CAJ 08/99

HOW TO SUPPORT SMALL-SCALE MILK PRODUCERS BEST?

An application of a household optimization model for the Encañada watershed

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October 1999

Cajamarca is the most important milkshed within Peru located in the higher Andes. Most milk produced by small-scale farmers, situated in three main ecological zones: Valley, Slope (lower hills), and Jalca (upper hills). Each of these zones reflects specific environmental and production conditions that vary with altitude, ranging from 2'800 to 3'700 m. (Table 1.). This study aims to prioritize further extension and research activities for raise particularly small-scale farmers' profits. The analysis is based on census data and farm surveys from the Encañada watershed, and the application of a household optimization model.

Table 1. Characteristics of the three common agro-ecological zones in northern Peru

Criteria	Valley	Slope	Jalca
Altitude	2500 – 3200 m	3200 – 3500 m	> 3500 m
Frost occurrence	strong	weak	strong
Average temperatures	high	medium	low
Access to irrigation	almost 100 %	almost none	partial
General soil quality	good	bad	good
Main crops	permanent pastures	potatoes, cereals	fodder crops, potatoes
Number of livestock	high	low	medium
Purpose of livestock	milk production	animal traction	milk and traction
Number of sheep	low	high	medium

The economic situation of farmers in the Encañada watershed is strongly determined by the differences in climate, topography, and access to irrigation in relation to the three ecological zone, creating a different set of feasible production activities and constraints for each zone. Since most farms in the study area are small—about 70 percent less than 3 hectares—incomes are very low, and farmers have difficulties saving money for investments. Production for home consumption is important to secure the family's base nutrition. However, the selling surplus agricultural production is equally important to generated cash for acquiring products that cannot be produced by the farmers themselves. These include food (rice, sugar, etc.), intermediate production inputs (fertilizer, pesticides, etc.), and other commodities (kerosene, batteries, etc.), as well as services (public transportation, school and medical services, etc.).

The relative importance of livestock and crop production varies among the three ecological zones. In the Valley, milk production dominates, since access to irrigation allows for cultivation of permanent pastures, primarily ryegrass-clover mixtures. With no access to irrigation—which is generally the case in the Slope zone and sometimes in the Jalca—agricultural crops dominate the production system, cultivated mainly during the rainy season (December until May). The pronounced seasonality of production has strong implications for these relatively poor farmers. They face a strong variation in liquidity as they require considerable amount of cash to purchase seed, fertilizer, and pesticide in the beginning of the rainy season while income is delayed until harvest time. Hence, these farmers tend to be very dependent on (usually expensive) seasonal credits in order to handle the investments at the beginning of the planting season. Continuous climatic and price risks explain why farmers in the study area prefer to hold livestock if the natural conditions allow it—for animal traction as well as for meat and milk production—providing a steadier and more secure income than agricultural crops.

Model results

The base runs—reflecting optimal production patterns according to average production conditions (yields, prices, labor costs, water availability, etc.)—show strong differences in expected profit for each zone (Table 2). This is explained by the varying feasibility to cultivate permanent pastures due to differences in access to irrigation, since milk production is more profitable than crop cultivation.

Table 2. Effect of different scenarios on expected profit for the three ecological zones

Base run		**Valley**	**Slope**	**Jalca**
0	Expected profit per hectare under average conditions	**500 $**	**125 $**	**250 $**
Scenarios		(change of profit)		
A	No animals	**-30%**	-9%	**-35%**
B	No fodder storage (hay and silage)	**-23%**	-6%	-8%
C	Calving in all seasons	-10%	-15%	-3%
D	Max. 2 kg of feed concentrate (cow / day)	-1%	no sol.	0%
B,C	No fodder storage, calving in all seasons	**-32%**	**-23%**	-14%
1	Increased protein in raygrass-clover (9 to 11%)	**34%**	0%	14%
2	Increase of the raygrass-clover yield by 10%	4%	0%	3%
3	Increase of oats for forage by 60%	13%	10%	10%
4	Higher yielding genotype (4000 liters per campaign)	12%	no sol.	15%
5	Yield and price increase in agricultural crops (by 10 %)	0%	**62%**	4%
1,2,3	Better fodder management	**73%**	10%	**35%**
1,2,3,4	Better fodder management with better genotype	**90%**	9%	**55%**

Obviously, Valley and Jalca farmers would be affected much more than Slope farmers would if constrained to have no animals. The lack of fodder conservation would harm the Valley farmer most, due to the lack of fodder in the dry season. The Slope and the Jalca farmers would be affected less, since crop residues provide an important share of the feed resources during this period. Indeed, the model shows that a lack of fodder storage (hay and silage) has an even stronger effect when combined with poor herd management (e.g., when calving occurs in all seasons and use of feed concentrate is limited to lactating cows). In such a setting, the model manifests a strong interaction between these components, as the total profit loss is higher than the sum of the individual effects.

This interaction is also apparent in the reverse scenario, when better fodder and herd management practices are combined. When cows are put on pasture earlier, profit increases considerably in the Valley, as the protein content of the ryegrass-clover mixture is higher in younger plants. In the Slope zone, better fodder management improves profits only little because of the minor importance of livestock. When the daily intake of feed concentrates is limited to 2 kg per cow or when a genetically improved dairy cattle is presumed, the model cannot find a solution anymore for Slope zone (i.e., the Slope farmer is not able to feed his dairy cows under these circumstances).

These results show two things: (1) access to irrigation for growing permanent pastures is essential to promote milk production, and (2) genetic improvement of dairy cattle makes only sense when good fodder management is put in practice. Correspondingly, if natural conditions are not favorable for milk production, interventions on the crop side are inevitable. A price or yield increase of 10 percent for all agricultural crops enhances profit by more than 60 percent in the Slope. In this case, the model indicates that the farmer should expand potato production, as that becomes more profitable than other agricultural crops.

NEED FOR ACTION

Because of the varying relative importance of milk versus crop production, model results suggest different interventions for each ecological zone (Table 3). In the pasture-based production system of the Valley, interventions have priority that lead to better fodder and herd management. Special attention must also be given to fodder storage (hay and silage production). In the Jalca, good management of annual fodder crops (oats mixed with field beans) is key, since these crops occupy a high share of the land that has no access to irrigation.

Table 3. Strategies for extension in relation to the three ecological zones

	Strategies for extension	Valley	Slope	Jalca
I	To improve management of permanent pastures	++		+
II	To improve management of annual fodder crops	+	+	++
III	To improve herd management	++		++
IV	To implement fodder conservation practices	++	+	+
V	To promote off-farm work	++	++	++
VI	To improve commercialization of crops (storage, marketing)		++	
VII	To establishment sprinkler irrigation on the Slope		++	

In the Slope zone, extension interventions are required that focus on crop marketing—assuming that interventions on the crop side would lead to lower prices at the local level and thus lower profits. Where there exists access to irrigation water in this zone, the promotion of sprinkler irrigation could be of interest to boost the cultivation of permanent pastures on the slopes, leading to positive impacts for farmers (income) and the public (erosion protection). Further research is needed to study the feasibility of such investments, taking into consideration that local credit institutions provide only loans with high interest rates (around 2 percent per month).

Nonetheless, since most farms are very small—and land is the most limiting production factor on profit—non-agricultural extension interventions and policies that promote off-farm income are crucial. Regular off-farm employment not only can generate higher total income but also can provide continuous income at low risk. Thus, farmers are put in a better position to invest in milk production. Off-farm work opportunities for men especially would also enhance the shift from crop towards milk production, since the activities involved in milk production are less time consuming than those in crop production. Moreover, many times women execute them all.