Staff Paper

Tomato Farmer Participation in Supermarket Market Channels in Guatemala: Determinants and Technology and Income Effects

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Summary. - The paper shows that in a comparison between supermarket channels (working via dedicated wholesalers) and traditional channels, farmers selling to supermarkets tend to be in the upper-end of the "small farmer" category (whereas the traditional-channel growers are in the smaller end), have more capital (in particular, irrigation, which allows them to supply all year and attain greater productivity and consistency), and be much more specialized in commercial horticulture in general and in tomatoes in particular, as compared to the traditional farmers. While they have higher yields, they also have higher input use, including use of chemicals, and these greater input expenditures (accompanied by more credit and technical assistance from the chemical companies) means that their profit rate is roughly similar to the farmers in the traditional channel. They tell us that they prefer still the more demanding wholesale-supermarket channel because it offers a lower risk and lower transaction cost outlet for the variety of their qualities and grades, all year. In turn, the supermarkets, who do not buy direct but rather source from a few dedicated wholesalers, rely on this year-round supply, lower transaction costs, and consistency. While the share of supermarkets in the produce market in Guatemala is still minor, these results mean merely that the more capitalized-tier of small farmers enjoy some advantages with the new channel, but also some entry costs that the traditional farmers as of yet do not face. As the supermarket channel grows, it is expected that more and more farmers will need to capitalized in ways that will either make them competitive in the new market, or in the traditional markets that will doubtless evolve to maintain competitiveness themselves. Development programs over the medium-long run will need to take into account the changing nature of farm-level investments thus implied.

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Tomato Farmer Participation in Supermarket Market Channels in Guatemala: Determinants and Technology and Income Effects

1. Introduction

Driven by rising incomes and urbanization, as well as foreign investment and procurement technology change, the share of supermarkets in food retail in Latin America rose from a mere 10-20% in 1990 to 50-60% by the early 2000s, displacing small shops and open-air markets (Reardon and Berdegué, 2002). That trend started somewhat later in Central America and has gone less far, reaching 20-40% (depending on the country) of food retail by the early 2000s, and rising (Berdegué et al. 2005). Guatemala is in the middle/upper end of the income distribution in the sub-region; the share of supermarkets in its food retail was a mere 15% in 1994 and had reached 35% by 2003, with a doubling in the number of stores (Orellana, 2003).

Such change downstream in the agrifood system can be hypothesized to be changing market conditions facing farmers. Generally, compared to traditional retailers, supermarkets have different and more demanding product and transaction requirements. However, despite the increasing importance of the rise of supermarkets, there has been little empirical research on the determinants of channel choice of farmers (between supermarket and traditional market channels) and the effects of those choices on net incomes and technologies.

This paper aims at those issues, taking as a case that of tomatoes growers selling (via wholesalers) to the supermarket channel versus the traditional retailer market channel in Guatemala. This subject has not been studied in Guatemala, and has received as yet little research attention in developing regions, mainly due to the newness of the structural change in markets. Tomatoes were chosen as the focus because they are grown by small and small-medium

producers only, and are the main produce item in the supermarket sales and in consumption. The analysis is based on field interviews with supermarkets and wholesalers, and a representative survey of farmers. The fieldwork took place in June-August 2004. The analysis focuses on (1) the determinants of market channel choice, and (2) the associated changes in practices (in particular technologies) and net incomes.

2. Context

Traditional retailing of food in Guatemala, as traditionally everywhere in the world, was and is composed of small shops, wetmarkets and other public markets, and street vendors. Into this setting came supermarkets, at first only as a tiny niche for upper income groups in the capital in the 1980s and early 1990s. However, between the mid 1990s and now, supermarket sector growth "took off" under the impetus mainly of domestic capital investments, only lately in foreign joint ventures. Today there are three supermarket chains (with 137 stores) and 30 independent supermarkets. One of the chains, La Fragua (with brands such as Paiz) has about 70% of the sector, so it is quite concentrated by international standards. Supermarkets have spread from the capital city to secondary then tertiary cities and towns over the past decade, and from high to middle to lower income segments, changing and adapting store formats and product offerings as they went.

