition from the firms concentrated in the area. The variable, NAFTA, which intended to capture the policy effect on location of the firms, was not found to be statistically significant. Finally, the level of wages was found to positively influence location decisions of the confectionary industries.

The U.S. Dairy Product Manufacturing Industry

U.S. dairy product establishments generally tend to locate near dairy farms for easy access to raw milk supply, which makes these firms mostly supply-oriented establishments. Also, small-size establishments are often owned by farmer cooperatives, which tend to operate near the dairy farms. The U.S. dairy product manufacturing industry (NAICS[1] 3115) consists of establishments that produce dairy products from raw milk, processed milk, and dairy substitutes. Dairy product manufacturing includes two industries: dairy product (except frozen) manufacturing (NAICS 31151) and ice cream and frozen dessert manufacturing (NAICS 31152). The former includes four sectors: fluid milk manufacturing (NAICS 311511), creamery butter manufacturing (NAICS311512), cheese manufacturing (NAICS 311513) and dry, condensed and evaporated dairy product manufacturing (NAICS 311514).

Table 1 presents the structure of the U.S. dairy product manufacturing industry. In 2002, there were 1,681 establishments involved in dairy product manufacturing, which represented 6% of all establishments involved in food manufacturing in the United States. The dairy product manufacturing industry generated $66,176 million in value of shipments and garnered $22,292 million in value added. This constituted 14.4% of the value of shipments and 11% of the value added generated by all food manufacturing industries in the United States. In terms of the value of shipments, the two largest sectors are fluid milk manufacturing (37.6%) and cheese manufacturing (33.3%), followed by dry, condensed and evaporated dairy product manufacturing (14.3%), ice cream and frozen dessert manufacturing (12.4%), and creamery butter manufacturing (2.4%).

[1] NAICS North American Classification System.

Table 1. The structure of the U.S. dairy product manufacturing industry (2002).

NAICS Code	Industry Sector	No. of establishments *counts*	Value of shipments *$1,000*	Value added *$1,000*
3115	**Dairy product manufacturing**	**1,681 (100.0)**	**66,175,885 (100.0)**	**22,291,744 (100.0)**
31151	Dairy product (except frozen) manufacturing	1,274(75.8)	57,969,908 (87.6)	17,880,827 (80.2)
311511	Fluid milk manufacturing	528 (31.4)	24,888,743 (37.6)	8,367,532 (37.5)
311512	Creamery butter manufacturing	35 (2.1)	1,604,947 (2.4)	268,567(1.2)
311513	Cheese manufacturing	500 (29.7)	22,006,031 (33.3)	5,002,480 (22.4)
311514	Dry, condensed and evaporated dairy product manufacturing	211 (12.6)	9,470,187 (14.3)	4,242,248 (19.0)
31152	Ice cream and frozen dessert manufacturing	407 (24.2)	8,205,977 (12.4)	4,410,917 (19.8)

The shares of individual dairy product manufacturing sectors in the total dairy product manufacturing are in the parentheses.

Table 2 presents the distribution of dairy product manufacturing establishments of different sizes from the years 1997 and 2002. During this time, the total number of establishments decreased from 1,830 in 1997 to 1,677 in 2002, or by approximately 8%. The number of small-size establishments, those with less than 20 employees, decreased from 791 in 1997 to 759 in 2002, or by 4%. The number of medium-large-size establishments, those with more than 20 employees, decreased from 1,039 in 1997 to 918 in 2002, or by almost 12%. However, the share of small-size establishments increased from 43.2% in 1997 to 45.3% in 2002. The share of medium-large-size establishments decreased from 56.8% in 1997 to 54.7% in 2002.

Table 2. The U.S. dairy product manufacturing: Number of establishments (1997-2002).

Size	1997 number (% of the total)	2002 number (% of the total)	Difference 2002-1997 (% change)
Small-size establishments (less than 20 employees)	791 (43.2)	759 (45.3)	- 32 (-4.0)
Medium-large-size establishments (more than 20 employees)	1,039 (56.8)	918 (54.7)	-121 (-11.6)
Total	1,830 (100.0)	1,677 (100.0)	- 153 (-8.4)

As for the individual states, Wisconsin had the largest number of total dairy product manufacturing establishments (240) in both 1997 and 2002. In 1997, Wisconsin also had the largest number of medium-large-size dairy product manufacturing establishments (147). In 2002 California reported the largest number of medium-large-size dairy manufacturing establishments (109). California had the largest number of small-size dairy product manufacturing establishments in 1997 (92). The states with the smallest number of the total dairy product manufacturing establishments in 2002 were Mississippi, Delaware and West Virginia; in 1997 it was West Virginia with four establishments. The states with the fewest number of medium-large-size establishments in 2002 were West Virginia, New Hampshire and Delaware. Each of these

states had two manufacturing establishments reported. The states with the smallest number of small-size establishments in 1997 was Mississippi with zero establishments reported. The average number of dairy product manufacturing establishments per state in 1997 was 38 and it decreased to 35 in 2002.

Conceptual Model, Data and Hypotheses

Following the approaches used by previous studies, we hypothesize that the growth of the dairy product manufacturing industry depends on access to dairy industry input and output markets, labor markets, and agglomeration. Therefore, the conceptual model used in this study is represented as:

$$Growth = f(Input\ Markets, Output\ Markets, Labor\ Markets, Agglomeration)$$

This model is used to study the growth of dairy product manufacturing establishments using state-level data. We hypothesize that the growth pattern of dairy product manufacturing establishments depends on their size, and thus we expect to find differences in the patterns of growth between small-size and medium-large-size dairy product manufacturing establishments. Our variable of interest (i.e., "Growth") is a change (i.e., increase or decrease) in the number of dairy product manufacturing establishments. Growth is calculated as the difference in the total number of dairy product manufacturing establishments in each state during the years 1997 and 2002, and is the dependent variable in our econometric models. This measure takes into account the effect of new establishments, establishments that exited the industry, and the establishments that were active during these two years. To collect data on the number of establishments, we used the U.S. Economic Census surveys that are conducted every five years; 1997 and 2002 are the most recent surveys for which data is publicly available.[2]

We considered the state-level analysis for two main reasons. First, the vast majority of counties in many states do not have dairy product manufacturing establishments. Second, in the cases of the counties with few establishments, there are data reporting problems. In particular, the total number of dairy product manufacturing establishments reported on a state level is not equal to the sum of the number of dairy product manufacturing establishments across all counties in the state. Also, we had to eliminate five states (Alaska, Minnesota, Oklahoma, Rhode Island, and Wyoming) from our study due to unavailable data.

Based on the approach used by the U.S. Economic Census to report data, we define a small-size establishment as one having less than 20 employees and we define a medium-large-size establishment as one having more than 20 employees. The U.S. Economic Census provides data on the total number of establishments and the number of establishments with 20 or more employees. Based on this information, we calculate the number of establishments with less than 20 employees (i.e., small-size dairy product manufacturing establishments). We analyze the growth characteristics of three groups of dairy product manufacturing establishments: small-size establishments, medium-large-size establishments and the overall group. Small-size

[2] The 2007 U.S. Economic Census data are not available yet.

establishments are likely to be locally owned businesses, and in many cases they are owned by dairy producers.

Table 3 presents descriptive statistics characterizing the overall sample used in the regression analysis. The average market value of raw dairy products sold in each state was $394 million during the analyzed period. The average population was about 6 million people. The average number of people with high school education or higher was about 3 million. The average hourly wage of a production worker was $13. The average per capita income was about $20,000.

Table 3. Growth of dairy product manufacturing establishments in the United States: Descriptive statistics

Variable Name	Units	Mean	St. Dev	Minimum	Maximum
All Dairy Est. 2002	count	35	46.97	4	240
Medium-Large Est. 2002	count	19	25.84	2	146
Small Est. 2002	count	16	48.97	1	109
All Dairy Est. 1997	count	38	56.97	4	240
Medium-Large Est.1997	count	22	57.97	2	148
Small Est. 1997	count	16	58.97	0	96
Independent Variables	***Input and Output Market***				
Population	million	6.00	6.38	0.61	33.87
Value of raw dairy products	$ million	394.14	638.36	19.26	3177.8
	Labor Market				
Education	million	3.12	3.18	0.34	16.36
Wage	$ per hour	13.02	1.79	9.95	17.87
Per capita income	thousand	20.76	2.92	15.85	28.77
	Agglomeration				
Concentration	count	38.49	48.31	4.00	240.00
Small-size/medium-size	ratio	1.59	1.13	0.00	6.00

Using the conceptual model and data collected, we estimate an econometric model for each of the identified groups of dairy product manufacturing establishments. While the dependent variables differ across these models, the same independent variables are used in all three models. These independent variables represent dairy product manufacturing industry input and output markets, labor markets, and agglomeration. Table 4 summarizes the explanatory variables, their expected signs and the data sources used to collect information for each variable. Below we provide a discussion of the variables and the corresponding hypotheses.

Dairy industry input and output market. The growth of food manufacturing establishments is affected by the availability and accessibility of agricultural input and output markets (Turhan et al. 2007); (Lambert et al. 2007). Supply oriented industries locate their establishments close to the sources of raw materials to ensure the quality of the raw materials needed for processing. Also, the firms save on transport costs due to the bulky nature and high perishability of the raw materials. Demand oriented industries locate their establishments close to the output markets to minimize transportation costs. The location decisions of the footloose industries are independent of the source of raw materials or the output market (Connor and Schiek 1997). The proximity of both the output and input markets decreases transportation costs and provides better information for decision-making (Rainey et al. 1999).

Table 4. The explanatory variables and data sources

Variable (Expected Sign)	Definition	Data Source
Dairy product manufacturing input market		
Value of raw dairy products (+)	Market value of raw dairy products (1997)	U.S. Census of Agriculture
Dairy product manufacturing output market		
Population (+)	Population (2000)	U.S. Census Bureau
Income (+)	Per capita income (1999)	U.S. Census Bureau
Labor market		
Education (+)	Number of people with at least high school degree (2000)	U.S. Census Bureau
Wage (-)	Ratio of production workers' wages to production workers' hours(1997)	Calculated using data reported by the U.S. Economic Census
Agglomeration effect		
Concentration (-)	Number of dairy product manufacturing establishments (1997)	U.S. Economic Census
Small-size/medium-large-size establishments ratio (+)	Ratio of the number of small-size establishments to the number of medium-large-size establishments (1997)	Calculated using data reported by the U.S. Economic Census

Data collected at state level.

In general, the proximity of agricultural input markets is more important to supply oriented firms because of the unique nature of the products that they use in food manufacturing (i.e., bulkiness and high perishability). The supply oriented firms are able to minimize the cost of transportation when they locate close to the input sources. Lambert et al. (2007) reported that higher value crops tend to be produced near urban centers, while lower value crops are produced in noncore regions. This study found that the proximity of the input market had a positive and significant effect on the location decisions of food industries. Henderson and McNamara (1997, 2000) and Lambert et al. (2007) used the sum of cash receipts for crops and livestock in each county as a measure of access to raw materials. Following these studies, we use the value of raw dairy products to measure the availability of raw materials in each state. This variable is expected to be positively related to the growth of the number of dairy product manufacturing establishments, independent of their size.

It is hypothesized that access and proximity to the product market has a positive effect on the location and growth of food manufacturing establishments. Population and per capita income have been used by previous studies to measure the size of the product market. Following Lambert et al. (2007), Henderson et al. (1997), and Pruitt and Tilley (2008), we use per capita income to measure the relative purchasing power of residents in the state. State population is used to measure the number of people in the state, which also indicates the size of market demand. Both input and output market variables are hypothesized to have a positive effect on the location decisions and on the growth of food manufacturing industries.

Labor Market. The productivity of food manufacturing depends on labor availability and diversity (Lambert et al. 2006, 2007, 2008). Rural areas will use labor as a means of attracting new manufacturing plants, which is a key economic development strategy (Davis and Schuler 2005). This is because most rural areas have a high percentage of unskilled labor earning low wages. Labor as a factor that influences the location and growth decisions of firms can be

characterized in terms of quality, quantity and cost. A county with a high level of labor heterogeneity will be able to attract and maintain more manufacturing establishments than those with a low level of labor heterogeneity (Davis and Schuler 2005).

A set of the labor market variables captures the effect of the quality, quantity, and cost of labor. A proportion of the population having a higher education is a proxy for labor quality. Following Henderson and McNamara (2000), Brown et al. (2009), and Pruitt and Tilley (2008), we used the number of people over 25 years of age and having at least a high school education to measure labor quality. A high level of labor quality leads to greater productivity and lower cost (Lambert et al. 2008).

Population is used to measure the availability of labor in the county (Lambert 2007); (Henderson and McNamara1997, 2000). A higher population in a county will provide firms with a larger labor pool (Lambert et al. 2008). We hypothesize that a large population base will have a positive effect on the location and growth of the firm. The cost of labor is also an important factor, as firms tend to locate their establishments in low labor cost areas (Lambert et al. 2008). A high labor cost is generally expected to have a negative effect on the location and the growth of firms, as a higher labor cost increases the cost of production (Brown et al. 2009); Lambert et al. 2008, 2007). However, this is not always the case, as Chen (2006) showed that firms will locate in regions with high cost of labor, which could indicate a high quality of labor and lifestyle of the people in the county. To measure the cost of labor, we use the ratio of the annual production workers' wages to the total number of production worker hours in dairy product manufacturing, which is the cost of one production worker hour.

Agglomeration. Agglomeration characterizes the intensity of business activities in and around a specific geographic area. The positive features of agglomeration include easier access to other businesses, a lower transport cost, and skilled labor availability. O'Sullivan (2003) observes that when firms locate close to each other, they can produce at a lower cost. Conversely, agglomeration could lead to more severe competition among firms, leading to higher input prices (Cohen and Morrison 2005). These positive and negative effects of agglomeration are more pronounced in rural areas because of remoteness and limited resources.

Henderson and McNamara (1997) used total population, the percentage of people employed in a manufacturing industry, and the total number of business service establishments as measures of agglomeration. Similarly, Togo and Arikwa (2002) used the number of establishments to measure industry agglomeration because of a high correlation between the number of establishments and the level of investment.

In our study, two variables are used to quantify agglomeration. The first is the concentration of dairy product establishments existing in a state in the previous period as a proxy for the agglomeration effect. This measure has also been used by other studies (Henderson and McNamara 1997, 2000); (Goetz 1997); and (Pruitt and Tilley 2008). This variable is hypothesized to have a negative effect on the growth of the number of dairy product manufacturing establishments because the more establishments there are in the current period, the less likely the total number of establishments is to increase in the future. The more establishments there are in the current period indicates that competition is very high, which means lower profitability and discourages firms to locate in this area in the future. Second, we

develop a new variable that is calculated as a ratio of the number of small-size establishments to the number of medium-large-size establishments. This variable captures the effect of competition between the small-size and medium-large-size dairy product manufacturing establishments in the region. An increase in this ratio is expected to have a positive effect on the growth of the number of dairy product manufacturing establishments.

