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SUPPLY CHAIN MODELS FOR SMALL-SCALE AGRICULTURAL BUSINESS

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ABSTRACT

Small-scale agricultural production enterprises have been under immense economic pressures for many years. It is our belief that, a convenient impact can be made on small farm business, through the development and application of models that address their basic needs and open new markets and production initiatives. In this paper, we develop models for supply chain issues facing small farmers, solve them, and suggest their uses and future examination. We evaluate key strategic decisions such as whether to farm cooperative agreements with other farmers and if so, how large to develop the cooperative and the production quantities at which farmers would like to sell directly to customers, with or without using the cooperative.

KEYWORDS: OR in agriculture, Supply chains, Cooperatives & Optimization

INTRODUCTION

Agriculture has been the backbone of the Indian economy and, it will continue to remain so for a long time. It has to support almost 17 per cent of world population from 2.3 percent of world geographical area and 4.2 percent of world's water resources. One particular area of agricultural production that is struggling is the small farm enterprise. There is an urgent need to increase productivity. The small farm enterprise has continued to decline and faces economic hardship, as industrialized agriculture grows and dictates the traditional markets. Smaller the farm, greater is the need for marketable surplus, so that small farmers can have a reasonable income. Farm business management has assumed greater importance not only in developed and commercial agriculture all round the world, but also in developing and maintaining type of agriculture. A farm manager must not only understand different methods of agricultural production, but also he must be caring with their costs and returns. He must know how to allocate scarce productive resources on the farm business, to meet his requirement and at the same time react to economic forces that arise from both within and outside the farm Agricultural production has some similarities, to "standard" production systems and many aspects that are special to farming.

SMALL AGRICULTURAL ENTERPRISES & COOPERATIVES

When considering farming as a production process one must realize, how unique this process is and how minor savings in the process can be critical. For example, consider the frighteningly small margins in farming. U. S. farmers spend a total of $185 billion annually on inputs such as chemicals, seeds, land, supplies, etc. and in return they sell $210 billion worth of outputs (Memishi 2001). Likewise, according to Lawrence and Duffy (1999), in the 1950's net farm income as a percent of gross farm income was 35 percent. Over the last ten years, a net value as a percent of gross has averaged less than 20 percent. This indicates why small farms have decreased, while industrialized farming has increased and the importance of the technology that would allow small farmers to rising their net percent of gross.

Small farmers cannot effectively participate in global markets optimized for industrialized agriculture. They cannot produce the efficiencies required to be competitive in such an environment. In order for the small farm business to be viable it must be able to respond quickly to product differentiation and to establish the product. As stated by Kinsey and Senaur (1996). A cooperative is a business firm owned by the users of the firm's services (Buccola 1994). The net profit of the cooperative is returned to the cooperative's users, on the basis of their use. The marketing cooperatives, which are the focus of this paper, assemble, process, and sell farm products.

MODEL DEVELOPMENT AND ANALYSIS

In the development of small-scale farm business, there are many decisions that must be made, such decisions include whether to farm or join a cooperative, what type of product to produce and how much, determination of when and how much to take a product to the market, etc. While the profit of cooperatives especially for small farmers can be very significant in many situations, the solution to these strategic decisions is not clear at all. In this section, we present mathematical models that address some of these issues. Specifically, we would like to develop mathematical models that help small farmers understand the following three key issues: 1) the optimal size of a cooperative level, 2) condition under which joining an existing cooperative is valuable and 3) the optimal quantity of a product to supply to a cooperative.

The agricultural cooperative under consideration can be representing as follows. Consider multiple farmers producing one specific product. Each farmer faces various local demands. Without joining a cooperative, small farmers have to sell their products individually to local consumers using farmers' markets, roadside stands, and other direct sales operations. They usually do not have accesses to wholesalers, large supermarkets, and institutional customers such as hospitals, schools, and hotels because of their small production quantities. However, a number of farmers may form a cooperative, so that they can have more stable demand with larger customers. The demand from wholesalers and institutions through a cooperative is deterministic with lower profit. That is, farmers may access larger stable markets but with a lower profit to compensate for the uncertainty of local direct markets, which pay more. We shall use the following notations:

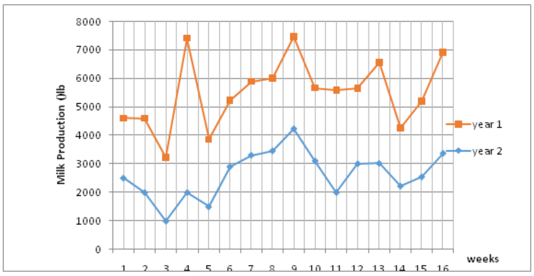


Figure 1: Weekly Milk Production Data for a Small Farm in India

Q production quantity of a farmer

N number of farmers in a cooperative

$D1$ demand from wholesalers to a cooperative

$D0$ local demand to a farmer

φ (·),_(·) pdf and cdf of the local demand

P0 unit profit in a local (direct selling) market

P1 unit profit through a cooperative, *p*1 <*p*0

A farmer's production quantity Q is assumed to be determining in our strategic analysis; however, we remove this assumption when we determine the delivery quantity to a cooperative. Note that Q is not a decision variable, which is different from the typical usage of production quantity in other supply chain related literature. The data show the farm's weekly production amount for two years. Although there are low production periods in summer and a slightly increasing trend, the overall production in each year leftover relatively constant. Even if the production quantity is not deterministic, it is reasonable to use the expected value of the production quantity for upper-level strategic decisions to avoid additional complications and then use of distribution for lower-level operational decisions to perform accurate analysis.

Optimal Co operative Size

One of the most necessary strategic decisions is whether to farm cooperative agreements with other farmers and if so, how large to make the cooperative. The analysis of the cooperatives over the decade it indicates that large cooperatives are more efficient in utilization of their assets, while small cooperatives have higher profitability (Lerman and Parliament 1989). Fischer et al. (1981) and Sexton (1986) discuss the relation for membership restrictions in a cooperative.

Without participating in a cooperative, farmer's expected income (call this *f (*0*)*) is entirely generated from local direct selling as follows.

$$F(0) = \int_0^Q p0x\emptyset(x)dx + \int_Q^\infty p0Q\emptyset(x)dx$$

$$= po[\int_0^\infty x\emptyset(x)dx + \int_Q^\infty (Q-x)\emptyset(x)dx]$$

$$= po[E[D_0] - \int_Q^\infty (x-Q)\emptyset(x)dx]$$

Suppose that there are n same farmers participating in a cooperative, and that they contribute products fairly to the cooperative's contract. Assuming that, the total production quantity nQ is larger than $D1$, a farmer's expected income is given by

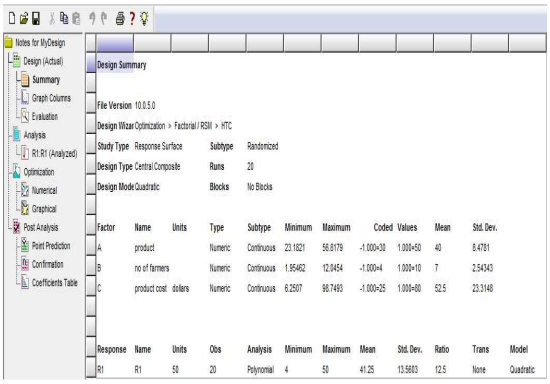
$$F(0) = p1\frac{D1}{n} + \int_0^{Q-D1} p0x\emptyset(x)dx + \int_{Q-D1/n}^0 \mathbf{p0}(\boldsymbol{Q}\frac{D1}{n})\,\emptyset(x)dx$$

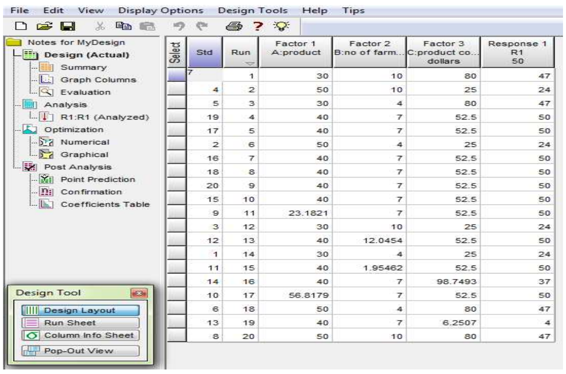
$$= p1\frac{D1}{n} + p0[(Q-\frac{D1}{n})\emptyset\,(Q-\frac{D1}{n})\emptyset - \int_0^{Q-D1}\emptyset(x)dx$$