As the supermarket sector grew, it went from having a very tiny offering of fruits and vegetables, to having some tenth of its food sales in these. As the volumes grew, the leading chain (La Fragua) in particular has modernized its procurement system to reduce costs (product and coordination costs) and increase quality and consistency. The leading chain has been

gradually moving away from the traditional procurement system, practiced earlier than a half decade ago by all retailers, and today still practiced by the secondary chains and independent supermarkets as well as the traditional wholesalers, of sourcing from brokers in the traditional wholesale markets, in spot market relations.

The general story of this procurement modernization is told in Berdegué et al. (2005) and can be summarized as a general and gradual shift, in particular over the past several years, toward centralization of buying in distribution centers (away from store by store procurement), toward the use of just a few specialized/dedicated wholesalers per product rubric, a gradual shift in several categories toward direct purchase from producers, and the introduction of private standards of quality. This description of system change is the "average", the center of gravity – while the coverage and speed of this procurement change varied greatly over types of products.

The traditional marketing channel of tomatoes is still as it has been for decades (Fletcher et al., 1970): tomatoes are grown in several zones, are bought in the field from the farmers by many small brokers, to zone level larger brokers, to traditional wholesalers based in the wholesale markets buy from the field brokers, and then sell in the traditional wholesale markets to the retailers.

The lead supermarket chains also still buy from the wholesale market, as in years past, but the difference is that in the past several years they have shifted from buying from many brokers and wholesalers to entering a relatively stable relationship with just a few specialized wholesalers that are partly "dedicated" to them, buying the commercial grade quality they require, sorting and selecting and boxing and delivering to the chain's distribution center, as well as selling to other markets. The lead chain told us that they shifted from the old system of sourcing from many smaller brokers to using several dedicated wholesalers in order to: (1) assure

quality and consistency of delivery of product year round (as the dedicated wholesalers have a large network of brokers and agents spread over several agroecological zones, given that it does not pay to have greenhouse production for the local market of these commodity products); (2) have a “one-stop shop” where they can source several types of produce at once, and thus reduce the risk they will be long on tomatoes but short on carrots, say; (3) deal with few intermediaries, reducing coordination costs by dealing with five rather than fifty or a hundred brokers.

While below we explore statistically the inter-household determinants of farmers selling to the traditional versus the supermarket channel, and thus the characteristics of the farmers in the two channels, we also asked qualitative questions of a subset of farmers, of those selling to the supermarkets, why they are in that channel. For them this question was equivalent to “why do you sell to the handful of large wholesalers that sell to the supermarkets inter alia?” They noted that selling to the large wholesalers who sell both the first-grade to the supermarkets and the seconds to other markets, means that they have a “one-stop shop” for selling their produce, and reduces the risk of being left with a certain grade but no ready buyer. But why do they prefer to sell to the wholesalers rather than directly to the supermarkets, perhaps thereby getting a better price? They noted that supermarkets pay with a delay of several weeks, while the wholesalers pay “cash on the barrel”, and that the wholesalers sweeten the relationship by throwing in credit (thus resolving an idiosyncratic credit market access constraint faced by the farmers. This amounts to tied product-credit markets of the type described in the “market linkages” literature (Eswaran and Kotwal, 1985) and the recent literature on addressing of idiosyncratic market failures by private sector actors such as processing firms buying from farmers (Gow and Swinnen, 2001).

3. Model and Data

3.1. General Analytical Approach

Our general analytical approach is as follows. First, we model market-channel "adoption," drawing from the behavioral function used in technology adoption; as market-channel is essentially a (post-harvest) technology decision, this is appropriate. Feder et al. (1985) found that this decision process can be modeled as a standard static adoption decision, and it is determined by the incentives and capacities of the farmer. The general form of adoption functions is similar to that of input demand functions such as those derived from profit functions (without requiring the assumption of profit maximization, Sadoulet and de Janvry, 1995): adoption of the channel or the input is a function of relative prices of outputs and inputs, risk, and a vector of quasi-fixed capital assets, as well as various context-specific shifters.