Results

The ordinary least square (OLS) technique was used to estimate the three models: all, medium-large-size, and small-size dairy product manufacturing establishments. We used a Breusch-Pagan method to test for the presence of heteroskedasticity. The results indicate that at the 5% level, heteroskedasticity was present in the model for all dairy manufacturing establishments and also for the small dairy manufacturing establishments. We therefore corrected for the heteroskedasticity for these two models using White's robust covariance matrix approach. The Breusch-Pagan test for medium-large-size dairy manufacturing establishments did not indicate the presence of the heteroskedasticity.

Table 5. Factors explaining growth of dairy product manufacturing establishments in the U.S.: OLS Estimation Results.

Variable	**Dairy Product Manufacturing Establishments**		
	All	Medium-Large > 20 employees	Small < 20 employees
Dairy product manufacturing input market			
Value of raw dairy products	0.65E-02**	0.23E-02	0.42E-02**
	(1.93)	(1.06)	(1.66)
Dairy product manufacturing output market			
Population	5.13**	-0.31	5.44***
	(1.90)	(-0.33)	(3.21)
Per capita income	0.56*	-0.11E-01	0.57***
	(1.60)	(-0.62E-01)	(2.38)
Labor market			
Education	-10.40**	0.24	-10.64***
	(-1.82)	(0.12)	(-3.00)
Wage	-0.27	0.81E-01	-0.35
	(-0.63)	(0.31)	(-1.08)
Agglomeration effect			
Concentration	-0.89E-01	-0.38E-01*	-0.51E-01*
	(-1.60)	(-1.31)	(-1.33)
The ratio of small-size to medium-large-size establishments	0.21	-0.47*	0.68***
	(0.59)	(-1.30)	(2.48)
R_2	0.37	0.30	0.58
Breusch-Pagan P values	0.00	0.24	0.00
Number of observations	45	45	45

The dependent variable is a change in the number of dairy product manufacturing establishments between 1997 and 2002. The data are collected at the state level. The entries in the cells are the estimated coefficients. *, **, *** indicates statistical significance using a one-sided Z-test at a 10%, 5% and 1% significance level. T-ratios are in parentheses.

Table 5 presents the OLS estimation results for the growth models based on all, medium-large-size, and small-size dairy product manufacturing establishments. Our empirical findings indicate that there are differences in the pattern of growth for small-size and medium-large-size establishments.

In the case of small-size dairy product manufacturing establishments, the concentration of establishments was found to be significant at the 10% level. Market value of raw dairy products was found to be statistically significant at the 5% level. Per capita income, the level of competition between the small-size and medium-large-size establishments, labor quality, and population were also significant at a 1% level. An increase in the market value of raw dairy products, an increase in population, or an increase in per capita income would result in an increase in the number of small-size dairy product manufacturing establishments in the region. An increase in the labor quality would have a negative effect on the growth of the number of small-size establishments.

The sign of the labor quality coefficient for all establishments and small-size establishments contradicts our hypothesis, and it is statistically significant. Similar to the result of Chen (2006) we note that a high labor quality could be associated with a high level of wage rate and this could be an explanation to the negative relation between the labor quality and growth. It is also possible that small firms may not be able to afford high labor quality. Therefore, a high quality of labor in the state may have a negative effect on the growth of the dairy manufacturing industry. The sign of the cost of labor coefficient is consistent with our hypothesis; however, the coefficient is not statistically significant.

The small-size dairy product manufacturing establishments tend to grow in the areas where their number was small in the previous period and in the areas where the number of small-size establishments is large relative to the number of medium-large-size establishments. In summary, our results suggest that the growth of small-size dairy product manufacturing is strongly affected by the proximity of both the input and output markets and by the presence of competition between the small-size and medium-large-size establishments. The pattern describing growth of all dairy product manufacturing establishments is similar to the pattern describing growth of small-size dairy product manufacturing establishments.

In the case of medium-large-size dairy product manufacturing establishments, only two variables are statistically related to the growth of this group of establishments: concentration and the ratio of small-size to medium-large-size establishments. These were both significant at a 10% level. The medium-large-size dairy product manufacturing establishments tend to grow in the areas where their number was small in the previous period and in the areas where the level of competition from small-size establishments is relatively low (i.e., the ratio of small-size to medium-large-size establishments is relatively small). Unlike in the other two models, the estimated coefficient for the variable– the value of raw dairy products – is statistically insignificant for the medium-large dairy establishments.

The signs of the estimated coefficients for the variables – population, per capita income, the level of education, and wage – are not as expected and also not statistically significant. In summary, our empirical results may suggest that the proximity of the input market is likely to have a much

stronger effect on the growth of medium-large-size dairy product manufacturing establishments than the proximity of the output market. In addition, the presence of competition from small-size dairy product manufacturing establishments is likely to have a negative effect on the growth of medium-large-size dairy product manufacturing establishments.

Conclusion

Our study provides empirical evidence suggesting that the patterns of growth of the number of small-size and medium-large-size dairy product manufacturing establishments in the United States are different. The results show that the proximity of the dairy industry output market strongly affects the growth of the number of small-size establishments. However, the proximity of the output market is not likely to be a significant determinant of the growth of the number of medium-large-size establishments. The number of small-size dairy product manufacturing establishments tends to grow in the areas where the level of per capita income and population are high. Furthermore, the number of small-size establishments tends to increase in the areas where there are many small-size establishments relative to the number of medium-large-size establishments. In contrast, the number of medium-large-size establishments tends to increase in the areas where the level of competition from the small-size establishments is low. We find that the market value of raw dairy products produced in the area has a positive effect on the growth of the number of dairy product manufacturing establishments regardless of their size.

Compared to the previous literature focusing on location and growth of all food manufacturing industries as a group, we find that factors explaining the growth of dairy product manufacturing establishments are similar to those explaining the growth of all food manufacturing industries as a group. An important finding of our study is that growth patterns of small-size and medium-large-size dairy product manufacturing establishments are somewhat different. This has implications for developing policies that target economic development of small-scale dairy product manufacturing businesses and for the strategic decision-making of dairy product manufacturing industry participants.

Our study determines the factors that affect the growth of different sizes of dairy manufacturing establishments. Results and implications that could be drawn from this study are important for economic development and employment opportunities. The study also showed that manufacturing establishments could still serve as an important development strategy for rural areas in America, since they have the raw materials, available labor, and have a lower concentration of other establishments in the region. States that produce dairy products could use the results of this study as a means of attracting other businesses into the region. The results of this study indicate that the development of allied “input and output” industries is important to attract dairy product manufacturing firms and thus to the economic growth and development of rural areas. Policy implications that can be drawn in this study are that rural areas can still rely on attracting and maintaining manufacturing establishments for their long-term development goals.

Rural areas with access to metropolitan counties have always been considered as having a comparative advantage in attracting manufacturing establishments because they have relatively abundant low-skilled labor as well as inputs needed for production. Results from this study show

that rural areas could still rely on the presence and growth of dairy establishments as an economic development strategy for the state. Small manufacturing establishments have an important role in the economic development of the rural sectors of most states. The majority of these small establishments are owned by farmer cooperatives of the rural area. These small establishments serve as means of employment to the people in the rural area which also leads to the improvement of the living conditions of these people. It is important that policy makers consider means for assisting small manufacturing establishments to allow them to grow because many small manufacturing establishments are going out of business.

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Appellation of Origin Status and Economic Development: A Case Study of the Mezcal Industry

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Abstract

Mezcal is an alcoholic beverage produced only in selected regions of Mexico under appellation of origin status from the Word Intellectual Property Organization. While it has been produced in Mexico for many centuries, mezcal's appellation of origin was only granted in 1995. Therefore efforts to produce and market it as a premium product have a relatively short history. This case study examines developments in the production and marketing of this unique product, and the activities of the marketing cooperative El Tecuán in Guerrero State in this process.

Keywords: mezcal, Mexico, appellation, marketing, cooperative

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Introduction

In 2009, members of El Comité Nacional del Sistema-Producto Maguey-Mezcal in México (i.e., the National Committee of Mezcal) were satisfied with their achievements in the mezcal industry[1] . The status of this industry looked very different in 2009 compared to 2005, when the National Committee of Mezcal first started to work for the mezcal industry (Figure 1, an excerpt of the 2005-2009 evaluation report by The National Committee of Mezcal). In 2006, only 23% of consumers in Mexico perceived mezcal to be a high quality alcoholic beverage. By 2008, this number rose to 41%, and in September 2009, mezcal was sold in "El Palacio de Hierro," one of the most exclusive stores in Mexico, for the first time. Promotional efforts targeting the international market were also beginning to show signs of success. Though the development of the mezcal market had come a long way, there were still many challenges the National Committee of Mezcal wanted to address in order to further help this industry.

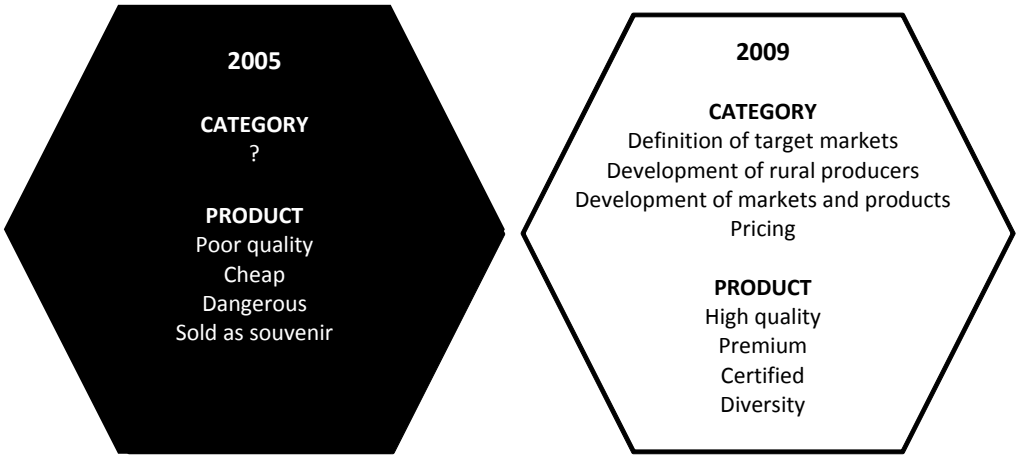


Figure 1. Selected Characteristics of the Mezcal Industry in Mexico, 2005 and 2009.
Source: El Comité Nacional del Sistema-Producto Maguey-Mezcal, 2005-2009 Evaluation

This article documents the evolution of the mezcal industry from the mid 1990s to 2009. The objective is to analyze the reorganization of industries following appellation of origin protection. Using the case methodology we focus on the appellation mezcal, which was granted to some areas of Mexico by the World Intellectual Property Organization in 1995.

The next section describes the production process and product line of mezcal. This is followed by the process of appellation of origin and the knowledge base on product differentiation based on geographic indications, emphasizing the case of mezcal. The marketing cooperative El Tecuán, which is considered by the authors a representative of the mezcal enterprise is introduced. The successes and current challenges of El Tecuán are documented in the context of the appellation mezcal from 1995 to 2009. After analyzing the value chain and comparing mezcal and tequila, some concluding remarks follow.

[1] Maguey is synonymous with agave, the plant from which mezcal is obtained.

The Liquor Mezcal

Production Process and Types of Mezcal

Mezcal is an authentic Mexican alcoholic beverage produced from the agave plant, commonly known as maguey in Mexico. The beverage is obtained by distilling cooked and fermented agave plants. Agave plants are harvested at maturity (seven to nine years) when the plants produce their single flower. The heads of the plants, with high concentrations of sugar, are slowly cooked in underground pits for three to five days. After this they are chilled and crumbled with mallets or mechanical mills. The remaining pulp is fermented in wooden vats with natural yeasts for ten to twelve days. The fermented pulp is then distilled (distillation involved the separation and concentration of the alcohol from the pulp) twice in copper stills. Mezcal production methods have been passed down from generation to generation for centuries.

After this process, the mezcal is ready for sale as white or young mezcal. Young mezcal can also be aged in wooden barrels, which allows the liquor to acquire a golden color and the flavor to be enhanced. Mezcal aged from four months to a year is known as rested, and mezcal aged for at least one year is known as aged. In addition to aging, mezcal producers can soften and smooth the flavor of mezcal by adding herbs or fruits, obtaining a semisweet mezcal. Thus, young, rested, aged, and semisweet mezcals are marketed.

According to the Mexican Official Standard for Production of Mezcal, administered by the Ministry of Economy, two types of mezcals can be produced: "Type I or 100% Agave Mezcal" (which is made only from the agave plant, meaning that only agave sugars were used for fermentation) and "Type II or Plain Mezcal" (which can contain up to 20% of fermenting sugars from sources other than agave) (DOF-IMPI (1994)).

Bottling

The Mexican Official Standard for the Production of Mezcal contains the specifications for raw materials and beverage production, bottling, and labeling. The establishment of bottling and marketing enterprises could increase sales opportunities by ensuring a consistent and high quality mezcal, providing traceability, and helping to ensure that the agave is harvested in a sustainable manner (Marshal, Schreckenberg and Newton (2006)). The establishment of bottling companies, however, was very challenging for several reasons. Mezcal is produced in areas with high levels of poverty, where most of the producers are organized as cooperatives. In addition, access to legal, financing, and market information was difficult for small farmers in the mezcal production areas. Technology was a constraint as well and available equipment for bottling in the market was designed for producing high volumes that could not be reached by individual mezcal enterprises in Mexico (UNEP World Conservation Monitoring Centre (2002)). For these reasons, leadership to organize the value chain was a key to success.

Geographical Indications and Product Differentiation

In 1995, some areas of Mexico were granted appellation of origin protection as exclusive areas to produce mezcal by the World Intellectual Property Organization under the Lisbon Agreement.[2]

[2] Lisbon Agreement for the Protection of Appellations of Origin and their International Registration.

Appellations of origin are based on geographical names or traditional designations used on products that have a specific quality and characteristic that are exclusively or essentially due to the geographical environment, including natural and human factors[3]. The term appellation of origin is a special kind of geographical indication[4] that encompasses more than just the geographical location of production. To obtain the appellation of origin, the product must also have characteristics that are part of the product, beyond just the location of production. Thus, all appellations of origin are geographical indications, but some geographical indications are not appellations of origin. Obtaining appellations is a complex process (Exhibit 1). Under the Lisbon Agreement, mezcal can only be produced in certain regions of world, all located in Mexico (Figure 2).

Figure 2. Areas for Production of Mezcal in Mexico
(1) State of Oaxaca, (2) Guerrero, (3) Guanajuato, (4) San Luis Potosi, (5) Zacatecas, (6) Durango, (7) Tamaulipas.
Source: www.sientemezcal.com (accessed on December 20, 2009).