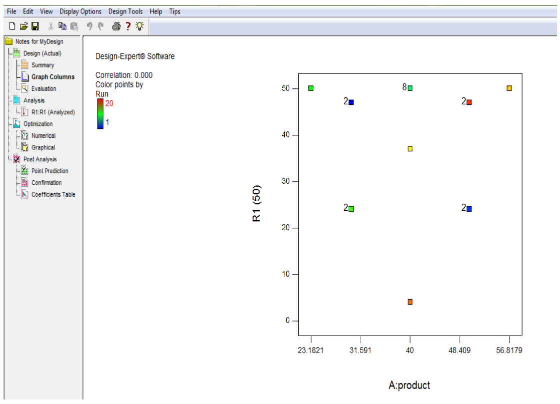
$$+ (Q-\frac{D1}{n})\,(1-\emptyset\,(Q-\frac{D1}{n}))]$$

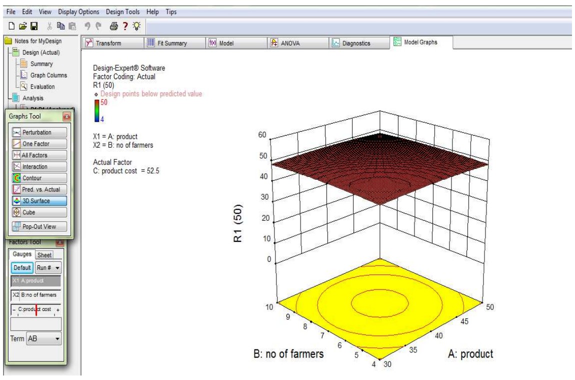
$$= poQ-(po-p1)\frac{D1}{n} - p0\int_0^{Q-D1/n}\emptyset(x)dx$$

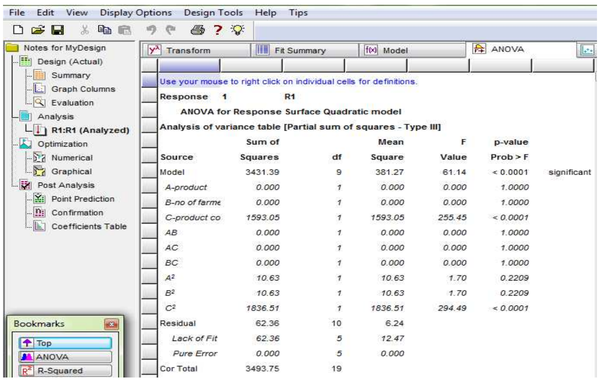
RESULT AND DISCUSSIONS











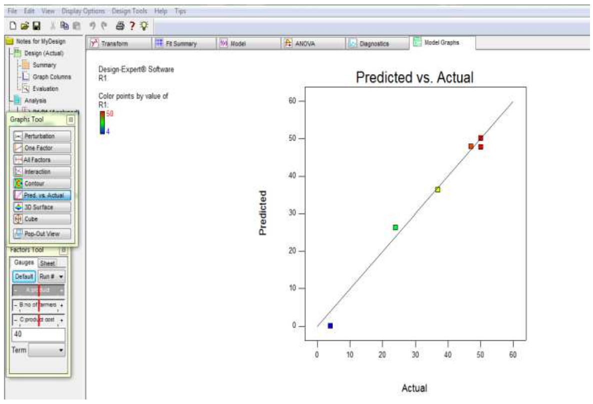
Use your mouse to right click on individual cells for definitions.

Response 1 R1

ANOVA for Response Surface Quadratic model

Analysis of variance table [Partial sum of squares - Type III]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	3431.39	9	381.27	61.14	< 0.0001	significant
A-product	0.000	1	0.000	0.000	1.0000	
B-no of farme	0.000	1	0.000	0.000	1.0000	
C-product co	1593.05	1	1593.05	255.45	< 0.0001	
AB	0.000	1	0.000	0.000	1.0000	
AC	0.000	1	0.000	0.000	1.0000	
BC	0.000	1	0.000	0.000	1.0000	
A^2	10.63	1	10.63	1.70	0.2209	
B^2	10.63	1	10.63	1.70	0.2209	
C^2	1836.51	1	1836.51	294.49	< 0.0001	
Residual	62.36	10	6.24			
Lack of Fit	62.36	5	12.47			
Pure Error	0.000	5	0.000			
Cor Total	3493.75	19				



CONCLUSIONS

In this paper we have revised operational research model and It is an attempt to gain a better understanding of the OR method used in the revised paper independent and oriented toward problem fixed rather than theory developing. As much there are some reviews done by previous research regarding agriculture. We have stated the fast growth and technification of the sector in the previous years, to satisfy the increasing demand, regulation completive present in the agriculture sector.

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