Second, we determine the effect of the channel adoption on the choice of technology by comparing the production functions of producers who sell to the adopted channel (supermarket) versus producers who sell to the traditional channels. We use the term "effect" with caution because our data do not allow us to determine the direction of causality, as they are cross-section. Our qualitative interviews lead us to believe that the decision process is indeed two-stage, with farmers deciding market channel and then making appropriate investments, but that assumption is not critical to our empirical analysis.

3.2. Implementation Model

Market Channel Adoption Determinants

We use a probit model for the regression determining market channel choice, between the supermarket channel (the leading two chains with about 80% of the supermarket sector) versus the traditional channel. The probit model is

(1) $G(z) = \Phi(z) \equiv \int_{-\infty}^{z} \phi(v)dv$

where $\phi(v)$ represents the standard normal probability distribution $(2\pi)^{-1/2} \exp^{(-z^2/2)}$. This model measures the producers' access probability to the supermarket channel taking into consideration the producer's characteristics:

$P(y = 1/ X) = P(y / x_1, x_2, ...x_k)$

Where:

i represents the producer (i = 1, …, 164);

y represents the market channel to which the producer sells to, where y=0 for the producers who sell to the traditional channel, and y=1 for the producers who sell to the supermarket channel;

P represents the probability that a market channel will be chosen by a producer i;

X represents the vector of characteristics of the producers as well as their farms, which includes the following variables: (1) Age of the producer, (2) education of the producer; (3) number of persons in the farm household; (4) access to means of transportation; (5) participation in farmer organization(s); (6) cattle as an asset; (7) distance from the market; (8) total farm size.

Technology Effects of Market Adoption

To measure the technological differences among the producers who sell to different channels, the production functions of the two groups were estimated and compared, and those are estimated for one production year (with aggregation for the farm over seasons if the producer cropped in more than one season). We use a Cobb Douglas production function:

(2) $$Y_i = \beta_o * X_1^{\beta_1} * X_2^{\beta_2} * X_3^{\beta_3} ..... * X_k^{\beta_k}$$

Where:

Y represents the total tomato production of each producer (i = 1, …, 164);

X is the vector of the k production factors, as follows:

$X_1^{\beta_1}$ = Labor measured by wages or days worked in preparation of the tomato plots, sowing of the tomato seeds, plant transplants, weed control, fertilizer and chemical applications, and harvesting.

$X_2^{\beta_2}$ = Represents the total tomato planting area during the past agricultural year.

$X_3^{\beta_3}$ = This is the total cost of the chemical solid fertilizers applied to the tomato plants, which represent the physical amount of the fertilizers (in kg) multiplied by their cost (price per kg for that producer); value was used in order to aggregate over various types of fertilizer.

$X_4^{\beta_4}$ = Represents the total costs of chemical foliage fertilizers

$X_5^{\beta_5}$ = This is the total cost of applied herbicides

$X_6^{\beta_6}$ = This is the total cost of applied fungicides

$X_7^{\beta_7}$ = It's the total cost of applied insecticides

$X_8^{\beta_8}$ = Represents the land quality variable, which is the ratio between the irrigated area and the total area of the farm (note that this is essentially the share of tomato land under irrigation as tomatoes dominate the cropped area).

3.3. Estimation Method: Switching Regressions

As the production function is estimated separately for each of the two strata, there is endogenous stratification. A usual way to address the selectivity bias and control for the conditional probability of a farm being in a given group is to use the two stage method of Heckman (1978, 1979). The procedure consists of the estimation of the production function for each group of producers stratified by the channel they represent. Through this process, the product function estimation uses the Inverse Mills Ratio (IMR) as a regressor and it is calculated from the market adoption probit model that has been presented in the section of determinants of the channel adoption. Hence,

(3) $$\ln Y_{CHANNEL} = \ln \beta_o + \beta_1 \ln x_1 + \beta_2 \ln x_2 + ...+ \beta_k \ln x_k + \gamma_1 \lambda(x\delta_1) + \varepsilon$$

where the inverse Mills Ratio is $\lambda \equiv \frac{\phi(x\delta_1)}{\Phi(x\delta_1)}$

Moreover, since this is a stratified sample by a possible endogenous variable, it was necessary to introduce a weighting procedure (WESML) to correct for sampling bias (Wooldridge, 2002), due to Manski and Lerman (1977) and for example applied in a similar situation by Pitt and Khandker (1998). We determined the population weights by cross checking information obtained from FASAGUA (Guatemalan Agricultural Associations Federation) concerning the number of tomato producers by production area and the information about

number of producers who supply to the supermarket channel by zone was obtained from the supermarket wholesalers.