[3] Lisbon Agreement: Article 2, Section 1. Available at: http://www.wipo.int/lisbon/en/legal_texts/lisbon_agreement.htm#P22_1099 Accessed on December 29, 2009.
[4] Geographical indications (GIs) are signs "… which identify a good as originating in the territory of a [World Trade Organization] Member, or a region or locality in that territory, where a given quality, reputation or other characteristics of the good is essentially attributable to its geographic origin." (The Word Trade Organization's Agreement of Trade-Related Aspects of Intellectual Property Rights (TRIPS), Part II, Section 22.1).

Exhibit 1. Appellation of Origin Protection

The Mexican Institute of Intellectual Property (IMPI, or Instituto Mexicano de la Propiedad Industrial) is the institution authorized in Mexico to declare protection of an appellation of origin ex officio or at the request of a party demonstrating legal interest (by individuals or firms devoted to the extraction, production, or preparation of the product for which coverage is provided by the appellation of origin; by chambers or association of producers; or by the government) [Adapted from The Mexican Industrial Property Law (Ley Industrial de la Propiedad [de México]), Articles 1 and 158].

After all requirements are satisfied, IMPI publishes an extract of the application in the Official Gazette of the Federation (Diario Oficial de la Federation) and a two month period is allowed for third parties to raise objections, if any. Once the appellation of origin is granted IMPI publishes a decree in the Official Gazette of the Federation.

In the case of mezcal, The National Chamber of the Industry of Mezcal applied for appellation protection. Appellation protection was granted and published in the Official Gazette of the Federation on November 28, 1994 (an amendment to extend the geographical area was published on 1998). The publication included definitions, reference to official standards for the control of mezcal production, types of mezcal, legal matters, and regions of production for mezcal (DOF-IMPI (1994)). The states of Oaxaca, Guerrero, Durango, San Luis Potosi, and Zacatecas were declared as the territories where mezcal could be produced and bottled (the states of Guanajuato and Tamaulipas were later included in an amendment).

International Registration of Appellation of Origin

After a country designates appellation protection, international registration is requested by the authorized office of the country of origin in the name of any natural persons or legal entities, public or private, having a right to use such appellations [Adapted from the Lisbon Agreement, Article 5(1)]. The International Bureau of Intellectual Property of the World Intellectual Property Organization, without delay, notifies the countries to which the Lisbon Agreement applies of such registrations, and publishes them [Adapted from the Lisbon Agreement, Article 5(5)].
In the case of mezcal, IMPI applied for international registration of appellation of origin, which was granted on March 3, 1995 [appellation of origin number 731, Lisbon Agreement data base].

Protection of appellation

Following registration under the Lisbon Agreement, all countries to which the Lisbon Agreement applies agree to protect in their territories the appellations of origin of products of the other countries recognized and protected as such in the country of origin and registered at the International Bureau of Intellectual Property [Adapted from the Lisbon Agreement, Article 1(2)]. Protection is granted against any usurpation or imitation of the appellation of origin, even if the true origin of the product is indicated or if the appellation is used in translated form or accompanied by terms such as “kind,” “like,” “imitation,” or the like [Adapted from the Lisbon Agreement, Article 3]. For more information on the process of registering appellation of origin, see Rodriguez-Cisneros (2001).

Famous appellations of origin include Champagne, Prosciutto di Parma, Tequila, Roquefort Cheese, and cigars from Cuba among others. While these probably come to mind as high quality products, many appellations do not have such appreciation in terms of quality. Some research has documented price premiums associated with geographical indications (Carsten and Maskus (2006), Malorgio, Camanzi and Grazia (2007), and Teuber (2007)).

Like trademarks, appellations of origin and geographical indications, are forms of intellectual property. However, trademarks and geographical indications have important differences. A trademark is not limited by a territory and a geographical indication is linked to a geographical area. However, a trademark or certification mark can protect a product based on its origin or region of production. Secondly, while a trademark is a private right owned by a particular firm or by a trade association or group of producers in the case of certification marks (e.g., Indian River Citrus, owned by the Indian River Citrus League), geographical indications, and in particular appellations of origin are public rights, usually owned by a country (i.e., Mexico is the owner of the appellation mezcal).

These characteristics bring opportunities and problems for producers in an area with appellation of origin. The appellation functions as a barrier to entry for producers outside the geographical area protected. Because of this, an appellation of origin has been referred to as a collective monopoly right, which has the additional advantage of allowing the producers to differentiate their product in the market (Rangnekar (2004)). Thus, these advantages give producers an opportunity to capture the rents embedded in the appellation.

Rangnekar (2004) presents a mini case of mezcal as an example of strategies to penetrate external and distant markets through product differentiation. Apart from the two "types" of mezcal protected, there are other mezcal categories produced. Mezcal can be compared to whiskey in this regard (Table 1).

Table 1. Mezcal Portfolio of Products with Reference to Whiskey

Mezcal Product Differentiation	Description	Reference to Whiskey
100% Agave Mezcal	Type I (DOF-IMPI 1994)	Pure Malt Whiskey
Mexican Mezcal	Type II (DOF-IMPI 1994)	Scotch Whiskey
Blended Mezcal	From different agaves or semiweet mezcals	Blended Malts
Single Mezcal	From a single distillery or a single distillation batch	Single Malts
Mezcal Papalote de Guerrero	From *Agave cupreata*, variety grown in the State of Guerrero, also known locally as "Papalote", "Macho," or "Criollo (Wild)"	Speyside Single Malt

Source: Adapted from Rangnekar (2004)

Potential problems also arise by the shared nature of an appellation of origin. One concern is the existence of low-quality producers (free riders) taking advantage of the appellation and undermining the reputation of the generic product (Carsten and Maskus (2006)). While this concern is usually overcome by regulatory institutions, the transactional cost involved in

monitoring free riders is not trivial, and this might not be achieved. For mezcal, The Mexican Council for Quality Regulation of Mezcal (COMERCAM) was created in 1997[5] with the purpose of protecting the reputation of mezcal.

Also, efforts to coordinate, enforce, and jointly market products under appellations of origin are challenging. As the products themselves pre-exist their appellation of origin registration and protection (i.e., mezcal has been produced for centuries), the process of registration entails some reorganization of the existing supply chain, thus generating new economic opportunities for some producers while creating problems for others (Rangnekar (2004)).

El Tecuán- A Representative Mezcal Enterprise[6]

The members of the cooperative of Mezcal of Guerrero El Tecuán (El Tecuán) were peasants, living in the State of Guerrero in Mexico (Figure 2)[7]. The States of Guerrero and Oaxaca are the poorest States in Mexico. Although many of the members of El Tecuán spoke Spanish, others only spoke Náhuatl, a dialect originating with the ancient Aztecs.

To make a living, the peasant families of the central zone and mountainous state of Guerrero diversified their activities between subsistence agriculture, small scale livestock production, production of handicrafts, and wage labor. With each generation, more persons had to look for work in other parts of the country to earn enough to support their families. Many sent one or more family members to the United States to earn money to send back to Mexico. The "fabriqueros" (from the Spanish word "fabrica" or factory), as owners of the mezcal distilleries were known, were the few fortunate ones who did not need to emigrate to support their families (Marshal, Schreckenberg and Newton (2006)).

El Tecuán was started as a cooperative in 1994 with around one hundred members from five communities of the central zone of Guerrero. Like other cooperatives, El Tecuán was focused on serving the needs of the member-users. According to the cooperative structure of business, each member of El Tecuán had an equal vote on strategic issues, meaning management would need to convince the majority of members that this path was the correct one to take. This made managing more challenging than in a corporation, where voting rights belonged to shareholders based on shares held. For regular management issues, the cooperative was led by an Administrative Council elected by the members of the cooperative, and by an operations manager. El Tecuán was formed as a marketing cooperative, which meant the business took the mezcal produced by the members, and with greater volume than an individual producer would have, the cooperative would then market the product more extensively and return the profits to the members based on how much mezcal they contributed.

[5] More on COMERCAM in section "The Value Chain of Mezcal"
[6] This part of the case relies mainly on information from a master thesis co-directed by two of the authors, on interviews by the authors with employees from the cooperative, and on secondary sources.
[7] The official name of the cooperative was *Union de Productores de Mezcal Xochicalehuatl SPR de RL*. Locally, the cooperative was known as El Tecuán.

The cooperative's first Administrative Council elected by the assembly consisted of Don Fili[8], Don Adolfo, and Don Jesús, with Don Fili acting as President. This council began the challenging job of organizing and developing cohesion among mezcal producers, consolidating the organization, obtaining recognition and help from governmental authorities, developing and accrediting their products, and learning how to do business. A decade later, in 2005, acting as President of the Council of Agave-Mezcal of the State of Guerrero (El Consejo Estatal Maguey-Mezcal de Guerrero), Don Fili referred to the beginning of El Tecuán in a television program sponsored by INCA Rural, an institution promoting rural development in Mexico: *"The government officers wanted us, the mezcal producers, to officially incorporate as a company and pay taxes, they encouraged and supported us to work together as producers and to establish a bottling firm, they wanted us to do many things we did not know how to do, we only knew how to produce mezcal"* (INCA-Rural (2005), p.4).

In 1995, El Tecuán received help from the federal government to replant agave on land in their community because the plant retains water that can nourish streams and flowers and help the regeneration of the base organic material. The terrain where the agaves were replanted was not suitable for any other type of agriculture and in the majority of the cases, the land was deforested and erosion was becoming a large problem. The members of El Tecuán planted the agaves in a natural (wild) and organic manner without destroying the forest contributed to the rebuilding and protecting of the land.

By 1996 El Tecuán obtained their registration from the tax authorities (Secretaría de Salubridad y Asistencia and Secretaría de Hacienda y Crédito Público). A former Governor of the state of Guerrero, whose support was fundamental for the process, said this gave the cooperative the ability "to claim ancient cultural values and to dignify their honest work" (Leduc-García (2004)). The pioneers of El Tecuán achieved their goal that the producers of mezcal of Guerrero could work in the public light and enjoy the guarantees offered by the law through the hard work of many people.

Beginning in 1998, the operations of El Tecuán had three lines of business: producing and bottling mezcal (wholesale trade), a store (direct – retail sales), and a restaurant. Producing and bottling mezcal constituted the principal business for the cooperative, with wholesale trade representing 87% of total revenues by 2005.

Early in 2004, Mr. Adolfo Rojas, Don Adolfo, took over as President, replacing Don Fili, who continued as a member of El Tecuán Administrative Council but whose priority shifted to working on behalf of all of the mezcal producers in the state of Guerrero, who had already started to organize themselves as an industry. Don Adolfo's background was not very different from the rest of the members of the cooperative. He learned to make mezcal with his father after turning twelve. A fifth generation mezcalero, he inherited his father's factory and the commitment to preserve his family's tradition.

Brands of El Tecuán

In Náhuatl tecuán means jaguar. Traditionally, the tecuán has been the main character of the festivals of all the communities of central Guerrero. With the establishment of the cooperative,

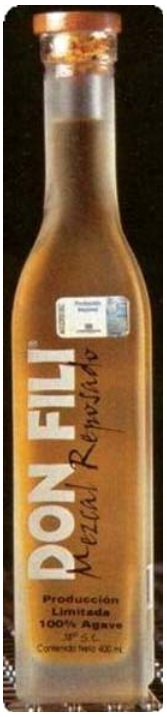
[8] In Spanish, "Don" is a title of respect.

El Tecuán, the jaguar also became the emblem of the cooperative. Indeed, the first brand of mezcal bottled for the cooperative was named Tecuán in honor of this tradition (Figure 3). Tecuán was a young mezcal, 100% from the agave plant. The first boxes with the brand name Tecuán were sold at the end of 1997. Tecuán was sold by specialized merchants and restaurants in the main cities of central Guerrero and was the main source of revenues for the company.

In general, the quality of liquor produced from the agave variety cupreata, predominant in the State of Guerrero, was recognized by connoisseurs for its flavor and bouquet (Marshal, Schreckenberg and Newton (2006)). Also, the production process in underground pits gave mezcal a smoky and earthy fragrance and taste. The mezcal Tecuán began to be recognized as a high quality mezcal in 2003 when the Beverage Testing Institute, founded in 1981 in Chicago with the objective of producing fair and impartial reviews of wine, beer and spirits for consumers, rated mezcal Tecuán as "Highly Recommended"[9].

The second brand for the cooperative was named Don Fili (Figure 3), named after the first President of the Cooperative. "Don Fili," a registered trademark for the company, was a rested mezcal 100% of agave produced under the supervision of Don Fili himself. Sales began in 1999, and the majority of the product was sold through one distributor in Mexico City, with a small portion distributed to Chicago mainly through networking of migrants from Guerrero living there.

Tecuán



Don Fili

Tecuán Damiana

Figure 3. Brands of El Tecuán

[9] http://www.tasting.com/scout_spirits.lasso?id=169180, (accessed on October 13, 2007).

To complement their line of product, the firm introduced a semisweet mezcal mixed with Damiana, a wild plant used for health and digestive purposes in Guerrero. Damiana had not been used before for liquors. Every bottle of this product contained a portion of the Damiana plant in the bottom, mimicking the tradition of mezcal producers from the state of Oaxaca who included worms in the bottle of mezcal liquors.

Marketing and Sales of El Tecuán

Building the reputation of mezcal as a quality liquor had faced difficulties in the past. A black market for the sale of mezcal had existed, including adulteration of the product and forgery of bottles, labels and trademarks. The adulteration of mezcal had left the reputation of this product tremendously damaged. In the mid-1990s there had been a series of deaths and health problems attributed to the consumption of an adulterated mezcal. Since that time, the Mexican government began fighting the black market through the PROFECO, an institution in charge of protecting consumers from abuses by firms. However, past experience has shown that black markets can be very difficult to eliminate. Certification of mezcals by COMERCAM was expected to alleviate the problem as consumers would start to recognize and value products from certified firms. Much work was put into the branding and trademark protection for products from El Tecuán.

By 2005 El Tecuán distributed its products mainly in regional markets, though they were trying to expand their presence in the national market (Mexico City and cities along the border with the United States), and even in international markets. They already had some sales in Chicago, where their mezcals were distributed in small volumes primarily among emigrants from Guerrero. Members of El Tecuán participated in all the expos they could attend. The cooperative was helped by the Mexican Bank of International Trade, Bancomex, by funding participation in expositions and distribution of samples of their products outside Mexico. In particular, members of El Tecuán attended food exhibition shows like the Food Marketing Institute show in Chicago, the "Francia SIAL" show, and the International Food & Beverage Exhibition "Foodex" in Tokyo.

The international market was attractive to mezcal producers for two primary reasons: there were special tax exemptions (SAGARPA (2005a)), and the consumer perception of mezcal outside Mexico was good, mainly helped by the reputation gained by tequila (UNEP World Conservation Monitoring Centre (2002)). The management of El Tecuán analyzed the possibility of entering international markets, however, it seemed difficult given the infrastructure of the cooperative. They wondered if the effort would be more efficient if all firms of mezcal collectively promoted a generic mezcal for export. But, would El Tecuán fare well if buyers had to choose between brands? And were they prepared to go through the procedures necessary to obtain certifications to be able to export under the new requirements by COMERCAM?

The Value Chain of Mezcal

Until the late 1970s mezcal producers in Mexico were sometimes harassed and accused of practicing illegal activities such as production of alcohol without secure quality standards, and for not paying taxes (UNEP World Conservation Monitoring Centre (2002)). Over time, the

government's attitude towards mezcal producers changed, and during the 1990s, the government started to be very supportive, offering subsidies, technical assistance, and interest-free loans for organized mezcal producers.

In 1994, the National Chamber of Industry of Mezcal applied for appellation protection with the Mexican Institute for Intellectual Property (IMPI) [10]. IMPI approved appellation protection and, as the authorized office in Mexico, applied for international registration of the appellation of origin for mezcal to the World Intellectual Property Organization under the Lisbon Agreement. International registration and protection of the appellation of origin mezcal was granted in 1995, with mezcal only being allowed to be produced and bottled in specific regions in Mexico (Figure 2). Appellations of origin most likely trigger a positive reaction in the mind of producers and participants of value chains as they realize that their efforts are linked in the production and marketing cycle of a product recognized for its unique quality. The mezcal appellation encouraged the reorganization of the value chain and the start up of bottling firms of mezcal. El Tecuán was one of the first formal organizations of mezcal producers in Guerrero. El Tecuán opened its bottling enterprise in 1997. This was the first bottling enterprise in the State of Guerrero. By 2005, six bottling firms were already established in the state of Guerrero. Figure 4 shows partially the value chain for mezcal in the State of Guerrero in 2005. Owners of both distilleries and maguey plantations were highly integrated, thus avoiding intermediaries in the value chain (SAGARPA (2005b)).

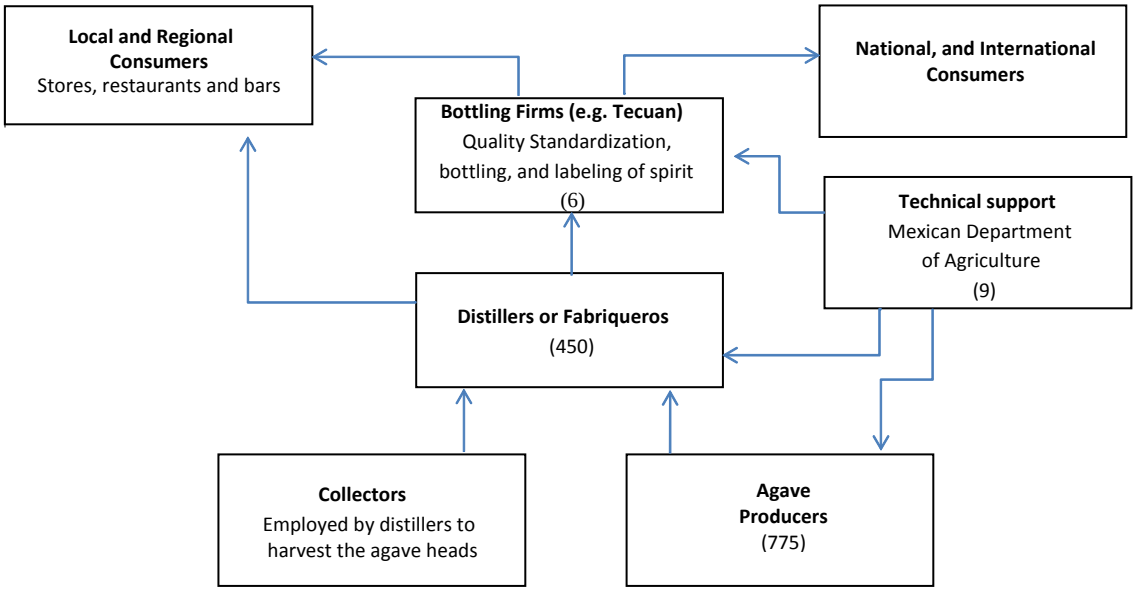


Figure 4. Partial Value Chain for Mezcal in the State of Guerrero, Mexico
Number of producers, distillers, bottling firms, and technicians are indicated in parenthesis. Estimations by SAGARPA (2005a).
Source: Prepared by authors from Marshal, Schreckenberg and Newton (2006); and SAGARPA (2005a).

[10] IMPI stands for Instituto Mexicano de la Propiedad Industrial

In terms of reorganization of the supply chain, the Mexican Official Standard was decreed by the Ministry of Economy in 1997. The Official Standard contained the specifications for raw materials and beverage production, bottling, and labeling, among others (DOF-SECOFI (1997)). As a consequence The Mexican Council for Quality Regulation of Mezcal (COMERCAM)[11], a private institution, was created to certify the quality and authenticity of mezcal, and to prevent any usurpation or imitation of the appellation of origin mezcal[12].

Management of El Tecuán was aware that it would take several years for this cooperative and for the other enterprises in Guerrero to be certified by COMERCAM. They recognized their internal systems and equipment needed to be improved in order to face the new regulatory challenges. In the late 1990s producers of mezcal in Guerrero started to meet regularly in order to create a network that they felt was necessary to address the opportunities and challenges for the industry of mezcal of Guerrero. The leadership of Don Fili, President of the Administrative Council of El Tecuán, was key in the cohesion of producers. In 2004, the producers created a not-for-profit organization, the Council for Agave-Mezcal of Guerrero (El Consejo Estatal de Maguey-Mezcal de Guerrero), which represented all producers of maguey and mezcal. Don Fili, President of El Tecuán, was elected President of the Council for Agave-Mezcal of Guerrero. Since 2003, Don Fili had also been an elected member of COMERCAM.

In Mexico, rural value chains have been integrated by what are called System-Products[13] since 2001. The aim of these chains was to achieve competitiveness, promote conditions of equality and trust among participants in the value chain, and to satisfy market demand. For each System-Product a National Committee existed ([Mexican] Law of Sustainable Rural Development, December 7, 2001). The National Committee of The System-Product Maguey Mezcal (i.e., The National Committee of Mezcal) was created in November 2004 and was governed by The Mexican Department of Agriculture.

It was estimated that the value chain for mezcal (Figure 5) generated 29,000 jobs in Mexico. COMPROMMAC, an association integrated by both mezcal and agave producers, was considered the most important player of the System-Product Maguey-Mezcal. The National Committee of Mezcal worked very closely with COMPROMMAC in coordinating all efforts for the value chain for mezcal. For example, by using money from both the Mexican government Producers and COMPROMMAC, a marketing campaign was implemented in 2007 and 2008.

[11] The Mexican Council for Quality Regulation of Mezcal (COMERCAM) is El Consejo Mexicano Regulador de la Calidad del Mezcal.

[12] In 2003 COMERCAM was officially recognized by the Mexican government as the institution in charge of implementing the Mexican Official Standard. Ministry of Economy, accessed on November 13, 2008: http://diariooficial.segob.gob.mx/index.php

[13] A System-Product is an official organization (i.e., a committee for rural development) governed by the Mexican Department of Agriculture. This organization is integrated by government officials and by representatives of all the supply chain value of strategic products, as defined by the Mexican Department of Agriculture in their National Plan for Development. The objectives of system-products are: i) achieve consensus on national production programs, ii) establish plans for strategic expansion or reduction of level of production according to conditions in the market, iii) establish strategic alliances and negotiations for the integration of chain values, iv) define norms and procedures for commercial transactions and for derivatives products, v) participate in the definition of tariffs, quotas, and other imports modalities, and vi) generate mechanisms for consensus among producers, marketers, and the government. For additional information refer to the Mexican Department of Agriculture's web site, http://www.sagarpa.gob.mx/agricultura/Publicaciones/SistemaProducto/Paginas/default.aspx**}**, accessed on February 2010.

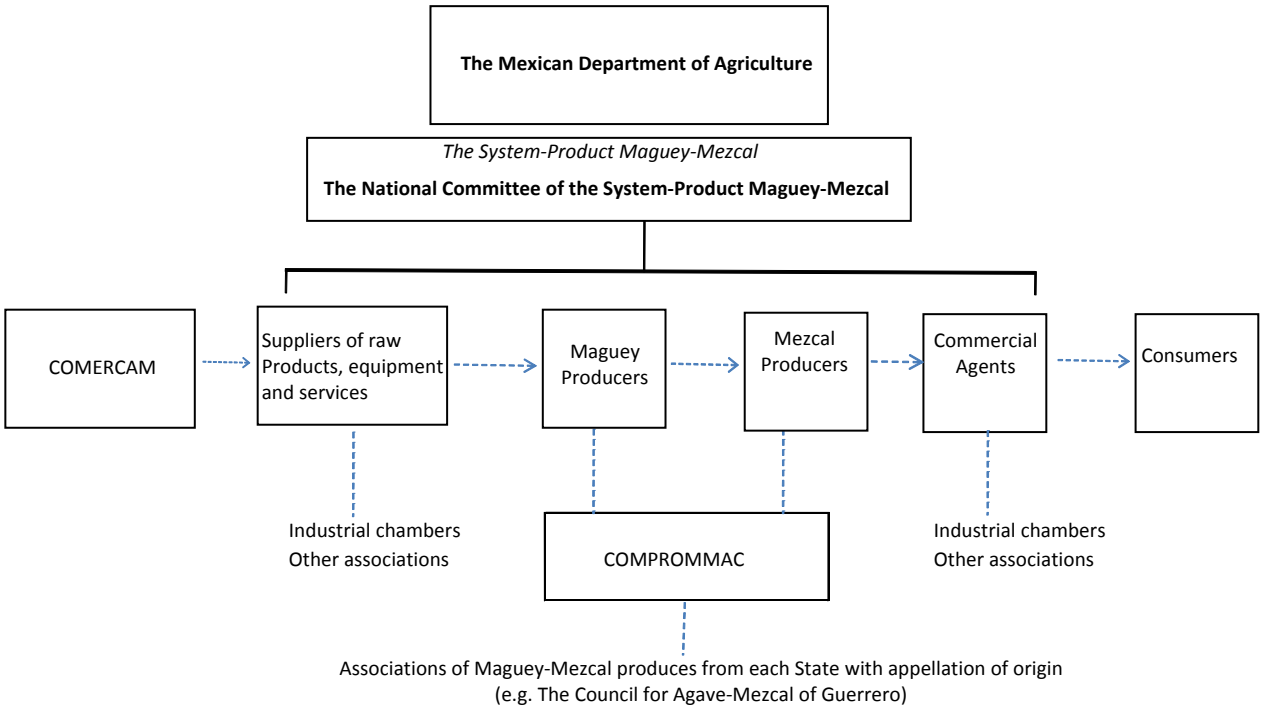


Figure 5. Selected Players in the Value Chain for Mezcal
Note: 1. COMPROMMAC stands for El Consejo Mexicano de Productores de Maguey-Mezcal A. C., the Mexican Council of Maguey-Mezcal Producers; 2. COMERCAM stands for Consejo Mexicano Regulador de la Calidad del Mezcal, the Mexican Council for Quality Regulation of Mezcal.

to promote mezcal in domestic and international markets. Details of the marketing campaigns can be found in COMPROMMAC (2008).

From 2005 to 2009, the National Committee of Mezcal and COMPROMMAC had worked together in diverse initiatives to help the System-Product Maguey Mezcal. Over the 2005 to 2008 time period, production had steadily increased, as had exports (Table 2). In addition, as of 2009, 131 distillers had received help for capital expenditures to improve their distilleries, 13 quality control laboratories had been established in the country, and more than 200 distilleries had been certified by COMERCAM. The National Committee of Mezcal and COMPROMMAC had also collectively promoted sales in international markets (Figure 6 shows some brands that were promoted through the efforts of the National Committee of Mezcal).

One of the main concerns of participants in the mezcal industry was to achieve better cohesion and trust among mezcal firms. For example, promoting products collectively might create result in savings for mezcal producers.

Table 2. Selected Statistics from the Mezcal Value Chain, 2005 to 2008 and Projections 2012

Year	Production (liters)	Exports (liters)	Number of brands	Perception about quality		
				Bad	Good	None
2005	433,927	214,664	20			
2006	473,407	528,507	26	67%	23%	10%
2007	994,231	407,863	27	62%	29%	9%
2008	1,824,393	352,072	34	50%	41%	9%
Proj. 2012	7,500,000	4,500,000	NA	NA	NA	NA

Source: Assembled with data from The National Committee of The System-Product Maguey-Mezcal, 2005-2009 Evaluation. Original in Spanish, adapted by authors.
http://www.sientemezcal.com/2009/pdf/SPMMEvaluacion2005_2009.pdf. (accessed on December 21, 2009).
Note: 1. Perceptions about quality of mezcal based on surveys of 800 final consumers (COMPROMMAC (2008)); 2. Projections by The National Committee of The System-Product Maguey-Mezcal.

Figure 6. Selected Certified Mezcals Promoted in International Markets by the National Committee of Mezcal and COMPROMMAC as of 2009.
Source: Cruz-Barrera, A. (2009).

Mezcal and Tequila

From 2005 to 2009, the global market for spirits grew slowly, around 2% per year. During the same time, combined sales of tequila and mezcal had grown at slightly higher rates in international markets (Table 3). However, within Mexico, combined sales of tequila and mezcal grew at slower rates than the spirits segment, especially in 2008 and 2009 (bottom panel Table 3). A more thorough examination of the data, however, shows that sales of tequila decreased in

2008, while sales of mezcal increased (The IWSR 1995-2009 Report, in Cruz-Barrera (2009)). In fact, sales of mezcal has been increasing every year since 2005 (Table 2).