3.4. Data

The data come from a grower survey (using a structured questionnaire that covered household characteristics, farm production, characteristics, and sales, and participation in organizations, as well access to services like credit and technical assistance) undertaken in June-August 2004.

A two-stage stratified random sample was undertaken of tomato growers who participate in the supermarket channel (as well usually as the other channel) and traditional-channel-only growers. The sampling from the two populations was done in stages. (1) We identified the production areas where traditional wholesalers and the dedicated wholesalers source tomatoes by asking wholesalers in what zones tomatoes are sourced and double checking that against information from the government statistics. All commercial production areas were considered, but some were left out of the sampling due to very small numbers of producers, so we focused on the main production zones where the wholesalers source. (2) We undertook a random sample of 164 tomato growers in those areas. We weighted the sampling of areas by the number of tomato producers in the different zones, and randomly sampled in those zones. We had prior information on the set of wholesalers selling to supermarkets, and by asking to which wholesalers or local brokers the farmers sold, we could classify the farmers. From the 164 farms sampled, 112 belong to the supermarket channel and 52 to the traditional channel.

4. Patterns in Differences between Groups

First, despite an expectation that supermarket-channel farms would be bigger, a hypothesis that is heard commonly concerning whether one has to be a large farmer to access modernized segments of urban markets - in fact there were no significant differences in overall farm sizes between the groups. Of course, in that these are non-staple food farmers, and commercial rather than subsistence farmers, they are on average a bit larger than the average farm in Guatemala, as one would expect. The traditional channel farm is on average 7.8 ha, although that is two-thirds pasture land (non-arable land such as hillsides), with only 2.5 hectares of cultivable land, small indeed. The supermarket channel average farm is larger, 9.3 ha, but half is non-arable (just pastures) and only 4.6 ha of arable land. So from the perspective of cropping, these are all small farms, and not too far from the national average size farm of 4.5 hectares (INE, 2004). Household size is about the same for the two groups (5 persons) so the farms under consideration are 0.5 to 1 ha per capita, small farms.

Moreover, the rental share (rented land is arable land, farmers do not rent pastures) is notably high among the supermarket channel farmers – 40% of their arable land! – with only 20% rate for the traditional farmers. Both rates are higher than the national rate on annual and perennial farmlands (18.7%, see INE 2004), indicating that prime horticultural land is under high demand in those zones. High rental rates also appear to indicate that it is relatively expensive to buy land, and owners do not want to part with it.

Finally, the crop composition data show that the supermarket channels are far more specialized in tomato production (91% of their cropped land) than are the traditional channel farmers (only 68% of their land, still a surprisingly high share, showing the horticulture focus of these zones). Moreover, the supermarket channel producers are much more specialized in

horticultural crops in the rest of their farms (outside tomatoes), as 50% of them grow other horticultural crops compared to only 19% of traditional producers doing so. Traditional producers tend to produce more basic grains than supermarket producers, since 77% of traditional producers grow grains compared to 61% of supermarket producers. The picture that emerges is that slightly larger, but much more horticulture and commercially specialized producers are the supermarket channel producers, compared to the traditional channel farmers.