Table 3. Volume of Sales of Spirits Worldwide and Mexico (000s liters)

	2005	2006	2007	2008	2009
		Worldwide			
Spirits - total worldwide	13,201,082.0	13,306,356.7	13,637,101.2	13,942,314.1	14,212,539.9
Other Spirits	5,985,110.1	5,942,192.6	6,004,936.8	6,101,007.0	6,250,438.7
White Spirits	3,586,264.2	3,592,443.3	3,645,291.2	3,650,955.9	3,617,983.7
Whisky	1,377,133.3	1,448,297.6	1,539,453.6	1,647,927.6	1,744,983.3
Rum	810,457.0	835,420.8	892,008.6	937,311.2	974,050.7
Brandy and Cognac	757,552.7	784,965.8	829,281.0	869,047.9	883,484.4
Liqueurs	547,181.8	558,302.2	574,425.5	580,613.9	581,466.3
Tequila and Mezcal	137,383.0	144,734.4	151,704.4	155,450.6	160,132.8
Year to year growth total spirits worldwide		0.8%	2.5%	2.2%	1.9%
Year to year growth total Tequila and Mezcal		5.4%	4.8%	2.5%	3.0%
		Mexico			
Spirits - Total Mexico	135,516.2	135,901.5	137,456.2	139,813.8	145,639.1
Tequila and Mezcal	61,866.1	62,591.7	64,012.5	63,620.3	65,500.5
Brandy and Cognac	33,137.6	31,126.2	28,740.2	29,703.7	31,460.2
Rum	23,286.2	23,727.4	25,815.8	24,290.6	22,836.1
Whisky	4,203.7	4,492.3	4,989.4	7,582.8	9,774.6
Liqueurs	3,384.4	3,408.6	3,130.3	3,178.5	3,558.9
Other Spirits	2,538.2	2,508.4	2,457.7	2,754.9	3,002.2
White Spirits	1,115.2	1,544.6	1,621.4	1,767.8	2,169.9
Year to year growth total spirits in Mexico		0.3%	1.1%	1.7%	4.2%
Year to year growth total Tequila & Mezcal in Mexico		1.2%	2.3%	-0.6%	3.0%

Source: Assembled with data from Euromonitor. Data obtained on January 1, 2010
Whiskey: The aggregation of single malt scotch whiskey, blended scotch whiskey, bourbon/other US whiskey, Canadian whiskey, Irish whiskey, Japanese whiskey and Other whiskey. **White Spirits:** This is the aggregation of gin and vodka. **Rum:** This is the aggregation of white and dark rum; **Liqueurs:** Aggregation of cream-based, bitters and all other types of liqueurs. **Other Spirits:** Examples include Korn, Grappa, Calvados, Slivovizla, Rakkija, Arrak, Ouzo, Pernod, Ricard, Pastis, Suchu, Shou Xi.

Mezcal could be seen as similar to tequila because both were Mexican liquors distilled from agave plants with protected appellations (the appellation tequila was granted in 1978). However, while tequila was well appreciated domestically and internationally, mezcal had not achieved the recognition that many local residents, producers, researchers (Marshal, Schreckenberg and Newton (2006)), and governmental authorities (SAGARPA (2005a); INCA-Rural (2005)) believed it deserved for the quality of the beverage, and its economic, social, cultural, and environmental importance.

Until recently, mezcal had been considered a low quality spirit in Mexico (i.e., the alcoholic beverage for the poorest groups of the population). This was similar to consumers' perception of tequila in Mexico about thirty years ago. In the late seventies, when the appellation of origin tequila was granted, the tequila industry started to have visibility in both national (before, like mezcal, tequila was largely a regional beverage) and international markets, particularly because

of a range of business alliances, joint ventures, and acquisitions (Casas (2006)) together with mass promotion. This gradually allowed the image of the product to change.

Consumers' perception regarding mezcal has started to change (UNEP World Conservation Monitoring Centre (2002), and surveys in Table 2). Not only is mezcal being sold in one of the most exclusive stores in Mexico, some brands of mezcal were priced slightly higher than well known tequila brands. For example, in one case rested mezcal semillero and one of the best known brands of tequila, José Cuervo Traditional, were advertised in December 2009 (Figure 7). The price of a 750 ml bottle of rested mezcal semillero was advertized at about $18 USD, equivalent to approximately $24 USD per liter, compared to below $20 USD per liter for José Cuervo Traditional. In the US, retail prices of mezcal were reported to be between $25 and $30 USD (COMPROMMAC (2008)).

Finally, the tequila industry relied mostly on medium to highly technological processes (Cedeno-Cruz and Alvarez-Jacobs (1999); Casas (2006)). In contrast, most mezcal in Guerrero was produced in small distilleries (Illsley, Gomez, Edouard and Marshal (2006)); some of Guerrero's mezcal distilleries had a considerable level of deterioration, complicating the process of obtaining quality certification from COMERCAM (SAGARPA (2005a)).

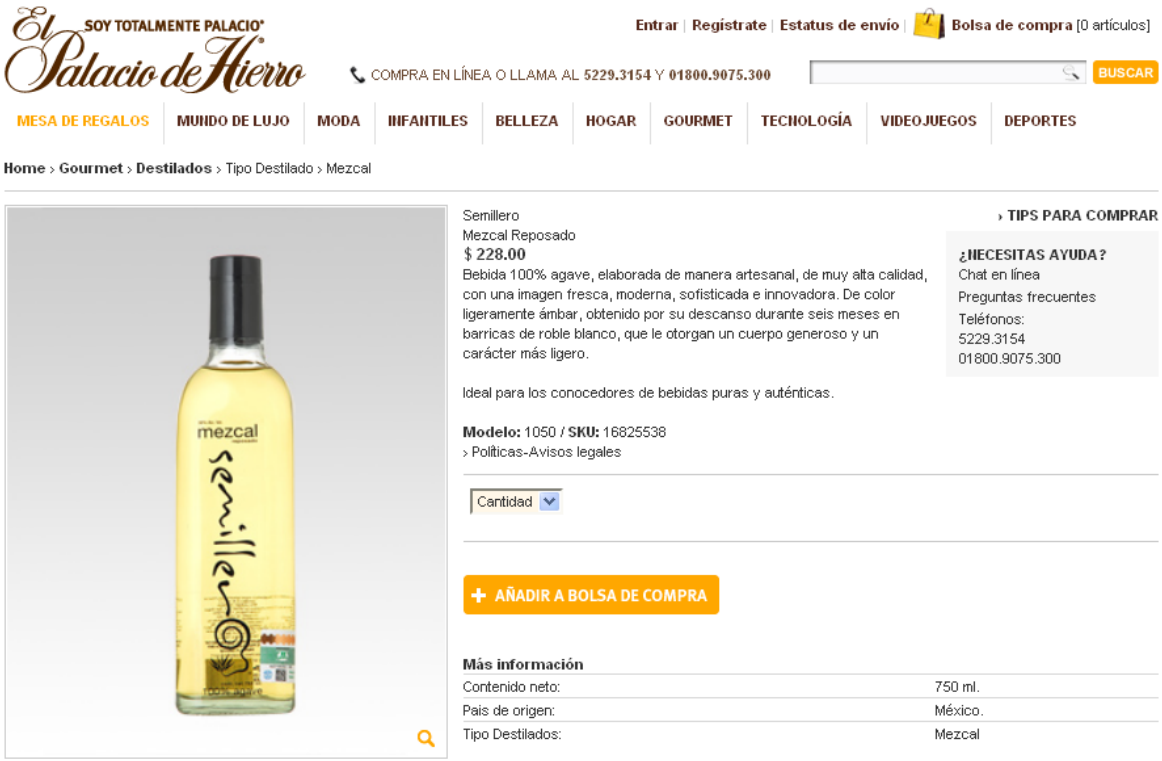


Figure 7. Mezcal and Tequila as advertized online. El Palacio de Hierro, Mexico City.
Notes: Rested mezcal "semillero" (750 ml) and rested tequila Jose Cuervo Traditional (950 ml).
El Palacio de Hierro's web site, gourmet department. December 30, 2009.

Current Situation

In a 2008 interview, the manager of El Tecuán indicated that one of the main difficulties the cooperative was facing was cohesion among their members. In addition, El Tecuán was struggling to increase its sales mainly because they had not been able to obtain labeling certification for all of their products by COMERCAM. Its semisweet product had not received the acceptance among consumers that had been expected. While members of El Tecuán were positive about the efforts by the System-Product Maguey-Mezcal to internationally market generic mezcal products, they were not fully participating in those benefits, as their products had not completed the registration process. Instead, they were focusing on sales in local markets.

The managers and leaders of El Tecuán, however, were confident that their efforts to modernize their distilleries would allow them to obtain the appropriate certification in order to export their products in the near future. They already had contacts with prospective customers outside Mexico. Finally, financing for working capital requirements was reported as a necessity.

Conclusion

The reorganization of the industry mezcal following the appellation of origin protection granted to Mexico by the World Intellectual Property Organization is analyzed in this article. Although appellations of origin have been referred to as conveying collective monopoly rights, appellations are not guarantee of success. In fact, the total number of appellation of origin

protections granted by the WIPO is rather high compared to the successful appellations. The challenges to capture the rents embedded in an appellation are not trivial.

One of the main challenges mezcal firms faced in the last fifteen years is the reorganization of the supply chain. This has been led in part by the Mexican government through the establishment of mechanisms to protect the appellation and to coordinate the industry efforts through the National Committee of Mezcal. In addition, mezcal producers have found new ways of organization to achieve cohesion to succeed not as individual firms but as an industry. All this has come with some costs. Supply chain reorganization is accompanied by distress of firms, especially because mezcal production and bottling take place in one of the poorest areas of Mexico with rural mezcal producers lacking the best technology and management and marketing skills. Without the support by the Mexican government to the mezcal industry capturing the opportunities of the appellation would be very difficult.

As of the end of 2009 we find positive signals for the potential success of this industry. The comparisons between mezcal and tequila –a successful appellation, show that the appellation mezcal is having the visibility tequila started to have after its appellation was granted. For instance, consumers' perception of mezcal as a low quality spirit has started to change due mainly to the marketing efforts coordinated by the National Committee of Mezcal. While in 2003 23% of consumers in Mexico perceived mezcal to be a high quality alcoholic beverage, by 2008 this number rose to 41%. This has allowed better distribution, better pricing, and the increase of sales of mezcal in Mexico and internationally. In addition, the mezcal industry has implemented a successful marketing strategy through product differentiation. Apart of the two types of mezcal protected, other mezcal categories have been launched and accepted by the market.

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'Tenderstem' Broccoli for Export Markets: an Analysis Study on the AgroFood Company

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Abstract

The AgroFood Company desires to produce exportable 'Tenderstem' broccoli in Egypt using unique production practices. Production and distribution of a new specialty vegetable crop presents specific challenges to farm managers. An analysis of the company, competition, consumer, market channel, and conditions, provides insight into possible solutions to the challenges faced by the farm management. Designed for undergraduate classroom use, this case encourages students to think outside of traditional production techniques to arrive at solutions that are viable from both crop culture and financial standpoints.

Keywords: Decision case, horticulture, agriculture economics, broccoli production, protected vegetable production

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IAMA Agribusiness Case 13.2

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Introduction

In Egypt at the corporate headquarters of AgroFood Company, a discussion is taking place between two of the company owners, Mr. Salah Hegazy and Mr. Ahmed Farrag. The discussion is about a recent opportunity to supply a novel type of broccoli, 'Tenderstem' broccoli, presented to them by a client from the European Union (EU). The client was seeking an Egyptian partner to supply 'Tenderstem' broccoli when the product is unavailable from other international producers.

"The opportunity would allow us to expand into a new area internationally as we have not provided this product in the past. Compared to our current broccoli product, the contract for 'Tenderstem' broccoli appears to be very attractive. What do you think about the opportunity?" said Salah.

"I agree that the terms of the contract look promising, but I'm a little concerned about growing this new crop at our specialty crop farm site. We have some difficulties during winter production of broccoli at this location due to the cool winter temperatures. If the client becomes interested in a year-round supply from us, we will need to consider some novel production schemes for 'Tenderstem' broccoli. I'm not sure what the costs or benefits might be when we alter our production practices." said Ahmed.

"Let's discuss this with Nada because she likely will have some insights into current market trends for broccoli in Europe. I wonder how stable the prices are for 'Tenderstem' broccoli and if producers in other countries are aware of the supply gap. If the contract price is lowered significantly or if the supply gap is filled, this opportunity may become a liability. We need to analyze the situation a bit more before we commit to the contract. When the three of us get together, I think we will be able to determine if this opportunity is logistically possible and financially beneficial to AgroFoods Company." said Salah.

After this conversation, the management of AgroFood Company embarked upon a fact finding expedition to determine if the opportunity presented was in the company's best interest.

The Case

Company Background

The AgroFood Company was established in 1992 by three partners, two Egyptians, Mr. Salah Hegazy and Mr. Ahmed Farrag, and one Italian, Mr. M. Simaria, with each partner taking responsibility for a different operation within the company. Mr. Hegazy oversaw general affairs and communications with import companies, Mr. Farrag was responsible for the production of fruit and vegetables, and Mr. Simaria took care of marketing. Upon the death of Mr. Simaria in 2004, his wife, Mrs. Nada Polis, acquired her husband's portion of the AgroFood Company and maintains an active role in company management.

In the beginning, the firm exported only fava beans, but it quickly expanded its operations to include the exportation of potatoes to Turkey. The owners then discovered that potato

exportation to the European Union (EU) market was profitable and expanded their potato cultivation accordingly. The company has altered its product mix over several years to meet market requirements and fill market niches. Because of this, the AgroFood Company is now one of the leading Egyptian agricultural firms exporting potatoes and onions to the EU market.

The AgroFood Company believes that the EU market is a key to future success of the company. With a population of more than 491 million people, the EU market is considered the largest market to which products may be exported from the AgroFood Company. The EU market is geographically close to Egypt and has limited raw materials and production capacity (EuroStat, 2008). Consumers in the EU market have tremendous purchasing power (GDP per capital = 23,500 €), healthy lifestyles, and enjoy convenient ready-to-use products. Dolan and Humphrey (2000) state that retail supermarkets have emphasized fresh, healthy food, ease of preparation and innovation to attract consumers. Fresh produce has become a 'destination' category in supermarkets resulting in a doubling of the shelf area allocated to vegetables (Fearne and Hughes 1999). For some products, such as organically produced vegetables, the market demand remains unmet (Dolan and Humphrey, 2000). One goal of the AgroFood Company, as defined by company owners and managers, is to provide high quality, organic products to the EU market, especially England, Italy and Germany, and to improve their EU market share.

The AgroFood Company owners have witnessed the dramatic change in marketing channels that has occurred recently within the EU market. The development of tightly knit supply chains where EU retail outlets, such as supermarkets, drive production in and exportation from African countries has resulted in major multinational food companies gaining a larger percentage of the market, while smaller retailers are forced out of the market (Dolan and Humphrey, 2000; 2004). Large retailers are increasingly specifying the parameters that must be followed along the value chain including how products are grown, harvested, processed, transported, and stored (Dolan and Humphrey 2004). As a result, working directly with and meeting expectations of large EU clients is becoming essential for success. Smaller producers and exporters are sidelined in the channel as they are increasingly unable to meet large retailer expectations. This has resulted in large producers supplying an increasingly greater percentage of vegetables exported to the EU (Dolan and Humphrey, 2000; 2004).

Companies wanting to increase their market share in the EU need to be more than growers or traders. They must develop detailed production guidelines, invest in cold storage, processing facilities, and rapid transportation routes (Dolan and Humphrey, 2004). Success in the current EU market requires a significant paradigm shift for many specialty crop producers towards large-scale production.

The exception in the tendency toward tightly knit supply chains and concentration is in organic produce. For organic specialty vegetable crops, the EU supply base is fragmented which allows smaller companies, including Egyptian companies, an opportunity to fill the unmet market demand (Dolan and Humphrey 2000). With sales near 10.5 million Egyptian Pounds (L.E.)[1], the AgroFood Company is considered a small vegetable processing company by the Union of

[1]One (1) L.E. = 0.174 USD in November 2006 when information was collected for case.

Producers and Exporters of Horticultural Crops[2] (UPEHC 2007). As such, the AgroFood Company is poised to fill some of the unmet market demand.

The AgroFood Company has developed an excellent reputation with EU importers by meeting EU clients' "higher bar" requirements in terms of product and production standards and safety, as well cultivating new crops upon request. Recently, the AgroFood Company started producing high value specialty crops, such as peas, colored peppers, green peppers, green beans, broccoli, and cucumbers, due to changing market demands. The firm is willing to accept some of the risks associated with these new crops for the sake of clients' satisfaction.

When asked to describe their reasoning for shifting production towards specialty vegetable crops, the company owners identified the following points:

1. Brown rot, a fungal disease, exists in some Egyptian potatoes and is unacceptable in the EU. When detected, this disease can significantly reduce the quantity of potatoes imported by the EU making the market unstable for Egyptian potatoes.

2. Commodity products, such as potatoes and onions, are subject to large price fluctuations based on supply and demand.

3. EU supermarkets are demanding more specialty crops, including organically produced products.

4. EU supermarkets desire to have an uninterrupted supply of specialty vegetable crops.

5. Consolidation in the EU market has necessitated the development of partnerships and contracts with exclusivity clauses for some high value specialty vegetables.

6. The AgroFood Company has facilities to evaluate specialty crops under Egyptian conditions and is willing to accept some of the risks associated with these evaluations to ensure continued clients' satisfaction and partnerships.

Company Strengths

In light of the stated goals and justifications for shifting production towards specialty vegetable crops, the owners of the firm were asked "*What are specific strategies or strengths currently within the company that will assist you in achieving your stated goals?"* In response, the owners and managers indicated that the AgroFood Company has adopted several strategies to maintain its position as a leading producer and exporter of Egyptian vegetable products. First, the firm has adopted organic cultivation methods as prices of organic products are about 25% higher than products produced using non-organic methods. Overall, the trend of prices for organic products is decreasing due to an increased supply of organic products. However, in many EU markets, consumer demand for organic products remains high.

[2] UPEHC categories of large, medium, and small processors are based upon sales and capital expenditures of ≥ 50 million L.E., 15 to 49 million L.E., and < 15 million L.E., respectively.

Second, the AgroFood Company is committed to supplying clients with products on a year-round basis in an effort to foster a more positive trade relationship. To this end, the firm has begun expanding its product offerings to include processed vegetables. Processing is seen as a future opportunity by the company owners, who have invested significant resources into establishing a cold supply chain that meets organic certification requirements for the EU market. Company owned refrigerated trucks pick up pre-cooled field packed vegetables and deliver them to a modern processing and packinghouse that only handles organically produced crops. This AgroFood Company owned post-harvest processing and cold storage capacity facility ensures that products destined for exportation are handled in a hygienically and temperature-controlled manner meeting organic certification standards. Products, after being custom packed to meet EU client requirements, are delivered by airfreight to maximize product quality, aesthetics, and freshness. The company will continue to export the highest quality (first grade) products, but the lower quality (second grade) products will be processed, frozen, packaged, and exported. Currently, the company is conducting small scale processing trials with lower quality green beans and hot peppers to satisfy client requests, open new markets, and provide an alternative market for the lower grade products.

Third, the firm has three production locations northwest of Cairo along the Cairo-Alexandria Desert Road. The first is primarily a potato production site; the second is devoted to onion cultivation; and the third location is for specialty crops. The AgroFood Company specialty crops production site is a 95 feddan[3] production facility with 75 feddan of greenhouses and 25 feddan of open fields. Cultivation of seedlings and mature plants occurs in plastic covered greenhouses which allows for protected winter production by increasing the daytime air temperature (El-Sayed 2006a and 2006b). The use of greenhouses extends the fruiting season from two months up to nine months, thereby increasing crop yields, compared with open field production (Exhibit 1). Open field cultivation is devoted to evaluating specialty crops under Egyptian conditions when these products are unavailable elsewhere. In addition to these three production sites, the firm has pursued long-term relationships with farmers in the local area by offering them high prices for contract grown products that meet EU importer standards and by offering free technical assistance. These relationships have expanded the AgroFood Company's production potential.

Finally, the AgroFood Company has developed partnerships which provide increased market exposure and ensure certification requirements are met. The company is a member of Expo Link that helps the AgroFood Company in exhibitions and international trade fairs. The company partners with the Industrial Modernization Center (IMC) which implements Hazard Analysis and Critical Control Points (HACCP) and gap analysis for Egyptian companies. The AgroFood Company is also a member of the Chamber of Food Industries (CFI) and Horticultural Export Improvement Association (HEIA) that carries out different training programs.

The company investments described above along with the domestic and international partnerships listed enable the AgroFood Company to provide high quality, organic products to

[3] Feddan is a local measure of land equal to 4,200 square meters or 1.038 acres

the EU market. The owners of the AgroFood Company wish to expand their market share of exported vegetables, and are constantly seeking new opportunities for specialty products.

The Opportunity

As evidence of how past activities and preparation are beginning to be fruitful, the firm owners and management described a recent opportunity that was presented to them by an EU client. The client was seeking an Egyptian partner to supply a novel type of broccoli, 'Tenderstem' broccoli, in which the plant stems are harvested, as opposed to the immature plant flower (crown) with traditional broccoli[4]. The client has requested 1.5 metric tons (1,000 kg) of 'Tenderstem' broccoli per week from November to June (6 months), in 200 gram packages, containing stems of 16 to 22 cm in length. The client is willing to pay 35,000 L.E. per metric ton for 'Tenderstem' broccoli meeting these parameters. If the AgroFood Company successfully delivers high quality 'Tenderstem' broccoli to the EU client, the client has expressed interest in partnering with AgroFood Company to provide 'Tenderstem' broccoli year-round. This appears to be an opportunity that will benefit the AgroFood Company but is not without risks.

The challenge identified immediately by farm management is that 'Tenderstem' broccoli has never been produced in Egypt so cultural guidelines for this crop under Egyptian conditions are nonexistent. While commercial companies have developed guides to assist producers in other countries (O'Keefe 2009), no one is certain if 'Tenderstem' broccoli production is possible in Egypt or if the stems produced will meet EU client specified standards. Thus, one of the first questions that must be addressed by the AgroFood Company is "*Should 'Tenderstem' broccoli be grown in Egypt?*"

The AgroFood Company has positioned itself to be able to answer this question and is willing to accept some of the risks associated with evaluating new crops under Egyptian conditions. Cultivation trials at the specialty crop farm near Cairo are used to determine if proposed crops are technically feasible and financially viable. The AgroFood Company provides land and labor, while clients provide seed, technical assistance, and labor training for crop cultivation and processing. The 'Tenderstem' broccoli opportunity is a good example of how the AgroFood Company must evaluate potential export crops from both crop culture and financial standpoints.

Current Situation and Challenges

As a starting point for discussion, the firm owners and management were asked "*What are the main challenge(s) faced by the AgroFood Company related to 'Tenderstem' broccoli?"* The firm identified three main questions that needed to be addressed before 'Tenderstem' broccoli was added to their product mix:

1. Can current cultural practices for broccoli be modified using existing infrastructure, such as greenhouses, to develop a set of guidelines for 'Tenderstem' broccoli production in Egypt that meet client standards for packaged stems on a seasonal and/or year-round basis?

[4]Traditional broccoli will be referred to as "broccoli" in this manuscript. 'Tenderstem' broccoli will carry the 'Tenderstem' designation.

2. What are the financial costs and benefits for each of the possible production scenarios?

3. At what price will 'Tenderstem' broccoli be profitable for the AgroFood Company?

The AgroFood Company team began by investigating broccoli production and exportation in Egypt. Broccoli is a crop exported to the EU by Egyptian producers; however, high temperatures limit field production of exportable broccoli crowns during late summer and early winter. Broccoli flower formation is disrupted when temperatures exceed 30 ºC (Björkman and Pearson, 1998) resulting in broccoli crowns that are not marketable. The average yield for cauliflower and broccoli[5] produced in Egypt during 2006 was about 10.5 metric tons per feddan with a farm gate value of 504 L.E. per metric ton (FOASTAT, 2009). Processing broccoli adds tremendous value to exportable products as evidenced by the January 2007 to July 2007 average price of 27, 920 L.E. per metric ton for processed broccoli exported from Egypt to the EU (AMAL, 2009). In the Cairo-Alexandria region of Egypt, broccoli cultivars have a tendency to flower after winter transplanting (November 15 through January 15) which leads to unmarketable small crowns and reduced yields. Cool temperatures promote flowering of broccoli, so shifting crop production to warmer regions of Egypt during winter months is common. Unfortunately, Upper Egypt production sites are greater distances from major airports and ports. This creates added production and/or transportation challenges including increased shipping expenses and product losses. The production of broccoli in Egyptian greenhouses is undocumented but likely possible.

To determine if 'Tenderstem' broccoli meeting client expectations could be produced, the AgroFood Company initiated trials to identify crop performance under Egyptian conditions. AgroFood Company management modified existing broccoli production guidelines to meet 'Tenderstem' broccoli needs. 'Tenderstem' broccoli seedlings are produced in isolated greenhouses for six to eight weeks then transplanted to open fields. Cultivation of the 'Tenderstem' broccoli requires the removal of the apical meristem (small broccoli crown) about eight to nine weeks after transplanting to encourage stem formation. Beginning ten to eleven weeks after transplanting, stems are harvested weekly for six weeks. Total crop time after transplanting is sixteen to eighteen weeks depending on climate. Field trials indicated that each feddan yields an average of 1.5 metric tons of stems over a six week period with about 70% of the harvested stems meeting export standards.

After the initial trials were completed, the owners of AgroFood Company had identified several challenges that needed to be addressed before the company could meet client expectations for a six month contract or a non-interrupted supply of 'Tenderstem' broccoli. The owners expressed the following concerns:

1. Based upon the field trial, approximately six feddan of 'Tenderstem' broccoli transplanted each month beginning in early July for six months would supply about 9.0 metric tons of ungraded stems per month of which 6.3 metric tons (approximately 1.5 metric tons per week) should meet client standards. However, open field space at the specialty crop farm site is limited.

[5] Cauliflower and broccoli are closely related vegetable crops whose production and market value data are often combined in public databases. This is the case for Egyptian broccoli in the FAOSTAT database.

2. High temperatures in Egypt limit field production of exportable broccoli during late summer and early winter. The owners expect 'Tenderstem' broccoli to have similar production limits if requested to provide a year-round supply of product.

3. Broccoli must be grown in a warmer climate during the winter (in greenhouses or in Upper Egypt fields) to minimize flowering. The 'Tenderstem' cultivar is relatively tolerant to winter flowering; however, some flowering was noted for winter produced 'Tenderstem' broccoli at the AgroFood Company farm. This will reduce marketable yields during late spring unless alternative sites or protected cultivation systems are used.

4. The removal of the apical meristem (small broccoli crown) is done to promote stem development. Because a local market does not exist, the small crowns (about 500 kg/feddan) are discarded or given to farm employees for personal use.

5. Only 40% of the stems harvested late in the production cycle (week five to week six of harvest) meet the 16 to 22 cm (Grade 1) or 11 to 15 cm (Grade 2) stem length standards for the European market. These last two harvests increase the total percentage of unmarketable stems to about 30% for the six week yield.

In addition to cultural limits, the owners cited limited knowledge about competitors and production costs for 'Tenderstem' broccoli as other challenges that must be answered before production begins. Identifying Egyptian companies that are in direct competition with the AgroFood Company is difficult; however, other producers and processors are located in the same geographic area as the AgroFood Company and may be considered competitors for resources and market share. International competitors for the 'Tenderstem' market exist, as evidenced by O'Keefe (2009), but reliable data for the 'Tenderstem' broccoli market size and competition does not appear to exist in public databases. As value chain consolidations continue, competition is expected to increase, even for organically produced products. When tied to the fact that AgroFood Company currently has a single client interested in 'Tenderstem' broccoli, future demands for the product are unknown. There are no clear answers to the issues of competition from other suppliers of 'Tenderstem' broccoli or what market trends are likely to emerge for 'Tenderstem' broccoli. However, the overall trend for trade of specialty vegetable crops between Africa and EU is increasing (Dolan and Humphrey, 2000; 2004). The AgroFood Company owners believe demand for 'Tenderstem' broccoli will increase as well.

While the expected costs for producing 'Tenderstem' broccoli in Egypt do not exist, the AgroFood Company has generated an estimate near 11,000 L.E. per feddan to produce one metric ton of broccoli in open fields, process the harvest at their facilities, and deliver processed products to EU clients (Exhibit 2). Similar costs are expected for the 'Tenderstem' broccoli crop once production guidelines are firmly established for the company. The management of the AgroFood Company believes there are several options that can be pursued to provide a high quality year-round supply of 'Tenderstem' broccoli. These solutions may include:

〉 growing 'Tenderstem' broccoli plants in plastic covered greenhouses during the winter season, especially when transplanting takes place from mid-November to mid-January,

- using multiple locations (Upper and Lower Egypt) to provide a year-round supply of 'Tenderstem' broccoli, or

- planting 'Tenderstem' broccoli every three weeks, as opposed to monthly plantings, to minimize declines in quality of the late harvests.

The management of the AgroFood Company is seeking assistance in identifying which options have the most potential to increase their share of the 'Tenderstem' broccoli export market and provides significant financial gain for the company. When asked "*How would you assess the costs and benefits of producing 'Tenderstem' broccoli in open field or under covered greenhouses"*, the owners indicated that an economic analysis of the three proposed solutions was needed. With the information above and other available resources, such as information on Egyptian agriculture from the Horticultural Export Improvement Association (HEIA) (http://www.manarasoft.com/heia/), the Union of Producers and Exporters of Horticultural Commodities (UPEHC) (http://www.upehc.org/), or the Horticulture Research Institute (http://www.hortinst.com/index.php?lang=english), financial statements can be generated for each production option. Choosing among these options, or other undefined options, can be a daunting task. The AgroFood Company believes that careful consideration of a) resource availability, b) the level of on-site expertise and experiences, and c) the total cost versus anticipated gains generated from each solution should be included when making decisions.