Technological and Yield differences

First, the main difference in production technology between supermarket-channel and traditional producers is that the farms of the farmer are far more irrigated: 80% have irrigation, while only 35% of the traditional channel farmers have it; half of their farmland is irrigated, while only one-seventh of that of the traditional farmers is. Some supermarket channel producers had irrigation already and some put it in after entered the channel. Our farmer survey asked about the farm's irrigated area "five years ago, and now" and about when the farmer entered the supermarket channel. We analyzed these data and found that: (1) farmers who were longstanding participants in the supermarket channel (in it in 1999 or before) had 2.6 ha on average of irrigated area, when they started, and added 2 more ha from 1999 to 2003; (2) those who joined the supermarket channel recently (1999-2003) had only 0.8. ha when they started but added 0.7 ha since, and (3) the traditional channel producers, who had only 0.5 ha of irrigated land when they stared, and added a mere 0.3 ha in the past five years. All the differences are significant at a 10% level. Thus, the supermarket channel growers both had more irrigation to start and invested far more quickly in it as compared to the traditional growers. This corroborates the statements we heard from the dedicated wholesalers that they prefer farmers who have irrigation. More irrigation has two important effects: (1) better quality and consistency of the

product, with a higher share of commercial grade product; (2) ability to multiple-crop over a year, that is, have multiple "production cycles": 74% of supermarket-channel farmers sow twice a year, while only 20% of the traditional channel do; the statistical correlation between double cropping and have irrigation is strong and significant.

Moreover, supermarket-channel farmers have 20% better yields. That, combined with twice the farm land dedicated to tomatoes, and nearly twice the cropping cycles, spells 300% more tomato volume from an average supermarket-channel farm compared to traditional-channel farmers. Volume, consistency over the year in output, quality – all spell attractive characteristics to have these farms on the preferred supplier lists of dedicated wholesalers who need to deliver to supermarket chains, all year (supermarket procurement officers complained to us about the sharply seasonal glut of tomatoes in wholesale markets and then dearth other times), good quality tomatoes, and do it competitively, hence getting as much per farmer as possible to reduce transaction costs. The mirror image of this calculation appears to be made by the farmers who sell to that channel: they want the greatest payoff at least transaction cost and risk to provide a good return on their investment in irrigation and their technology practices providing better yields.

Credit Access and Technical assistance

First, 83% of supermarket-channel, and 71% of traditional-channel farmers get input credit from the input companies; apparently the latter are not more attracted to the larger more specialized producers in the supermarket-channel. Supermarket-channel farmers obtain twice the amount of credit per farm, but that is merely consonant with the greater production volume, in fact is less than proportionate to it. Supermarkets and the dedicated-wholesalers do not provide

input credit; they obviously do not need to, given the availability of credit from input companies, so there is little to no "market failure" for them to resolve.

Second, 81% of supermarket-channel, and 62% of traditional-channel farmers get technical assistance – and nearly all of this is from input companies, at no explicit charge. The gap is explained by the great input use intensity and complexity employed by the supermarket-channel producers, hence more need for advice from the vendors. Note that input suppliers supplant public extension services – in fact there has never been in these zones consistent availability of public extension for horticulture products only the odd project here and there, and input suppliers for decades have played the role of vendor, creditor, and advisor.

Economic benefit analysis of the market adoption

It is interesting that while we found that while supermarket-channel farmers earn more gross income per hectare (24% more, which would be accounted for merely by yield differences, as the price is the same between the channels), they achieve those higher yields with greater variable input outlays (and have 36% higher costs), hence actually earn slightly less per hectare than do the traditional-channel farmers. There is no statistical difference in the net income per hectare between the channels. However, note that in section 5 we show that the marginal value product of two key chemical inputs is well below the factor price, implying allocative inefficiency (Lau and Yotopoulos 1971) – overuse, in the economic sense – of the chemicals – literally "overkill." This is a common finding by agronomists in the 1970s and 1980s in the horticulture areas of Central America, finding that growers overused chemicals relative to their agronomic payoff, or as we show here, their economic payoff. This could be due to the explanation so often given in the literature, that the input companies are advising them to buy things they do not need, and the farmers do not know the difference. Or it could be for the

explanation one finds in the agribusiness literature, that farmers overuse chemicals to reduce the downside risk. Both could be true, we did not return and explore this further, and should. It is clear, however, that these are all basically small farmers, and some of them depend for their livelihoods nearly exclusively on tomatoes, and are perhaps fearful of "getting it wrong" and so overreact (in an economic sense) to risk.