In order to calculate financial statements, assumptions must be made. Several of these assumptions may be based on the trial data generated on the AgroFood Company farm while others must be best estimates based on market information. The AgroFood Company management made the following assumptions for each production option.

1. 'Tenderstem' broccoli will have an open field yield about 1.5 metric tons per feddan of which 70% is exportable. This will remain constant across seasons for open field production.

2. Given yield increases of other crops produced in greenhouses (Exhibit 1), a conservative yield increase of 200% for 'Tenderstem' broccoli under protected cultivation (3.0 metric tons per feddan) is reasonable if greenhouse space is available and unlimited; however, greenhouses must be covered with plastic each year at a cost of 40,000 L.E. per feddan.

3. Because a local alternate market (local or processed) for the 2nd grade 'Tenderstem' broccoli and small crowns does not exist, about 30% of open field harvest is considered shrinkage.

4. Because the greatest percentage of non-exportable stems was harvested late in the production cycle, one can assume that exportable stem percentages will be increased if the late harvests are eliminated. For analysis, the AgroFood Company owners estimated that removing the last two weekly harvests from each cycle would increase the average percentage of exportable stems from 70 to 82%.

5. For production at alternate locations (Upper Egypt), the AgroFood Company owners assumed that land is readily available, suitable, and not limited during the winter.

6. 'Tenderstem' broccoli produced in Upper Egypt can be field sorted into exportable and non-exportable stems before shipping to reduce transportation costs; however, transporting the sorted product will result in additional losses. The owners will use 20% as an estimate for additional losses during transit from Upper to Lower Egypt.

7. Because AgroFood Company trucks are limited and required for transportation in Lower Egypt, an outside company must be hired to ship products from Upper to Lower Egypt. Ground transportation costs are assumed to be doubled due to distance and outside company involvement.

8. Consolidation of the EU market channel will continue. Organically produced products will be supplied by international partners able to meet client expectations for quality and quantity. AgroFood Company will meet client expectations for 'Tenderstem' broccoli.

There are production and time factors (i.e., anticipated crop yield, crop quality, and additional costs and benefits) that need to be determined for each of the proposed systems. For instance, altering cultural practices and farm production schedule to utilize existing greenhouse structures will be of benefit to the company. However, the use of existing greenhouses for 'Tenderstem' broccoli production means that these houses are no longer available for other profitable crops, such as hot peppers. The potential impacts of these factors are not being estimated currently by AgroFood Company management.

For each of the options identified above, the AgroFood Company has identified several changes in resource allocation (land, labor, equipment, etc …) that would need to occur in order for the company to meet client expectations of packaged 'Tenderstem' broccoli. Based upon the field trial, six feddan of land would need to be planted monthly to yield the 9.0 metric tons of ungraded product required each month. Thus, a total of 12 plantings would occur yearly and use 72 feddan of open field space. Harvests would occur over a six week period. This is considered the current production model to which all other options will be compared.

To produce 'Tenderstem' broccoli in greenhouses during a six month period, three feddan of land would need to be planted monthly. Thus, a total of 18 feddan of greenhouse space would be utilized during the winter by six monthly plantings. Harvests would occur over a six week period. When combined with open field plantings, a year-round supply of 'Tenderstem' broccoli is anticipated.

Production in Upper Egypt during the winter is another option under consideration. Due to increased shrinkage of product during transport to Lower Egypt, the monthly yield of ungraded stems must be near 11.25 metric tons. To meet this increase, the area of land planted per month must be increased to 7.5 feddan. Thus, a total of six monthly plantings would use 45 feddan of land. Harvests would occur over a six week period. When combined with plantings in Lower Egypt, a year-round supply of 'Tenderstem' broccoli is anticipated.

The final option discussed is to reduce the time between plantings from four weeks (monthly) to three weeks in an effort to maximize the percentage of marketable stems to 82%. With the increased percentage of marketable stems, just over five feddan would need to be planted each time. Thus, a total of 18 plantings would occur annually and use about 92 feddan of space. Harvests would occur over a four week period. This production scheme could be used throughout Egypt in open field and/or protected cultivation systems to provide a year-round supply of 'Tenderstem' broccoli.

An initial analysis of the viability of 'Tenderstem' broccoli was conducted by calculating the costs to produce an exportable yield of 6.3 metric tons per month for each of the systems (Exhibit 2). This makes it possible to calculate profitability thresholds defined according to the production system(s) used. Thus, if, within the said system(s), one considers the so-called opportunity costs of the owner (income from land, interest on invested capital, etc.), this threshold will be the price above which the owner covers all his production costs and can earn a profit (Fco et al., 2002). The AgroFood Company management has decided to estimate the profitability of 'Tenderstem' broccoli by using break-even cost per feddan and gross and economic margins for each of the production options previously identified. Break-even cost compares the expected market price (35,000 L.E.) with the unit cost of production. Gross return is what is often referred to as profit if there is no debt on the farming operation. This approximates the returns to management and investment. The analysis for each production system is summarized in Exhibit 2.

Key Questions

Given the information presented in this case, the AgroFood Company has an excellent idea of their future direction. They would like to obtain your thoughts on the following:

1. What do you see as the main strengths, weaknesses, opportunities, and threats (current and future) of their proposal to produce 'Tenderstem' broccoli?

2. What options do the decision makers have in resolving dilemmas so that the future success of the farm is ensured?

3. Given the production scenarios outlined, which do you consider the "best option" for the future success of the AgroFood Company?

4. Because a local market does not exist for second grade 'Tenderstem' broccoli, what are the possible alternative markets for this product?

5. Given that specialty vegetable crops are subject to price fluctuations based on supply and demand, what impact would a large short-term or long-term price fluctuation have on your recommendation to the AgroFood Company?

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Appendix

Exhibit 1. Annual yield of selected vegetable crops produced in Egypt in open fields during 2006 or unheated plastic covered greenhouses.

Vegetable Crop	2006 Open Field Yield (metric ton/feddan)	Greenhouse Yield (metric ton/feddan)	Yield Increase in Greenhouses (%)
Tomatoes	16.4	100	609.8
Sweet Peppers	11.7	50	426.3
Hot Peppers	6.8	33	488.2
Cucumbers	9.0	25	277.8
Snap Beans	4.2	16	377.4
Cauliflower/broccoli	10.5	N/A	

Source: FAOSTAT (2000) for field grown tomatoes, cucumber, snap beans and cauliflower/broccoli 92006 data), AMAL (2009) for field grown sweet peppers, and hot peppers (2006 data), El Sayed (2006b) for greenhouse grown crops except cucumber, El Aidy and El Sheikh (1990) for greenhouse grown cucumber.

Exhibit 2.

Income statement for the AgroFood Company for the production of 'Tenderstem' broccoli in five production scenarios; 1) open field (current production model), 2) protected cultivation (greenhouse), 3) open field in Upper Egypt, 4) open field in Lower Egypt with three week plantings cycles or 5) open field in Upper Egypt with three week planting cycles. Production scenarios 1, 2, and 3 require monthly plantings with six harvest dates per planting. Production scenarios 4 and 5 require plantings on a three week cycle with four harvest dates per planting. Expense estimates were used to calculate variable and fixed costs associated with production of 6.3 metric tons (MT) of exportable product per month. This monthly production is required to meet the proposed contract of 1.5 metric tons of exportable 'Tenderstem' broccoli per week. Assumptions for each of the production scenarios are presented in the case narrative. Revenue based on suggested contract price of 35,000 L.E. per metric ton of exportable product.

	Current Model - Open Field		**Greenhouse**		**Open Field Upper Egypt**		**Open Field Lower Egypt 3 Week Cycle**		**Open Field Upper Egypt 3 Week Cycle**	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(MT)	(L.E.)	(MT)	(L.E.)	(MT)	(L.E.)	(MT)	(L.E.)	(MT)	(L.E.)
Revenue										
'Tenderstem' Broccoli Exports	**6.30**	220,500	**6.30**	220,500	**6.30**	220,500	**6.30**	220,500	**6.30**	220,500
Non-Exportable 'Tenderstem' Broccoli	2.70	0	2.70	0	1.58	0	1.38	0	1.58	0
Waste 'Tenderstem' Broccoli Sales	0	0	0	0	3.38	0	0	0	1.73	0
Total		**220,500**		**220,500**		**220,500**		**220,500**		**220,500**
Variable Costs										
Expenses for Production[1]	(feddan)		(feddan)		(feddan)		(feddan)		(feddan)	
Soil - Tilling and Compost	6.00	1,200	3.00	600	7.50	1,500	5.12	1,024	6.40	1,280
Fertilizers	6.00	3,600	3.00	1,800	7.50	4,500	5.12	3,073	6.40	3,841
Seedlings/Plants[2]	6.00	13,320	3.00	6,660	7.50	16,650	5.12	11,371	6.40	14,213
Irrigation Water	6.00	2,400	3.00	1,200	7.50	3,000	5.12	2,049	6.40	2,561
Labor for Production	6.00	3,060	3.00	1,530	7.50	3,825	5.12	2,612	6.40	3,265
Land Rent	6.00	3,600	3.00	1,800	7.50	4,500	5.12	3,073	6.40	3,841
Plastic Covering (greenhouse)	0	0	3.00	120,000	0	0	0	0	0	0
Total Cost for Production		*27,180*		*133,590*		*33,975*		*23,202*		*29,003*

Expenses for Processing, Packaging, and Shipping	(MT)		(MT)		(MT)		(MT)		(MT)	
Transportation to Processing Station (Lower Egypt)[3]	9.00	1,620	9.00	1,620	0.00	0	7.68	1,383	0	0
Processing and Packaging in Field (Non-exportable)	0	0	0	0	3.38	1,688	0	0	1.73	864
Transportation of Waste (Upper Egypt)	0	0	0	0	3.38	1,215	0	0	1.73	622
Transportation to Processing Station (Upper to Lower Egypt)[4]	0	0	0	0	7.88	2,835	0	0	7.88	2,835
Processing and Packaging (Export)	6.30	14,396	6.30	14,396	6.30	14,396	6.30	14,395	6.30	14,396
Transportation to Airport (Export)	6.30	1,134	6.30	1,134	6.30	1,134	6.30	1,134	6.30	1,134
Air Freight to Europe (Export)[5]	6.30	22,050	6.30	22,050	6.30	22,050	6.30	22,050	6.30	22,050
Processing and Packaging (non-export)	2.70	1,350	2.70	1,350	1.58	788	1.38	691	1.58	788
Transportation of Waste (non-export)	2.70	486	2.70	486	1.58	284	1.38	249	1.58	284
Total Cost for Production		*41,036*		*41,036*		*44,388*		*39,903*		*42,972*
Total Variable Costs		**68,216**		**174,626**		**78,363**		**63,105**		**71,975**
Fixed Costs	(month)		(month)		(month)		(month)		(month)	
Administrative	1	667	1	667	1	667	1	667	1	667
Utilities - Telephone, Electricity	1	800	1	800	1	800	1	800	1	800
Postage	1	240	1	240	1	240	1	240	1	240
Other	1	150	1	150	1	150	1	150	1	150
Total Fixed Cost		**1,857**		**1,857**		**1,857**		**1,857**		**1,857**
Total Expenses		**70,073**		**176,483**		**80,220**		**64,962**		**73,832**
Net Cash Flow per Planting		150,428		44,018		140,280		155,538		146,668
Net Cash Flow per 6 Months		902,565		264,105		841,680		1,399,839		1,320,013
Net Cash Flow per 12 Months		1,805,130		528,210		1,683,360		2,799,679		2,640,025

[1]One Egyptian Pound (L.E.) = 0.174 USD in November 2006 when AgroFood Company management provided cost estimates.

[2]Broccoli cannot be direct seeded into the field in Egypt. Small transplants are produced in a greenhouse. This expense represents the costs associated with producing enough seedlings for a one feddan (4,200 m^2) field.
[3]Local ground transportation provided by AgroFood Company owned 1.5 metric ton refrigerated trucks.
[4]Contracted refrigerated trucks are required as AgroFood Company trucks are unavailable for long distance transport.
[5]Based on Swanson et al. (2004)

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Industry Speaks

Building a Talent Pipeline: Development of the 'Alltech Mini-MBA'

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Abstract

By the time Alltech had reached its twentieth anniversary, the Company's growth had surpassed even the ambitious goals of its founder, Pearse Lyons. This success, however, has led to a dilemma faced by many corporate leaders—a need to create a new cadre of managers who can take the company forward.

After analyzing how best to fill this gap a commitment was made to build a highly customized, internal education program using lecture, case study and project-based learning processes. Developing staff management skills, increasing loyalty and empowering complex decision-making have been some of the rewards realized from this commitment. Backed by senior management, Alltech has used lessons learned from the mini-MBA to shape its future strategy. This paper examines the options Alltech explored, the model it chose, and the costs and benefits of adopting an executive education program in agribusiness.

Keywords: Alltech, Executive Education, MBA.

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Background

By the time Alltech had reached its twentieth anniversary, the Company's growth had surpassed even the most ambitious goals of its founder. This success, however, led to a dilemma familiar to many agribusinesses—a need to develop a succession program by grooming new managers who could take the Company forward, expand and manage new opportunities while maintaining the corporate culture and vision. The challenge of creating a pipeline which ensures advancement is common, while the specifics differ by company and industry.

Founded in 1980 by Dr. T.P. Lyons, Alltech is now the eighth largest firm in the animal health industry globally, and the only company among the top 20 entirely committed to 'natural nutritional solutions'. Starting with a modest investment of just $10,000, Dr. Lyons forecasts a future of $1 billion in sales. Alltech markets its solutions in 116 countries, through 86 of its own offices. Alltech managers are typically young, highly educated, technically skilled in animal nutrition or veterinarian science, and ambitious, but with a relatively low level of formal business education. Managers are expected to follow the example of the President by visiting farmers and feed mills directly to understand market needs, including those in non-sales or marketing positions. Examples abound of managers who were promoted after succeeding in the face of overwhelming odds. The corporate culture reflects the style of its President, valuing decisiveness, self-reliance, and technological skills. Alltech seeks employees who are articulate, hard working, possess a 'fire in the belly' and a sense of fun.

There were two unique requisites in the development of new Alltech managers. Although the company was young, and relatively small by international standards, it already had an unusual global reach. The manufacturing, research and development, and sales and marketing operations are divided nearly equally across the major regions of the world. Since managers come from, and work in, many languages and cultures, developing a strong sense of the Alltech corporate culture was a priority. Secondly, Alltech was unusual in its industry because of its balance between an emphasis on hands-on relationships with customers, a strong research focus, and a commitment to marketing and sales. Consequently, it was important that a management development plan incorporate elements from across divisional boundaries.

Options

After reviewing the options, the three most effective strategies appeared to be:

1) headhunt successful agribusiness executives from other organizations;
2) train key employees through existing university MBA and executive education programs in both a business and agribusiness focus;
3) build an internal executive education program.

In evaluating the costs and benefits of these options, the following points were considered:

Head-hunting

The obvious cost in recruiting new ag-executives is the agency fee which is often 30% of the first year's salary. A hidden cost, however, is the time it takes to acclimate a new executive. It is estimated to take two years to learn the culture of Alltech, and adapt to the Company's practices and philosophies. Executives in the agribusiness industry conservatively calculate the cost of finding new executives to be topping $250,000.

MBA Programs

There are a variety of MBA programs on the market, from the short executive education seminars to stand-alone courses. Alltech has had some experience with these options and noted the following points when considering them for a wider company application:

Employees who are looking to advance their careers often request the opportunity to do an MBA. Organizations often agree because they are afraid of losing the employee, and/ or they feel it will help prepare the employee for a move to a more senior position. Regular MBAs typically involve either a one-year full time program or a two-year part time program, while Executive MBAs are typically part-time. Part-time and Executive MBAs can be more attractive to the organization, because they allow employees to continue working while completing their studies at night and at weekends. Employees like the degree status and reputation the MBA has developed.

However, there are significant disadvantages for the organization. During the program, the additional demands on the employee can reduce their effectiveness in their current position. Anecdotal evidence suggests that this marathon of short nights, long days and busy weekends, leads to stress in both work and family life. Then, having completed the MBA, the graduate may become frustrated by a perceived lack of opportunities within the organization; if the employee feels that the employer and fellow workers are not respecting their new skills; or if the graduate feels that the organization is not receptive to adopting their suggestions for change. Considerable anecdotal evidence exists of employees leaving for other organizations within a year of completing their MBA, making it a bad investment for the organization that has invested $100,000 in the employee. Finally, even when all goes well, the relative value of the MBA for the organization may be limited, as much of the course is not relevant to the organization, or to the industry in which it competes. This is particularly true for agribusiness, which differs significantly from most industries which offer MBA programs.

Executive Education Courses

Another approach is to use a la carte courses, offered by universities, business schools and independent programs. These courses can be useful, particularly when addressing specific needs. However, they are generally piecemeal, and are frequently employee driven, rather than representing a considered plan that reflects both the employees' desires and the organizational needs. Costs of such programs typically range from $5,000 to $45,000. Only a handful of institutes offer courses with an agribusiness perspective.

Management Development Programs

Finally, a company may hire consultants to provide development programs for employees. Such programs are usually ad-hoc but may include a more structured program developed in conjunction with university-based business schools. These programs vary in purpose, from training and staff development to morale boosting. The most relevant for Alltech are those that provide an overview of business management. Typically they run for 3-10 days. These courses are most beneficial for managers with a lot of experience, either as a refresher, or to familiarize them with the basics of expertise outside their own. However, they are too short to actually serve a development function. Such programs can be expensive, with investments ranging from $1,000 to $10,000 per employee per course.

Additionally, the Company's experience with underwriting MBAs has been disappointing. While MBA graduates acknowledge value gained from the training, much of the program was not relevant to their work or the Company. Despite the extraordinary effort made by participants, work suffered during the MBA process; moreover, the cost to the families of the employees was unacceptably high. Half of the sponsored employees left the firm within two years of completing their MBAs. Frustration arose when promotions were not given or suggestions not implemented.

EMBAs obviously miss the target population within Alltech, and while Executive Education courses are also used by Alltech, they are too specific to be seen as a management development solution. The Company was intrigued by Management Development programs, often offered in association with well-respected universities, but felt that although the short time frame was attractive in work terms, it was insufficient to lead to meaningful management development. As with virtually every course and program examined, the emphasis is too often on industries that are fundamentally different to agriculture.

Developing an Internal Executive Education Program – A hybrid solution

Alltech's objective was to find a way to systematically develop the management potential of existing employees in ways that would complement the technical nature of the industry and the corporate culture. In the final analysis, building its own program by adapting the best, most relevant elements from the available options was considered more cost efficient than sponsoring MBAs and off-the-shelf programs. Structuring the program to fit the needs of the company would not only maximize the return on the investment but make it less easily transferable to other firms.

The Alltech Advanced Management Development Program (AMDP)

In 1998, Alltech Vice President, Aidan Connolly partnered with his former professor, Professor Frank Bradley, Head of the Department of Marketing at University College Dublin (UCD, Ireland) to design a program for Alltech. Connolly felt some of the classes offered by UCD on negotiations, marketing, and finance could be easily adapted to fit, while other courses such as leading strategy innovation at Alltech, managing an agri-sales team, personal organization, decision making in a global enterprise and communication skills would require new course development. The courses were designed to maximize program impact while minimizing the

time spent away from the office. The timing of the program worked around the business cycle of the Company.

Initially, the program was proposed as a single two-week module. Such was its success that subsequent modules were proposed and accepted, leading to a total course load completed in one-third to one-half the time of a classic MBA program. Although the first module reflected the bias of its creators—a sales and marketing focus, subsequent modules covered a broad range of skills managers needed to assume senior positions. Critical feedback was solicited from participants upon module conclusion in a 'town hall' format. The lessons learned from previous classes continued to shape and refine the course content.

Structure of the AMDP

Known colloquially as the 'Alltech mini-MBA', the program is broken up into four modules, with interstitial 'refreshers', and runs over four years:

Module 1: Strategic Market Management

This 10-day double-length module introduces the core topics, including business concepts (Financial analysis; Competitive marketplace); strategy (Strategic analysis; Strategies for growth), relationship management (Managing sales relationships, Customer management; Managing partners); and industry (Managing technological products; Managing the challenges of sustainability). The module concludes with a project workshop, business theory, case studies and presentations by participants. The fortnight format contributes in several ways; it establishes the 'bootcamp' atmosphere, creates a critical momentum for attendees who often have not studied for several years, and allows students to adapt to business models and frame their thinking processes.

Module 2: Brand Driven Growth

This six-day module examines the elements of developing and using the brand, from inception (Fundamentals of brand driven growth: Brand ideation workshop), to application (Tactical use of sponsorship; Sponsorship for growth). The art and skill of negotiating is also covered (Negotiation strategy and skills). The module concludes with the students preparing presentations to address specific challenges. Project work in this field has included market plans for new Alltech products and product ranges such as Alltech's Lifeforce™ for horses.

Module 3: Managing Groups and Teams

This module was developed to reflect Alltech's highly group-based management and operational style. Over a 5-day period, the students work on the nature of groups (Managing groups and teams exercise, Responding to the leadership challenge), as they relate to their own region (Managing people and change; Managing the sales team), and the firm as a whole (Managing the global enterprise). The program concludes with the students working in teams to prepare project presentations.

Module 4: Thought Leadership and Innovation in Agribusiness Firms

The final section of the Alltech mini-MBA is heavily focused on developing leadership skills and innovation (Coaching for innovation; Driving management innovation; Leading strategy innovation in Alltech; Value innovation leadership).

The modules emphasize skills development, and are supplemented with 'refreshers' between each module, in which the class meets to complete eight case studies over a two-day period. The refreshers emphasize industry knowledge and understanding, using case studies chosen to reinforce particular themes and the latest in competitor intelligence. The case studies come from the best recently published cases from the Harvard Agribusiness program, from other Universities that illustrate food, feed or agribusiness themes, and from within Alltech. A team of case writers ensure that cases written from an internal Alltech perspective are high-quality and reflect standards of those purchased from outside the organization. Over 27 unique cases have been produced during the past 10 years, with many peer-reviewed.

The first two-week module is held on the campus of the Michael Smurfit School of Business at UCD. Subsequent modules are held at Alltech's European headquarters in Dublin, Ireland and the refresher courses are held at corporate headquarters in Kentucky. Bringing the students to Alltech centers not only contributes to corporate culture development, but also strengthens the relationships between the offices. It also facilitates one of the highlights the program. Upon completion of each module is a final project, in which participants are divided into teams and asked to address a challenge the Company is currently facing. On the last day the teams present their analysis of the challenge and recommendations for action to a panel that includes senior directors of the Company. This high-profile exercise not only gives senior management the benefit of the ideas of their best and brightest up-and-coming managers, but it lets them see how the participants perform in a realistic pressure situation. The participants love the opportunity to show senior management just what they are capable of and to feel they are contributing to the strategic direction of the Company.

The Students

Mini-MBA candidates are selected from the pool of Alltech's 2,200 plus employees, and are recommended by both a line manager and a director as having shown management potential. In some cases they have been recently promoted to, or hired for, management positions. In all cases, each cohort, or 'class', is vetted by Connolly to reflect considerations such as regional balance, area of expertise, and level of experience. The idea is to achieve a level of productive diversity, so that each participant brings something to the class.

Although the first candidates had an average of 10 years' experience with the organization, and typically came from sales and marketing, more recent groups have less corporate experience. Naturally this has also influenced the program content and this has moved in recent years from a pure strategic focus to allowing more time for discussion of current processes and procedures. Another trend has been the broader range of departments represented, and this has influenced the need to deepen the element of agribusiness since these candidates are less likely to be familiar with modern farming practices.

Over the last 10 years, seven classes have graduated from the course, representing 98 senior managers, with a further 88 currently at various stages of the 4 year program. The program has been such a success that other employee programs have been developed around it. A Talent Development Program (TDP) has been put in place, which focuses on employees who are not ready for the mini-MBA.

For employees that have completed the mini-MBA an 'Alumni' program has been developed. This has the multiple benefits of continuing to develop skills, of continuing recognition of the status attained by having completed the mini-MBA, and of allowing the Company to avail of the base of expertise within the firm. Case study analysis involving competitor firms, for example, or of firms facing similar challenges can yield fruitful insights and perspectives for the Company. The program uses an on-line blog system so that participants can review and comment on the teaching material (usually case studies) before the session. The sessions are then held by teleconference, so there are no travel requirements (or costs). Because only 'Alums' can participate, they are all experienced in case study analysis, and the case studies are of firms that are relevant to their work, resulting in discussion that is lively and productive. Nearly half the Alumni participated in the initial session.

The success of the mini-MBA has exceeded all expectations, but perhaps the most unexpected benefit has been the value that employees put on participation in the program. Within the firm, selection for participation in the program is genuinely valued, and graduation with the receipt of a certificate from the Alltech AMDP is recognized as a mark of achievement.

Outcomes

Outcomes for Alltech

Although the Alltech 'mini-MBA' is not inexpensive, estimated at $2,000 per employee per five-day-module, it is clearly more cost-effective than the other options. Internationally the cost for a five-day open enrolment module ranges from $5,000 to $7,500. This allows more employees to participate. As the mini-MBA is structured solely for Alltech, and agribusiness, participants are able to use and apply everything they learn.

The course is designed to roll out over a four-year-period; building upon each Module and Refresher, participants can consolidate what they have learned by using it in the workplace

Measuring the effectiveness of development programs is generally difficult, but easier with an in-house program. Feedback is solicited after each course and changes are implemented based on this feedback. Participant progress is easy to track through annual reviews and advancement to more senior positions. Retention rates—a critical metric, are more than 93% for program graduates over the past ten years. These are exceptionally strong results in the agribusiness sector and compared with a typical exit rate (voluntary and involuntary combined) of 15% per annum. These rates are higher for a number of reasons. While in the four-year-program, participants look forward to doing the next module and the continued interaction. Most

employers request a 2-3 year "golden handcuffs[1]" phase following the completion of a sponsored EMBA as a suitable ROI[2] period for their investment of time and money. With a smaller investment, Alltech is enjoying the ROI from employees, and there stands to be even greater benefits in the long term.

Program participants know they have been selected to do something that no other firm in the industry offers. They are taught how to use their new skills to make a difference to the Company and are given the tools to do so. Turnover in the most relevant positions has dropped by more than half of what is normally expected. Moreover, the effects seem to be long-lasting, as some graduated more than seven years ago.

Comments made by the attendees include:

'I've worked for Alltech for 10 years and this is the first time I truly feel I understand the strategy and where we will be in the future'

'the best part of the course is interacting with colleagues from all over the world – we represent 16 countries in my group – and understanding that the issues faced by all of us are very much the same'

'I now understand better where Alltech is positioned in its competitive space'

'coming from the finance department, the exposure to our sales and marketing strategy, our customers and competitors, was something I had not been exposed to before'

Additional benefits for Alltech include: the relationships that are fostered between employees from far-flung offices, better communication between senior management and rising managers, and the deepening of the Alltech culture. These benefits in turn help make the Company more effective, and increase job satisfaction. Finally, the relationship between Alltech and the University has not only improved the mini-MBA, but has led to the formation of other working relationships.

Outcomes for the University

The Alltech program has also been a success from the University's point of view. The commitment of Prof. Bradley, and his successor Prof. Damien McLoughlin, has driven this success. Obviously, the Alltech program is a source of continuing revenue that allows the University to maximize the value of its existing assets (staff, program courses and infrastructure). It is a source of industry input, including voices from the field. Perhaps the most telling change has been the change in attitude over time on the part of the other instructors. Initially, there was little interest, and instructor recruitment was not easy. Now, instructors are asking to participate. They have discovered that the diversity and experience of the groups adds

[1] Golden handcuffs are a system of financial incentives designed to keep an employee from leaving the company. These can include employee stock options which will not vest for several years but are more often contractual obligations to give back lucrative bonuses or other compensation if the employee leaves for another company.
[2] Return on investment.

to their own understanding of their subject, and the groups have developed a reputation for being highly motivated, highly capable students.

Fittingly, it has also proved to be a good way for the University to develop its team of Executive Education instructors. Similar programs have since been developed by the Smurfit School of Business at UCD for a myriad of organizations including the Irish Food development (Bord Bia), Google, the Irish Electricity utility (ESB) to name but a few. These institutions are using the same basic format as the Alltech program.

Conclusions

The growth and success of the Alltech Management Development Program was nearly as seamless as it seems in this review, and itself reflects the corporate culture of the Company and the industry within which it works. With a founder who values decisiveness and innovation, this allowed the creation of a program that would suit the Company's need to develop the managerial skills of their articulate, hard working employees. It takes both 'fire in the belly' and a sense of fun to be nominated for and to successfully complete, the Alltech mini-MBA.

That culture was the agar in the Petri dish of the developing mini-MBA. The components were basic: clearly identified objectives; thoughtful analysis of the ideal ingredients, continuous feedback loops, and a highly committed internal champion.

Alltech's commitment to its customized executive education program is providing a series of positive outcomes including improving managers' understanding of the corporate vision and strategy as well as of their industry; creating a cadre of the next generation of leaders, while deepening their loyalty; developing corporate competencies; and in the process identifying new business strategies. Crucially, these results are being achieved in a very cost effective manner.

Finally, the process has opened doors for Alltech to engage other organizations in a discussion about management development. This includes the CEOs of Alltech's customers, fellow suppliers to the agriculture industry and companies from other fields in how Alltech has created a pipeline of new agribusiness management talent.