As the payoff between the two channels does not differ, why do the larger, more capitalized, more specialized, more productive farmers bother to "go the extra mile" and sell to the dedicated wholesalers that serve the supermarket channel, and not just to the traditional brokers? We asked the farmers this in a qualitative section of the questionnaire and report main results in Table 9. The general implication of the responses is that dedicated wholesalers represent a lower risk (to sell year round and to get paid) and lower transaction cost option as compared with the traditional wholesalers and rural brokers. This is not then a story about the supermarkets per se, but about the types of wholesalers that are gravitating toward being the preferred intermediaries for supermarkets, and the benefits, mainly in transaction costs and risk reduction, that these larger wholesalers confer on farmers – as well, as we noted above, on their clients the supermarkets.

5. Econometric Results

5.1. Determinants of Market Channel Choice

Regression results for channel choice are shown in Table 6.[1] Two results stand out. First, as expected from the descriptive analysis, the regression results in Table 6 showed that having irrigation is an important driver of being in the supermarket channel.

Second, surprisingly the other variable which was significant in the model was the organization level of the producer. The coefficient is negative which implies that producers who belong to a producer's association or cooperative tend not to adopt the supermarket channel. The explanation appears to reside in the tendency for smaller, less capitalized farmers to associate, and get three things from the association: (1) ability to borrow equipment (such as sprayers) owned collectively; (2) transport through the coop truck; (3) access to inputs, as some of the associations buy inputs collectively, getting better prices, and then distribute them among the members. Moreover, our interviews with the dedicated wholesalers revealed that they prefer to hand-pick good producers and bulk and select themselves, rather than rely on the (from their perspective, imperfect) services of the small farmers own groups.

5.2. Production function estimates: comparison between groups

We expected to find differences in the production functions between producers of each channel, expecting producers of the supermarket channel to use a technology more intensive in capital versus labor or land than the traditional producers, given the quality and consistency requirements of the dedicated wholesalers representing the supermarkets.

We estimated the respective production functions and show the results in Table 7, and compared them using a Chow test[2], and found evidence of structural differences. As expected, the results show the supermarket channels to be more capital-intensive.

[1] The regressors passed (at 10% level) the Hausman exogeneity test.

Using the significant coefficients and predicted values, we estimated the marginal product values (MPV) and show them in Table 8. The MVP of land under tomatoes is less than the factor price of one ha of land; we compared the MVP with the rental cost (an important comparison) and found that the MVP of land is above the rental cost, implying a land constraint for this good land.

As announced above, we found here that the MVPs of fungicides and insecticides are well above the factor prices, indicating that they are being overused in an allocative efficiency sense, for the supermarket channel, and are being underused in the traditional channel. This mirrors the results of Carter and Wiebe (1990) who found capital constraints among the smaller farmers in wheat production in Kenya employing the same methodology.

6. Conclusions

The paper showed that in comparison between supermarket channels (working via dedicated wholesalers) and traditional channels, farmers selling to supermarkets tend to be in the upper-end of the "small farmer" category (whereas the traditional-channel growers are in the smaller end), have more capital (in particular, irrigation, which allows them to supply all year and attain greater productivity and consistency), and be much more specialized in commercial horticulture in general and in tomatoes in particular, as compared to the traditional farmers. While they have higher yields, they also have higher input use, including use of chemicals, and these greater input expenditures (accompanied by more credit and technical assistance from the chemical companies) means that their profit rate is roughly similar to the farmers in the traditional channel. They tell us that they prefer still the more demanding wholesale-supermarket channel

[2] The Chow test works under the homoskedasticity assumption, therefore before computing the chow test, we performed the Bruesch Pagan and White tests for evidence of heteroskedasticity; the results showed that there was no evidence of heteroskedasticiy at a 10% significance level.

because it offers a lower risk and lower transaction cost outlet for the variety of their qualities and grades, all year. In turn, the supermarkets, who do not buy direct but rather source from a few dedicated wholesalers, rely on this year-round supply, lower transaction costs, and consistency. While the share of supermarkets in the produce market in Guatemala is still minor, these results mean merely that the more capitalized-tier of small farmers enjoy some advantages with the new channel, but also some entry costs that the traditional farmers as of yet do not face. As the supermarket channel grows, it is expected that more and more farmers will need to capitalized in ways that will either make them competitive in the new market, or in the traditional markets that will doubtless evolve to maintain competitiveness themselves. Development programs over the medium-long run will need to take into account the changing nature of farm-level investments thus implied.

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Table 1. Comparison of Land Access Characteristics between Groups of Tomato Producers (grouped by channel)

	Total N=164	Supermarket-channel growers n=112	Traditional-channel growers n=52	Sig.
Access to Land (average in Ha)				
Own property (Ha)	5.9	5.4	7.0	
Obtained for usufruct (Ha)	1.0	1.4	0.1	
Rented (Ha)	1.5	2.0	0.6	A
Sharecropped (Ha)	0.6	0.7	0.3	A
Leased (Ha)	0.1	0.1	0.1	
Half leased (Ha)	0.1	0.1	0.2	
Total (Ha)	8.8	9.3	7.8	
Land use				
Agriculture (Ha)	3.9	4.6	2.5	a
Livestock (Ha)	4.7	4.4	5.3	
Other (Ha)	0.3	0.4	0.0	
Agriculture (%)	44.2	48.9	32.1	
Livestock (%)	53.1	47.4	67.7	
Other (%)	2.8	3.8	0.2	
Property title				
Yes (%)	60.4	58.0	65.4	
No (%)	7.3	7.1	7.7	
No Response (%)	32.3	34.8	26.9	

Note a = statistically different at 10% significant level

Table 2. Comparison of Technology Indicators between groups of tomato producers (grouped by channel)

	Total	Supermarket-channel growers	Traditional-channel Growers	Sig
Irrigation technology in 2004				
Growers with irrigation (%)	65.9	80.4	34.6	a
Growers without irrigation (%)	34.1	19.6	65.4	a
Total (%)	100	100	100	
Irrigated area (avg. Ha)	3.5	4.5	1.2	a
Irrigated area (%)	39%	49%	16%	a

Note a = statistically different at 10% significant level

Table 3. Comparison of Output and Yields between Groups

	Total n=164	Supermarket n=112	Traditional N=52	Sig
Farm size (Avg. Ha)	8.8	9.3	7.8	
Tomato Area (Avg. Ha)	3.4	4.2	1.7	a
Tomato production (MT)	168.6	215.8	66.7	a
Yield/ Ha (MT)	41.4	43.7	36.6	a
Tomato cycles (Average)	1.6	1.79	1.19	a
Growers that plant once a year (%)	41.5	23.2	80.8	a
Growers that plant twice a year (%)	56.7	74.1	19.2	a
Growers that plant three times a year (%)	1.8	2.7	0	

Note, a= significant differences at 10% level.

Table 4. Comparison of Credit Access and Technical Assistance Between Groups of Tomato Producers by Channel.

	Total	Supermarket	Traditional	Sig
Credit Access (%)				
Yes (%)	79.3	83	71.2	
No (%)	20.7	17	28.8	
Total (%)	100	100	100	
Total Credit amount received by all sources	6,409	7,504	3,656	A
Access to Technical Assistance				
Yes (%)	75	81.3	61.5	A
No (%)	25	18.8	38.5	A
Total (%)	100	100	100	

Note a = statistically different at 10% significant level

Table 5. Comparison of gross margins between groups of tomato producers by channel.

	Total n=164	Supermarket channel growers n=112	Traditional Channel growers n=52	Sig
Price (50 Lbs. box, in Quetzales)				
Average Price	0.29	0.29	0.29	
Maximum average price	0.57	0.57	0.57	
Minimum average price	0.09	0.11	0.09	
Standard. Deviation	0.09	0.09	0.09	
Range	0.47	0.45	0.47	
Gross Income by 1 Mz in Quetzales	11,749	12,509	10,111	A
Total Cost (1Mz)	8,339	9,097	6,685	A
Marketing and transportation Cost	1,573	1,834	1,010	A
Total Input Cost	4,438	4,871	3,506	A
Total Labor Cost	2,175	2,220	2,056	A
Total Plowing Cost	154	173	113	A
Net Income (1Mz)	3,409	3,412	3,426	
NET INCOME (dollars per ha)	612	613	615	
Net margin (%)	29	27.3	33.9	

Note; 1 manzana (mz)=.7 ha; a = statistically different at 10% significant level

Table 6. Determinants of Tomato Grower adoption of the Supermarket Channel

Variables	Coeficient	(SE)	Sign.
Constant	-0.038	0.760	
Grower's age (years)	-0.015	0.012	
Grower's education (years)	-0.050	0.036	
Family size	-0.060	0.066	
Equipped with transportation means (Yes=1 No=0)	0.502	0.315	
Distance to Market (Kms)	0.000	0.001	
Association level (Associated=1, Not Assoc.=0)	-0.594	0.315	*
Irrigation (has irrigation=1, No=0)	1.365	0.294	**
NFRI Ratio, (Non-Farm Rural Income)	-0.802	0.985	
Livestock (Head)	-0.010	0.009	
Land (Farm size)	0.010	0.016	
Land2 (Farm size squared)	0.000	0.000	
Number of observations	164		
Pseudo R2	0.231		
Wald chi-squared (11)	41.46		

Notes: ** significant at 5%; * significant at 10%

Table 7. Cobb Douglas Production Function Estimation Results

	Supermarket-channel growers		Traditional-channel growers	
	Elasticity (Coefficient)	(SE)	Elasticity (Coefficient)	(SE)
Constant	5.2896	0.8278	4.4444	1.3613
Labor	0.1852	0.1178	-0.1399	0.2015
Tomato area	0.7689**	0.1361	0.7431**	0.2271
Fertilizers	0.0571	0.0659	0.1159	0.1731
Foliars	-0.0354	0.0504	0.0242	0.0767
Herbicides	-0.0005	0.0066	0.0030	0.0100
Fungicides	0.0412**	0.0184	0.3354**	0.1059
Insecticides	0.0478**	0.0223	-0.0584	0.1058
Land quality	-0.0032	0.0187	0.0262*	0.0156
Inverse Mills Ratio	-0.1092*	0.1498	0.0675	0.1129
R-squared	0.9207		0.9137	
Prob > F	0.0000		0.0000	

Notes: ** significant at 5%; * significant at 10%

Table 8. Marginal Value Products

	Supermarket			**Traditional**		
	MPV		**Factor Cost**	**MPV**		**Factor Cost**
Tomato Area (Ha)	$11,126	>	$554	$9,265	>	$458
Fungicides (Cost)	$0.62	<	$1	$5.92	>	$1
Insecticides	$0.47	<	$1			
Land quality (%)				$19.48		NA
	Average Productivity			**Average Productivity**		
Labor (per day/Ha)	$29.55			$25.20		
Land (per Ha)	$14,778			$11,672		
	Sample Average			**Sample Average**		
Labor (days)	500			463		
Land (Ha)	1.6			1.4		

Table 9: Qualitative Evaluations of Market Channels by the grower groups

			Supermarket channel growers' judgments of channels n=112		Traditional channel growers' judgments of channels n=52	Sig
Ability to sell all-year to this channel	Direct to supermarket		20%		23%	
	Broker at farmgate		13%	*	29%	
	Wholesaler (specific to the grower's group/stratum)	*	65%	*	42%	a
	No response		2%		6%	
Ability to sell all qualities/grades to this channel	Direct to supermarket		5%		4%	
	Broker at farmgate		7%	*	29%	
	Wholesaler (specific to grower's group)	*	83%	*	63%	a
	No response		4%		4%	
Ability to sell at low transaction cost and risk to this channel	Direct to supermarket		6%		4%	
	Broker at farmgate		31%	*	52%	
	Wholesaler (specific to grower's group)	*	57%	*	42%	a
	No response		5%		2%	
Ability to be paid quickly by this channel	Direct to supermarket		7%		4%	
	Broker at farmgate		40%	*	56%	
	Wholesaler (specific to grower's group)	*	52%	*	33%	a
	No response		1%		8%	

* = dedicated wholesaler for supermarket channel growers, and = traditional wholesalers and brokers for traditional channel growers